CEREAL GRAIN:
PRODUCTIONS AND IMPROVEMENT

EDITOR: Assoc. Prof. Dr. Fatih ÇIĞ

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EDITOR:

Assoc. Prof. Dr. Fatih ÇIĞ

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Assoc. Prof. Dr. Abdullah EREN
Assoc. Prof. Dr. Aydın ALP
Assoc. Prof. Dr. Cumali ÖZASLAN
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Agricultural Engineer Halil KAPAR
Agricultural Engineer Mehmet PAMUKÇU

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Development and Social
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(The Licence Number of Publicator: 2014/31220)
TURKEY TR: +90 342 606 06 75
USA: +1 631 685 0 853
E mail: iksadyayinevi@gmail.com
www.iksadyayinevi.com

ISBN: 978-625-7687-40-9
Cover Design: İbrahim KAYA
December / 2020
Ankara / Turkey
Size = 16 x 24 cm

CONTENTS

The increase in population there is a great necessity to increase crop productivity of staple crops but the productivity and qualıty is greatly affected by various environmental stress factors. Therefore, there is a great necessity of inter-disciplinary study to address this issue.

Cereal grains are one of the main sources of human caloric intake as human food. This book focuses and reviews on the main types of cereals, their role in food security, and highlights of new developments and techniques of breeding programme that may imrove the production in the future. changing global climate is affecting the crop productivity and quality. So, understanding into the physiology of grain development can help to improve the grain production and quality level under the influence of various environment .

Our aims of present book is to produce a new approaches of agriculture management practices to improve yield and grain quality of cereal crops . accordıngly, developing crop cultivars and using the best management practices could assist to enhance the performance crop and adaptability under climate change. So, i would like to express my special thanks to our valuable authors who shared their research with us in the creation of our book.

Sincerely Yours

Fatih ÇIĞ

CHAPTER 1

ASSIGNMENT OF POPCORN (*Zea mays* L. *everta*) BREEDING LINES TO HETEROTIC GROUPS

Assoc. Prof. Dr. Şekip ERDAL*

Agricultural Engineer Mehmet PAMUKÇU*

M Sc Ahmet ÖZTÜRK*

Dr. Erkan ÖZATA**

Agricultural Engineer Halil KAPAR**

Assoc. Prof. Dr. Yalçın COŞKUNER***

Prof. Dr. Burhan KARA****

*Bati Akdeniz Agricultural Research Institute, Department of Field Crops, Antalya, Turkey. sekip.erdal@tarimorman.gov.tr, mehmet.pamukcu@tarimorman.gov.tr, ozturk.ahmet@gov.tr

**Blacksea Agricultural Research Institute, Department of Field Crops, Samsun, Turkey. erkan.ozata@tarimorman.gov.tr, halil.kapar@tarimorman.gov.tr

***Karamanoğlu Mehmetbey University, Faculty of Engineering, Department of Food Engineering, Karaman, Turkey. yalcincoskuner@kmu.edu.tr

****Isparta University of Applied Sciences, Faculty of Agriculture, Department of Field Crops, Isparta, Turkey. burhankara@isparta.edu.tr

INTRODUCTION

The most important step in maize breeding is developing inbred lines that to be used in hybrid combinations. Both the doubled haploid technique and the classical method of selfing yield a large number of lines from populations in maize. Especially in the classical pedigree method, numerous segregating lines are selfed for obtaining new generations. During these stages an early selection is necessary to reduce number of inbred lines and thus decrease labor and time.

In hybrid maize breeding, the development of lines with good agronomic characteristics is as important as how these lines will perform in hybrid combinations.

A test comparing inbred line performance with a known tester line is called a topcross (testcross) and evaluates the combining ability of a potential line using common tester lines. (Pehlman & Slepper, 1995).
Combining abilities of the lines give clues about the potential line performance in a hybrid. General combining ability (GCA) is a measure of the average or overall performance of a line in a cross set. Hallauer & Miranda (1987) defined GCA as the difference of a F_1 hybrid performance from the average performance of hybrids. The lines that have good combining abilities are selected from top crossing method and subjected for further investigation.

GCA generally reflects additive effects (Sprague & Tatum, 1942). Additive effects are highly heritable and less effected by the environment (Fasahat et al. 2016). Therefore, it is very important for breeders to select germplasm with higher GCA effects.

Determining heterotic groups of the lines is necessary to achive high heterosis in hybrids. Utilization of heterotic patterns (Iowa Stiff Stalk Synthetic x Lancester Sure Crop, etc) in maize led to higher grain yield and other agronomic traits (Hallauer et al. 2010). GCA effect of a line not only gives information about how useful a line under investigation but also can estimate the heterotic group of the line. Heterotic groups and testers which represent each group are used extensively in grain tropical and tempereate maize (Hallauer et al. 2010). However, little known about common testers and heterotic groups in sweet corn and popcorn maize types when compared to common grain type maize. With the advance of molecular markers some heterotic groups identified in popcorn in different countries. Yellow Pearl Popcorn, North American Pointed Rice Popcorns and North American Early Popcorns heterotic groups were proposed by Santa cruz-Varela et al. (2004) in the US. Also Vitorazzi et al. (2018) reported the genetic variability in popcorn and proposed new heterotic groups for Brasilian popcorn breeding.

Topcross GCA values can be used to determine heterotic groups if known successful testers are available. In the absence of common testers, lines that have high combining ability and also sufficient seed may be used as testers to identify heterotic groups. To date we could not find any study in Turkish popcorn germplasm related to heterotic groups.

The objectives of this study were to identify GCA effects of the Turkish popcorn inbred lines and assigning popcorn inbred lines to heterotic groups based on yield and popping volume traits.

1. MATERIAL AND METHODS

1.1. Germplasm

A Popcorn breeding programme was initiated with one hundred three initial source populations in Turkey. Fifty six of these popcorn source germplasm developed by Bati Akdeniz Agricultural Research Institute and Maize Research Institute of Turkey. Five populations from gene banks around the World and forty two populations were provided from Turkey Eagean Agricultural Research Gene Bank. Ant-89989 and 85 Ant 2503 inbred lines were used as tester lines in this study. These testers have different genetic backgrounds and have been developed within the framework of the Mediterranean Region Popcorn breeding studies. Ant-89989 line was selected from P 206 public popcorn accession. Another tester 85 Ant 2503 line was developed from a population developped ear to row pedigree breeding.

1.2. Producing Top Crosses

Pedigree ear to row breeding procedures were used for inbred line development. Both greenhouse (winter season) and field (summer season) were used for selfing and selections. Studies were started in 2014. Two generations per each year was successfully achived. When sufficient amonut seed did not obtained for a segregated line, stock seed of the line was resown. The selfing blocks were planted in 5 rows with a row spacing of 20 cm and 70 cm between rows. The selfing was performed in all possible plants for each genotype. After harvesting, the ears selected and were transferred to the next period.

After final evaluations ninety eight S_3 popcorn inbred lines were selected and transfered for top crossing. Topcrosses were produced in 2016 summer season in Antalya province in Turkey. The lines were planted as female parents in two different isolated fields (no adjacent or at least 500 m distant maize production) and testers (male) were immediately sown in the adjacent rows. Lines and testers were planted in a four and two rows of plots, respectively. Tassel of the female popcorn lines were detasseled by hand just before pollen shading during flowering time to assure pollination by the common testers. During harvest all rows of the crossed lines wer harvested, bulked and packed for topcross experiments.

1.3. Topcross experiments

Top cross experiments were carried out at four different locations (Antalya BATEM, Isparta Süleyman Demirel University, Izmir Poltar agricultural experimental station and KTAE Samsun). Top crosses that have sufficient seed which were 98 hybrids and plus 2 commercial checks were tested in a partially balanced lattice experimental design using three replications. Since two testers were used, each experiments were sown side by side at the same locations. Totally 200 hybrids were tested in 2017. Plots were consisted of 2 rows, 5 meters long and the distance of on row and inter rows were 18 cm and 70 cm, respectively.

The plot weight obtained after harvesting and each plot weight was converted into plot yield (PY) with the help of the formula below.

GY= plot weight (kg) x [(100- grain moisture content)/85) x (grain/ear ratio)/100]

In order to determine popping volume (cm^3 g^{-1}) 50 g popcorn grain samples which contanining 11.8-12.5% moisture content as suggested by Ziegler et al. (1984), Allred-Coyle et al. (2000), Pajic et al. (2006) was used. A of each plot was popped. Samples popped out via a hot air popcorn maker machine (1100 W Kiwi KPM-7408) and popcorn measured in a 2000 ml glass cylinder (Tekkanat and Soylu 2005).

1.4. Statistical Analysis

Analysis of variance (ANOVA) was performed on data and Least Significiant Differences (LSD) was used to compare hybrid means. General combining abilities of the inbred lines were determined according to the method of Hallauer & Miranda (1987). Combining ability analysis were done with linear comparison by using a PROC MIXED model (Erdal et al., 2010).

2. RESULTS AND DISCUSSION

Grain yield (kg ha^{-1}) performances of the best fifteen top crosses generated from Ant-89989 (Top cross-1) and 85 Ant 2503 (Top cross-2) testers and statistics related to the experiments are presented in Table 1. Significant interaction among hybrids and locations ($p < 0.01$) suggested hybrid ranks in the locations were not similiar.

Table 1. Grain Yield (kg ha^{-1}) Performances Of The Best Fifteen Top Crosses Generated From Ant-89989 (Top cross-1) And 85 Ant 2503 (Top cross-2) Testers

Top cross-1									
No	H	Antalya	H	Isparta	H	Izmir	H	Samsun	Mean
1	68	6649	26	7054	37	7970	93	7537	7302
2	97	6615	71	6339	1	7845	33	7173	6993
3	93	5694	96	5923	30	7714	42	7095	6606
4	35	5691	73	5833	2	7526	76	7037	6522
5	90	5508	50	5812	7	7429	3	7023	6443
6	1	5481	1	5798	SH9201	7086	68	7018	6346
7	70	5457	33	5791	34	7037	39	7017	6326
8	79	5430	13	5780	68	6984	50	6826	6255
9	72	5257	32	5762	86	6984	25	6634	6159
10	13	5208	20	5692	6	6964	1	6591	6114
11	2	5175	22	5656	46	6878	73	6561	6067
12	76	5124	42	5621	35	6663	19	6540	5987
13	84	5074	24	5601	23	6611	45	6491	5944
14	88	5038	5	5559	38	6565	82	6474	5909
15	67	4960	30	5552	14	6544	47	6431	5872
Mean		5491		5851		7120		6830	6323
Experiment mean		4194		5081		5444		5736	5114
Check mean		3258		4704		5992		5499	4863
CV (%)		14.15		15.86		16.6		15.00	
LSD		999.3**		1360.3^{ns}		1524.6**		1456.6^{ns}	
Hybrid x Location					**				
Top cross-2									
No	H	Antalya	H	Isparta	H	Izmir	H	Samsun	Mean
1	13	6816	93	7747	97	8349	2	7481	7598
2	3	6348	3	7544	79	6108	60	7449	6862
3	95	6348	96	7441	1	6099	91	7158	6761
4	2	6284	8	7374	68	6080	95	7066	6701
5	38	6130	58	7062	8	5927	30	6977	6524
6	15	610.4	65	6925	19	5888	89	6975	6473
7	45	5867	57	6888	55	5862	61	6817	6358
8	24	5861	2	6764	44	5818	94	6739	6295
9	55	5839	41	6530	30	5806	87	6655	6208
10	5	5820	45	6525	18	5732	90	6604	6170
11	85	5810	80	6422	2	5700	7	6602	6133
12	67	5754	29	6361	13	5612	77	6594	6080
13	34	5676	83	6341	93	5605	69	6584	6052
14	23	5589	90	6299	43	5515	73	6562	5991
15	42	5547	20	6274	45	5483	21	6423	5932
Mean		5986		6833		5972		6846	6409
Experiment mean		4792		5253		4463		5609	5029
Check mean		4936		5042		4578		4310	4716
CV (%)		19.3		19.4		16.45		17.5	
LSD		1884.3^{ns}		1717**		1239.1**		1652.6**	
Hybrid x Location					**				

H: hybrid, ** : $p<0.01$, *:$p<0.05$, ^{ns} not significant

While the difference between top cross hybrids was found to be significant in Antalya and Izmir locations, this difference was insignificant in Isparta and Samsun locations in Top cross-1 experiments. Commercial check means were lower than experiments mean except Izmir location. Grain Yield (kg ha^{-1}) performances of the best fifteen top crosses (Table 1) from tester Ant-89989 (Top cross-1) showed that new breeding lines have satisfacted yield potential. Especially, hybrid 1 showed very good performance in all four environemnts. This results indicates that the line 1 combined well with the tester.

Top cross-2 grain yield results are presented in Table 1. According to the results, check means were lowe than experiment means in Antalya, Isparta and Samsun locations. The results showed that breeding line 2 combined well with the tester-2 in all sites.

The experiment average of all locations was determined as 5072 kg ha^{-1}. Tekkanat & Soylu (2005) found the average grain yield as 6391 kg ha^{-1} in Konya (mid-Anatolia region) province, while Erdal et al. (2012) reported 4600 kg ha^{-1} obtained from four different locations in Turkey. On the other hand, Idikut et al. (2015) found the yield of local genotypes between 3695 kg ha^{-1} and 4985 kg ha^{-1} in Kahramanmaras (southern Anatolia). Yield differences could be attributed to the genotypes that tested and different agro-ecological conditions of the locations.

Popping volume (cm^3 g^{-1}) performances of the best fifteen breeding lines and experiments statistical analysis results are given in table 2. The results showed that there is a genotype by environment interaction in both experiments (Top cross-1 and Top cross-2). According to the

Top cross-1 experiment results, commercial checks mean in all four experiment was better than the experiment mean. However, the mean of best fifteen hybrids were greater than the checks mean in all sites. Although there were not hybrids that are successful in all four environments in Top cross-1 experiment, 64 and 17 numbered hybrids showed good performance in at least three sites. Popping volume results obtained from Top cross-2 experiment are summarized in Table 2. According to the results the best fifteen top crosses showed very good performance when compared to the commercial checks. Some topcrosses such as 25, 63 and 80 were successful in three locations.

One of the most important selection criteria in the popcorn breeding is the popping volume. It is the ultimate goal for many popcorn breeders to develop high grain yielding popcorn hybrids that also have high popping volume potential (Ziegler, 1987; Pajic & Babic, 1991; Merlo et al., 1998; Broccoli & Burak 2000). The different study results obtained by Ertaş et al. (2008) 19.79-22.92 cm^3 g^{-1}; Ozkaynak & Samancı (2003) 19.67-25.33 cm^3 g^{-1}; Tekkanat & Soylu (2005) 18.50-35.25 cm^3 g^{-1}; Koç et al. (2005) 21.0-27.5 cm^3 g^{-1}; Özkan (2007) 28.1-28.7 cm^3 $g^{-1;}$ Gözübenli et al. (2000) 32.41 cm^3 g^{-1} and Soylu & Tekkanat (2007) 18.50- 35.25 cm^3 g^{-1} supported our research results.

General combining ability (GCA) effects of the inbred lines for grain yield obtained from two testers are shown in Figure 1. Some lines (1,2, 68 and 97) combined well with both testers. There were many lines that gave negative GCA effects value. Also, it was determined that there were some lines found to be well combined with only one tester.

Table 2. Popping Volume (cm^3 g^{-1}) Values of The Best Fifteen Top Crosses Generated from Ant-89989 (Top cross-1) And 85 Ant 2503 (Top cross-2) Testers

Top cross-1									
No	H	Antalya	H	Isparta	H	Izmir	H	Samsun	Mean
1	98	26.7	97	38.3	64	37.6	6	37.5	35.0
2	82	26.3	94	37.6	5	35.4	11	37.5	34.2
3	86	26.3	20	37.5	SH 9201	34.4	64	37.4	33.9
4	85	26.2	79	37.2	9	34.3	17	36.8	33.6
5	15	26.0	42	36.7	4	34.2	5	36.7	33.4
6	<u>64</u>	26.0	18	36.6	16	34.0	4	36.5	33.3
7	97	26.0	95	36.3	17	33.4	43	35.7	32.9
8	41	25.8	37	36.3	83	33.2	83	35.5	32.7
9	81	25.8	23	36.3	6	32.6	91	35.3	32.5
10	14	25.5	36	36.2	91	32.5	16	35.2	32.4
11	16	25.5	<u>17</u>	36.0	71	32.4	SH 9201	34.9	32.2
12	19	25.5	22	35.9	11	32.2	10	34.5	32.0
13	95	25.5	39	35.9	52	32.1	70	33.9	31.9
14	21	25.4	3	35.7	43	31.8	9	33.8	31.7
15	34	25.4	19	35.5	76	31.7	71	33.5	31.5
Mean		25.9		36.5		33.5		35.6	32.9
Experiment mean		25		31.1		27.6		29	28.2
Check mean		25.3		31.05		32.8		34	30.8
CV (%)		1.2		1.12		2.3		2.8	
LSD		0.54 **		0.59**		1.1**		0.57**	
Hybrid x Location					**				
Top cross-2									
No	H	Antalya	H	Isparta	H	Izmir	H	Samsun	Mean
1	79	28.3	55	37.0	9	37.4	<u>80</u>	34.7	34.4
2	<u>25</u>	28.3	41	36.2	sh 9201	37.0	63	34.5	34.0
3	<u>80</u>	28.3	<u>63</u>	35.5	58	36.2	66	33.8	33.5
4	77	28.3	89	35.4	<u>80</u>	35.8	<u>25</u>	33.5	33.3
5	73	28.3	43	35.2	52	34.3	58	33.4	32.8
6	13	28.2	94	35.1	82	34.3	64	33.4	32.8
7	5	28.0	51	34.8	64	34.1	54	33.4	32.6
8	12	28.0	53	34.7	29	33.8	62	33.4	32.5
9	3	28.0	<u>25</u>	34.6	61	33.8	sh 9201	33.3	32.4
10	7	27.8	20	34.6	66	33.7	71	33.2	32.3
11	6	27.7	36	34.3	81	33.4	92	32.9	32.1
12	76	27.3	antcin 98	34.3	54	33.3	29	32.6	31.9
13	81	27.3	31	34.3	16	33.3	97	32.1	31.8
14	72	27.3	35	34.3	63	33.2	23	32.1	31.7
15	34	26.5	23	34.3	71	33.2	9	31.6	31.4
Mean		27.8		35.0		34.5		33.2	32.6
Experiment mean		25.3		30		27.6		28.8	27.9
Check mean		24.8		31.65		32.5		32.3	30.3
CV (%)		1.3		1.5		7.4		1.7	
LSD		0.59**		0.79**		3.46**		0.87**	
Hybrid x Location					**				

H: hybrid, ** : $p<0.01$, *:$p<0.05$, ^{ns} not significant

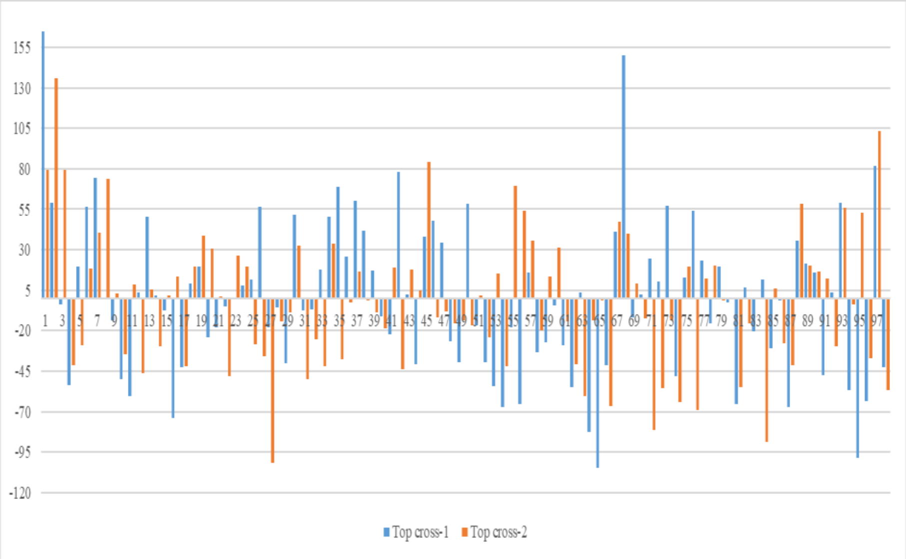

Figure 1. General Combining Ability Effects For Grain Yield

As it can be understood from Table 3, the lines giving high GCA effects with A group, B group and both groups were determined. It can be inferred from the GCA results that the genetic background of the lines that combined well with the both testers might be different from the used testers.

Table 3. Selected Breeding Lines Based on Grain Yield Combining Abilities and Their Heterotic Groups

Group A (Ant-89989)	Group B (85 Ant 2503)	A+B
3*	6*	1**
8**	7**	2**
45**	26*	97**
55*	35*	
	37*	
	42**	
	50*	
	68**	
	73*	
	76*	
	93*	

*: p<0.01, **:p<0.05

General combining ability (GCA) effects of the inbred lines for popping volume obtained from two testers are shown in Figure 2. Lines that had positive and significant (p <0.01 or p <0.05) GCA effects were selected and listed in Table 4.

It was determined that three lines had good GCA effects in terms of both grain yield and popping volume. Among these lines, line 97 combined well with the two testers, while line 7 with group B and line 8 with the group A. Therefore, giving high priority with these three lines may be a viable opportunity to develop high grain yield and high pooping volume hybrids.

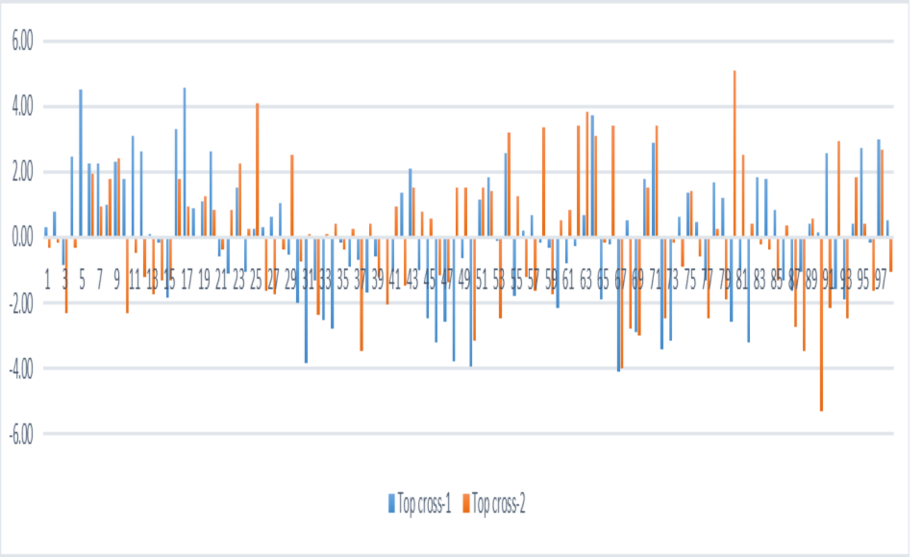

Figure 2. General Combining Ability Values for Popping Volume

Table 4. Selected Breeding Lines Based On Popping Volume Combining Abilities and Their Heterotic Groups

Group A (Ant-89989)	Group B (85 Ant 2503)	A+B
80**	17**	71**
25**	5**	54**
63**	64**	64**
62**	11**	97**
66**	97**	9*
58**	95**	6*
54**	12**	16*
64**	20**	
92**	54**	
97**	91**	
81**	4**	
29**	7**	
9**	43**	
23**	52*	
94*	83*	
8*	70*	
	10*	
	84*	
	70*	

*: p<0.01, **:p<0.05

In these special chapter a very important part of a popcorn maize breeding was discussed, the results were shared and information on how selections done were given.

ACKNOWLEDGEMENT

This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK) (Project No: 214O003-4).

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CHAPTER 2

ALLOMETRIC EFFECT OF K_2O ON MORPHO-PHYSIOLOGICAL STAGES OF MAIZE CROP

Assist. Prof. Dr. Haseeb UR REHMAN*

Dr. Muhammad IKRAM*

*Department of Agronomy Faculty of Agricultural Sciences and Technology Bahauddin Zakariya University, Multan Pakistan. r4rana88@gmail.com; mikram@szu.edu.cn.

INTRODUCTION

Maize is an important cereal crop of Pakistan. It is a C_4 plant that requires warm conditions for growing (Alias et al., 2009). It is photosynthetic explorative, most profitable and dependable agriculture crop in Pakistan. it is widely consumed as food and a number of by products are obtained from it. Approximately starch 72%, protein 10%, oil 4.8%, 5.8% fibers, sugar 3.0% and 1.7% ash contents are estimated in maize grain (Choudhry et al., 1994). It is used as a raw material for a series of products such as starch, glucose, malt dextrin, fiber and gluten-free products which are used in the production of alcohol, textiles, paper, pharmaceuticals, organic chemicals, cosmetics and edible oil (Aziz et al., 2013).

Importance of maize:

It is third important cereal crop after wheat and rice for its production in Pakistan. It has highest production potential among cereals with 1014 million tonnes (FAO, 2014). It contributes 2.1% to the value added in Agriculture and 0.4% to GDP. In Pakistan. It was cultivated on an area of 1.12 million hectares with an annual production of 4.527 million tonnes and the average grain yield of 4.053 kg ha^{-1} in Pakistan (GOP, 2014).

Maize is a multipurpose crop that is used as feed for livestock, food for human and provide raw material for several industries. It is a rich source of carbohydrates, proteins, fats and vitamins. It provides 20% of the world's food calories. It is being used in manufacture of corn sugar, corn oil, corn protein, corn flakes, corn syrup, plastic products, paper products, for fuel, and for animal food (MINFAL, 2009).

Production potential of maize is quite high but production in Pakistan is very low than other developed countries. Main reasons for declining the productivity of maize include several factors, the depletion of nutrients in soil, declining of soil fertility, no or low availability of water, excessive tillage, and unbalanced use of fertilizers are the prime factors for lowering maize yield in Pakistan. The demand for maize in the developing world is expected to be doubled by 2050 (Rosegrant et al., 2007).

Role of potassium:

Among the nutrients, potassium is third essential nutrient behind Nitrogen and Phosphorus critical for growth development and enlargement of the plant (Waraich et al., 2011). Potassium makes best use for the leaf expansion as well as length of the stem by sustaining the turgor pressure. K enhances the sun light absorption rate in the direction of increase in the growth that speed up the development of canopy arrangement and the growth of the plant delayed due to the deficiency of potassium. Many end results and experiments confirm that in maize the maximum growth as well as grain yield to be recorded as soon as K be apply @ 200 kg per hectare but among growth as well as yield decline be noted below and above this level but the grain quality was best when the maximum level of potassium (K) is being used (Alias et al., 2009).

It was reported so as to potassium (K) is one of the main well-to-do nutrient elements inside the soil and requires into large quantity through plants. One of the vast quantities of K in most of the soils that is readily available for direct uptake by the plants for a long time. Make best use of potassium in the soils plant have need of as well as from organic fertilizer, soil minerals, and facts of serious potassium thresholds to sustain the fertility of the soil and to increase the crop production (Askegaard et al., 2003).

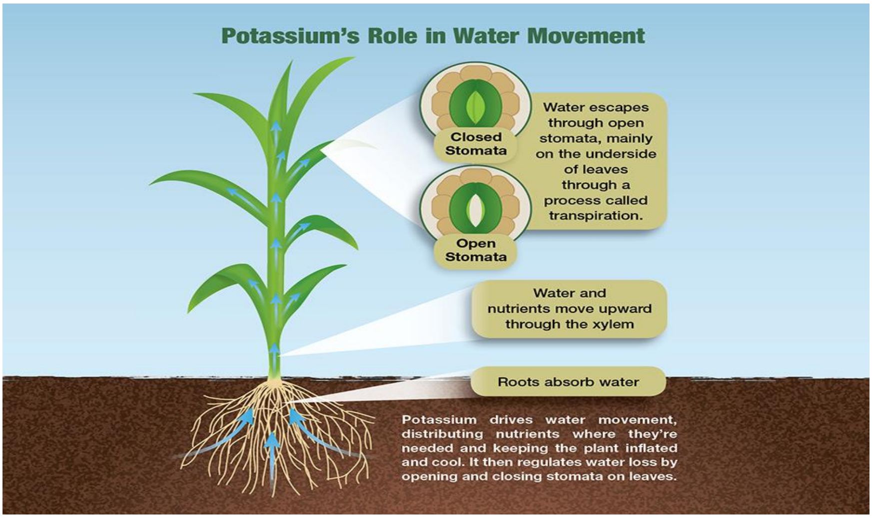

Fig1: Generalized soil cycle of k in the soil and where k may be annually applied or removed (Darrell Smith, 2013).

Hussain et al. (2007), statement that, high rates of K and P extensively raise the grain weight per cob, number of grains or as well as 1000-grain weight. Foliar application of potassium as a result increase the tolerance and development of plant when plant is in abiotic stress (Ashraf et al., 2013). It was studied that, Potassium nutrient necessary for many plant process like the activation of the enzymes, synthesis of the protein, photosynthesis, stomatal movements, phloem transport, electrical neutralization process as well as for the protection of anion-cataion balances inside the cystol and in the vacuole (Maser et al., 2002).

The potassium nutrient betters the maize yield although the reaction of dissimilar genotypes is changeable. Result of highlands system on the yield was different among levels of potassium as well as genotypes. Likewise, uptake of potassium (K) by the grains of maize is lower significantly in lowland area. As concerned the genotypes confirmed the statistical difference for the production in both the system of irrigation as well as potassium comeback. Concerning toward the growth as well as yield of the maize, the lowland system of the irrigation is quite better to the upland system of irrigation and application of potassium fertilizer support to increase the performance of crop in upland system of irrigation (Choudhry, 2009).

In the process of photosynthesis, C4 plant use more well CO2 and H_2O as compared to the C3 plants. Maize is monoecious plant contain staminate and pitilate flowers. It requires most favorable day temperature 22 to 23^0C and need the night temperature 16.7 to 23.30C. The rate of photosynthesis is more than the rate of transpiration at this temperature therefore healthier plant growth is attain. Ultimately, if the temperature reduced to 50^0 C as increase as of 32^0C then ultimately growth is effaced (Steven et al., 2006).

Role of potassium in photosynthesis:

Potassium needs cation in large amount by the plants. In the plants, potassium have an unique role for the activation of enzyme like in the process of photosynthesis. Huge amount of potassium are needed for its biophysical osmoregulation, water balance as well as cation-anion balance (Blevins, 1985). Potassium plays an important role for the movement of solute within the plants like photosynthesis to storage part like tubers and grains. Additionally, potassium is related with improve a biotic stress like as drought, frost, heat and high light intensity (Cakmak, 2007).

In water stress condition, water uptake and osmotic potential has a positive effect on the closure of stomata by the foliar application of potassium (Waraich et al., 2011). Ashraf et al. (2013), reported that, adequate potassium manuring of crop might permit osmotic change that finally increase the capacity of the plant to compensate under water deficit condition.

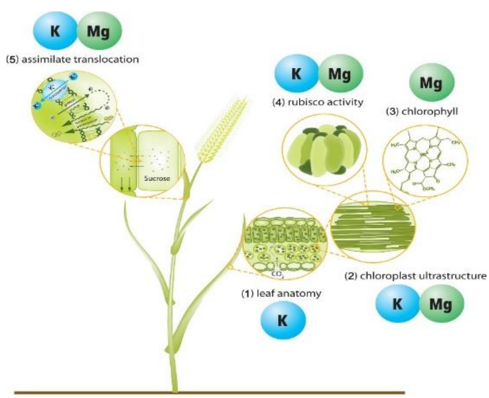

Fig:2 Functioning of potassium and magnesium in photosynthesis, photosynthate translocation and photoprotection (Ashraf et al., 2013).

Pettigrew et al. (2008), was carry out an experiment with unlike intercropping to determine or check the influence or persuade of K appliance on the maize hybrid by means of 5 unlike levels of potassium (K) experienced on the maize crop. The yield contributing characters as well as yield exerting had a significant changes suitable to application of unlike levels of potassium (K) as well as the best performing yield hybrid was testimony as of 36kg/ha be applied as well as the protein content was observed on or after 36kg ha of potassium (K) that is 7.87% and 5.99% superior in excess of the control treatment as well as the recommended dose treatment. The highest result was achieve from 36kg ha that was 40.25% high greater than the control.

Damon & Rengel (2007), reported that, Potassium inefficient mix up had turn down below inadequate potassium amount. The capability to bear small amount of K in plant material was insufficient in addition superior potassium effectiveness in favor of the yield of the plant. Potassium helpful half in split doses can get better the ability and support ability of oat control outlines.

(Khattak et al., 2004) perform an experiment and recommended that, highest maize yield was found by the application of NPK @ 120-74-50 Kg ha^{-1}. The study showed that, entire number of the tillers as well as fertile tiller as per unit area of the crop, structure of plant, number of gains per spike, straw yield and grain yield was considerably tall. Whereas, reduction in maize was occurred when fertilizer application to the maize crop was decreases. In favor of plants in un-applied ecosystem the main source of potassium (K) is the weathering of minerals of soil (Mengel et al., 2001).

Studied shows that, maize varsities react furthermore positively as compared to non-productive varsities to high border outlines compulsory by enhancing mass of grain and harvest. Potassium insufficiency tolerant maize hybrid partially and partially produces extra dry matter and increase the amount of sideways number of roots than potassium (Minjiane et al., 2007).

Potassium effect on maize hybrids:

The study examines and it was monitor that by the application of fertilizers regular raise in grain yield and crude fat protein. Application of fertilizer at the rate of 80-50-22 kg/ha shows that highest fodder yield was obtain three years continuously. Establish crude fat and determine protein in study was find by the application of N;P;K on the dosage of 80-50-22 kilogram per hectare.

Foliar mist or spray is correct method for application of fertilizers. Mg, Potassium, Ca substance in syrupy com as contrast to the other method of fertilizer application. These techniques provide best results in period of yield as like in the foliar spray calculated dose of the nutrients and fertilizer are used that provides best results and good mineral contents in maize (Orosz et al., 2009). Bakry et al. (2009), explains that foliar sprays was also increase the quantity of nitrogen, phosphorus, potassium, zinc and copper in maize crop

Hawkesford et al. (2012) Nitrogen, phosphorus and potassium in additionally one of the multi-use element in plants, can be move successfully among the tissues of plant. Nitrogen and phosphorus absorb in plant tissues to abundant their section. While, the potassium create structure in plant tissues and also affect the performance of the substances, development of protein end and opening of the plant stomata.

Muhammad et al. (2015) acknowledged so as to the dissimilar dosages of K (0, 1, 1.5 and 2%) with every one likely combination be use. When the harvesting of the crop is done plant minerals were calculated. A result shows that, the foliar application of K at the rate of 1.5% combination was most supportive at grain filling stage.

Ranjha et al. (2012) explained that, maize be not bare to stress due to water but it was observing that increase in the amount of yield directly correlated with application of potassium from 5.4 to 12.8 t/ha.

Foliar application fertilizer establishes to the most reasonable in tenure of productivity of the crop and crop profit and thus it can be improved the crop quality like edible portion of the crops that allow us to manage by serious shortage of the fertilizer nutrients as in humans or in the animals. To obtain for the best result of the foliar fertilizers, time and stage of the crop is most important (Amar & Cisse, 2007).

A research is done to check the control of different levels of the potassium @ 175.150.125 as well as 0 kg/ha on growth and development of maize. To check the superiority and yield were taken.

Hence, both yield and superiority be necessary by the application of potassium combination. Mainly serious height of the plant, number of column, number of cob, number of grains, cob length and 1000-grain weight be perceived with the use of potassium at the dose of 175 kg/ha (Ijaz et al. 2014).

Amanullah et al. (2010) performed an experiment to revise the most favorable quantity of the micro-nutrient for seed quality and highest profit in maize crop. The experiment was conducted at research place of agriculture university of Peshawar. RCBD design was used under split plot method with three replications. Different levels (0, 25, 50, 75, 100 and 125kg/ha) of K were applied at the main plot while P was placed in the sub plots at the rate of 0, 40, 80 and 125 kg/ha. Result of the experiment show that number of cob was enhance with the enhance in the concentration of potassium (K). While on the opposite site, decrease in the concentration of the potassium. In the end the number of cobs increased due to the raise in the concentration of potassium (K). Ultimately, the research of this study reveals that, potassium increased the overall yield of the maize crop under the environmental condition of the northwest condition of Pakistan.

Raza et al. (2013) stated that, by the use of 1% foliar potassium at 3 different growth stages (tillering, grain filling and flower initiation) to check the physical and uptake of nutrient of 2 wheat cultivars under drought resistance form. The exogenous compliance of K under water deficit condition at all three valuable stages of growth raises tolerance of wheat by declining the uptake of toxic nutrients and increase in the physiological ability. Hence, the research result explains that, when potassium was sensible at the stage of grain filling of both cultivars, then the highest development in the entire provided nutrients uptake.

A trial was going to revise the reaction of the maize to evapo transpiration deficiency compulsory at accurate plant growth stages. The research achieves highest yield of the seed (2.65 t ha^{-1}) on entirely control treatment. The evapotranspiration come into view at the entire developement stages that reduce the seed yield separately during the vegetative duration of the crop that are relative to the yield in full irrigated controller. The result indicates that, flowering and the stage of grain formation, grain filling crop sub-duration were 218% and 118% individually additional weak to the evapotranspiration deficiency than the stage of vegetative period (Chaudary et al., 2012).

Ahmed et al. 2006; Pettigrew (2008), was conducted an experiment and explains that, potassium considers an important role for increasing the quality and yield of maize grain. Numerous physiological practices of plans, influence on plant growth as well as yield as for as photosynthesis, activation of enzyme and assimilation that are affected by the foliar application of potassium nutrient. Potassium is a vital nutrient among nitrogen (N) and phosphorus (P) as meant for as grains crop.

The research study explains that, potassium significantly influences protein synthesis, activation of enzyme, osmoregulation, stomata movement, process of photosynthesis, transport of phloem, transfer of energy as well as cation-anion stability (Mallarino et al., 2014).

Concerning to the deficiency sign of potassium (K) clearly enclose not be show on the maize other than the end yield of maize crop reduces severely, if the deficiency of potassium are severe, then the symptoms can also monitor (Ahmad et al., 2012).

The Research clarify that, the soils in the Pakistan are normally high in potassium, however raise in the cropping intensity, more removal of straw from the field as well as more use of tube-well salty water and soil applied potassium are get attach with the minerals of clay that resulted in large exhaust of soil applied potassium (Achakzai et al., 2009). Furthermore, the rate of fertilizer is being paid higher and more expensive for community of farmers.

Muhammad et al. (2011), carry out a field experiment to examine the result of foliar application potassium on grain attributes of maize. The result shows that, all foliage spray of integrated potassium showed maximum significance for growth and the attributes of yield as compared to the soil application of potassium. The reason for maximum effect of foliar potassium on growth and yield is that, the nutrients are efficiently utilization and timely availability of potassium as compared to other nutrients.

Potassium foliar spray to maize crop influenced its shift from vegetative to reproductive phase the early pollen shedding and silking increased grain yield of corn because grain filling period was longer which accelerated the better absorption of nutrients. Days to 50% silking were minimum when potassium applied at foliage stage (Achakzai et al., 2009).

A field experiment was carrying out to assess the efficiency of K foliar spray beside soil application on maize hybrid. In experiment, treatment factor be: control, soil application of K @ 75kg K20 ha-1, 1% K_2O foliar spray, foliar spray 2% k_2O, foliar spray 3% K_2O. Hence, the result indicates that, foliar spray of potassium increases yield and its constituent as well as quality grain attributes higher than the soil application method. Concerning to the research of the study, the results shows that, the more grain and biological yield were 15.0 and 8.0 t ha-1, correspondingly under the foliar application treatment of 3% k_2O, as compared to 2% foliar spray. By the application of foliar potassium greater profit cost ratio and greater net profit was observed. Foliar applications of 3% potassium concentration are more resourceful for increasing the growth and yield of maize as compared to soil application or by the method of fertigation (Howard et al., 2011)

A study was done and investigates that foliar potassium fertilizer application is very helpful to increase the yield of the maize crop. In this regard, field experiment was done for the period of 2002 to test out the most excellent reaction of maize crop greater than a range of fertilizers. Basal dosage of N at 120kg ha-1 applied by way of potassium levels into maize. The application of potassium at 2% appreciably raises the grain yield of the crop from 2.55 t ha-1 in the treatment (control) by increase in yield up to 2.77 t ha-1 in so as to treatment which receive potassium at the dose of 60 kg ha-1 which give boost up of up to 13% more than control. Number of tillers, spike length, spike and plant height be radically raise by using potassium application. Result also shows positive reaction to K application in excess of growth as well as yield parameter extensively better in the potassium as compared to the control treatment. The number of spikes plant t ha-1, length of the spike and 1000 grain weight is also dramatically increases using potassium over the control. Highest grain yield was recorded by the application of 2% k_2O (Lu et al., 2012).

Eicharte et al. (2011) reported that, foliar potassium application is most target oriented, appropriate availability to crop and inexpensive procedure for raising the fertilizer use efficiency as well as grain yield over the method of soil application.

Superior plant height was recorded in the entire foliar spray treated plants as well as by soil application and method of fertigation. Highest plant height was 186 cm below 2% k_2O go behind 2% K_2O foliar application. Minimum plant height was observed in control. The foliar application of 2% K_2O gives highest number of leaves per plant as well as to additional potassium application doses. Minimum number of leaf per plant was seen in split doses of application of potassium. Highest ear is associated to the height of the plant. The height of maize plant raised by the application of potassium (Akram et al., 2010).

Maximum number of grains ear^{-1} was counted by the application of 3% K_2O treated plot that is being followed by 2% K_2O. Study shows that grain yield per unit of area raised by the application of foliar potassium due to the better activity of enzymes and this leads additional translocation of photosynthates from the leaf to the grain (John & Lester, 2011). The study shows that; potash nutrient extensively increases the leaf area index. The maximum leaf area index was recorded by the application of 2% foliar potassium K_2O (Mesbah, 2009; Akram et al., 2010).

An experiment was carrying out to test out the reaction of maize to the application of potassium. Foliar application of potassium be applied at the dose of 2% by the side of recommended dosage of nitrogen and phosphorus (150-125 kg ha^{-1}). Pot was filling up with soil as of two soils at the research place in the Pakistan toward check out the efficacy of soil in excess of the foliar application of potassium like medium texture and high textured. Application of K meaningfully raises the height or length as well as yield attributes or parameters of the maize in excess of the control treatment in both types of the soils.

Research (field) trial be carried out to test of unlike hybrid maize cultivar that is differed considerably in biomass production, the uptake of efficiency at both level of potassium (K) amount. The root as well as shoot production biomass be suggestively in the middle of varieties and resourceful cultivars that shows smallest amount was reduce in the portion of shoot dry matter because of potassium (K) deficiency (Ranjha et al., 2008). A research or experiment be carry out and results stated that, it was a considerable effect of K_2O on leaf area, height of the plant, biological yield as well as grain tield. Yield and cob diameter also significant by the application of K_2O (Ramzan, 2014).

The foliar appliance of fertilizer is broadly used to overcome the nutritional deficiency of the crop plant that is being caused by the inappropriate application of the nutrients. An experiment is conducted to check out the comeback of maize to the foliar appliance as well as by the soil appliance. It was observed that, after 55 days of application of potassium, crop plant shows important enhance in the root as well as in the shoot length, as well as fresh or dry weights plus leaf area as well as the chlorophyll contents of the plant (La Scala et al., 2009).

Mehmood (2012) conduct a research and observed the consequence of dissimilar levels of potassium on the growth as well as yield of sunflower and he reported that leaf area, dry matter %, biological yield was affected favorably by the potassium application. The application of K away from 100 kg ha^{-1} do not enhance the seed yield ha^{-1}. Application of potassium does not affect the protein contents and the harvest index.

The different dates of planting time as well as the foliage application of both water and KNO_3 have major consequence on yield as well as yield characteristic of the spring maize. The time of planting of maize on February 5 awarded a high grains yield. A range of the yield characteristic like the number of the cobs per plant, the length of the cob, girth as well as the number of row per cob plus the number of grains/cob, the numbers of grains row per cob as well as 100 GW along with the application of 2% KNO_3 foliar at the stage of tassel initiation that gave a considerably superior grain yield (Aslam et al., 2013).

K is necessary for the enlargement and improvement of cotton. Potassium is important for several enzyme systems in the cotton plant and it plays a key position for reducing the rate as well as severity of the diseases like cotton wilt. Research or study indicates that, potassium raises the deficiency also influence the speed of biological system almost in all plants. Furthermore, potassium in addition plays a vital role in the process of photophosphorylation, maintenance of turgor as well as transport of photoassimilate as of source tissues by the use of phloem portion to the skin tissues as well as stress tolerance and the activation of enzyme in the plants. In cotton, uptake of K enhance during the period of early boll position by means of some 70% of whole uptake taking place after the time of first bloom. As for as most regular supply of potassium is murate pf potash. Another resource that consist of potassium sulfate as well as potassium nitrate. The fertilization of potassium on the cotton crop must receive more interest as of the farmers.

Among the nutrients, potassium take part a leading role in the translocation of the carbohydrates, the process of photosynthesis, water relationship as well as resistance next to insect and diseases along with sustain equilibrium linking monovalent and the divalent catains (Bukhsh et al., 2011) in addition to involved within several biochemical and biophysiological procedures to facilitate especially crucial for the plant growth and yield (Marschner, 2013). Moreover, K also plays a main role on the process of photophosphorylation, maintenance of turgor, transport of photo assimilates as of the source tissues through phloem toward the sink tissues as well as the activation of enzymes in plants (Usherwood, 2008).

Potassium is measured to be there a key osmotic within plants because it supplies water relations in favor of plants make them to live on under or during the period of drought stress. Potassium (K) increases the delight of water (H_20) uptakes of the plant in the direction of stay seize of the turgor of the cell that is required for the development as well as growth the crop as it add on the development of the plant (De La Guardia & Benloch, 2009) as well as opportunity of the stomata as well as (K) is measured as a mobile on the plants and thus can translocate alongside tough electrical gradient as well as chemical gradient (Brar & Tiwari, 2004).

Study explains that, foliar supply of potassium (K) is a huge implication for the plants as it comprises lower cost, rapid reaction to plant. The application of fertilizer foliar use in little amount of nutrients as well as it provides a return for be short of soil fixation process, except at what time potassium (K) application are establish to a very elevated foliar application of fertilization could affect burn of foliar as well as be able to too compatibility harms by means of extra pesticides.

El-Ashry et al. (2005) studied and account that, the negative (-ve) effects of the drought on growth of wheat subsist able to decreses through the appliance of foliar spray of potassium (K). A plant translocates the potassium (K) in the direction of the each and every one parts of the plants and increase in yield per plant. For increasing the acquiesce of the cotton as well as foliar appliance of potassium (K) might be use to addition soil relevance. Scientist named as Weir (2014) acknowledged so as to the appliance of foliar potassium (K) has achieve attractiveness as soon as the variety of crop acquire crop nutrient at what time it turns out to be short or needed too most. Howard et al. (2011) studies and report that the fertilization of foliar might be useful to exact up K deficiencies while the growth of the root and uptake of the nutrients are limited. On the other hand, somewhere supply of the nutrients and the uptake of soil potassium I go to deficient for the demand of the plant claim the procedure of foliar fertilizer might supply of the plenty of nutrients for the growth of the plant (Pettigrew et al., 2009). Research scientist Howard et al. studied and experiential that in the season affect of foliar potassium spray be found more helpful as compared to the winter seasons since elevated temperature, humidity that favored the spray of foliar potassium (El-Fouly & El-Sayeed, 2012). The method of feeding of foliar potassium through plant nutrients that give immediate benefits as well as economizes element of the nutrients as compared to the soil application (Verma & Sahani, 2015).

Ahmad and Rashid (2014) confirmed the outcome of foliar application potassium (K) on the cotton yield as well as lint the quality factor. The study explains that, the yield of cotton and the quality parameter resembling the length of the fiber (mm), strength of fiber (μg/inch) have been superior by the application of foliar potassium at the rate of 1% as a source supplement under the condition of the drought stress. The research was done by Dewdar (2013) on cotton, research explains that an enhance in number of leaves per/plant as well as the dry weight of leaf per/plant, seed cotton yield, the no of bolls, the weight of the bolls, percentage (%) of the lint plus lint index plus seed index, the length of the fiber as well as the strength of the fiber as soon as they are treated with the soil applied and two times spray of potassium at the early on and crest boll formation stage compared to the treatment (control) where no potassium (K) should be applied.

Awon et al. (2012) carry out research taking place the foliar application of the potassium (K) at the different growth stages of the crop wheat i.e. tillering, initiation of flower stage as well as milking stage under the condition of the stress. The result of the research explains that, the foliar application of the potassium at the all important condition of the wheat going to improved the drought tolerance of the plants as well as particularly raises the growth parameters like height of the plant, length of the spike, number of spikelets as well as the components of yield like 100-grain weight, grain yield per plant, the number of the spike per plant be furthermore improved.

Aslam et al. (2013) accomplish research taking place the maize hybrid to check out the physiological as well as the morphological reaction of hybrid maize through the application of potassium foliar underneath the condition of the moisture stress. In this experiment five levels of potassium (K) was used i.e. 0.60,90,130, 150 mg/kg of soil. The result of the research indicates that, plant height, the area of the leaf, shoot fresh weight, the relative water content as well as the photosynthetic rate was to be higher as the potassium (K) level of 100mg/kilogram below the drought stress as contrast to the treatment of the control where no application of potassium was applied.

Effect of Foliar potassium on maize hybrids:

The field research was carry out to determine the effect of potassium foliar application as contrast to the soil potassium application of K on maize at Maize, sorghum at NARC Islamabad under the condition of the rained during the period of summer, 2014. The treatments of potassium were control (no K_2O application). Soil potassium applied at the rate of 70 kilogram K_2O/hectare, foliar application of 1%, 2%, 3% K_2O, soil fertigation at the dose of 75 kg K_2O/ha as well as split soil application respectively, to the all treatments at sowing.

Nelson et al., 2014 conducted a field research on the sandy loam soil that have a low amount of organic C as well as accessible N along with phosphorus as well as potassium throughout the spring season 2013 and 2014 at Research farm, Agriculture University, Ludhiana. The overall experiment was carry out in the split plot along with the four replication viz three planting dates Feburary 5 and March 2 as in main plots as well as seven treatments of foliar application viz foliar application of 1% KNO_3 at the stage of teaseling, 2% KNO_3 foliar at the stage of initiation of tassel, 1% Foliar KNO_3 at the time of tassel initiation plus another foliar spray after one week, 2% KNO_3 at the stage of tassel initiation, plus other spray after 7 days, WS next to tassel initiation plus another spray at the time duration of one week and control in the sub plots.

Two split foliage sprays of potassium oxide be applied at 40 days after sowing at the stage of 7^{th} leaf stage and at the time of 65 DAS at the stage of teaseling concerning to the research plan. The yield of the grain was 8.07 t ha^{-1} getting the foliage spray of 3% K_2O (13 K_2SO_4 kg ha-1), that are followed by 2% foliar spray of K_2O (8.5 K_2SO_4 kg ha-1). Likewise, height of the plant (188 cm) and the leaf area per plant (450 cm) were showing significant results that are receiving 3% foliar potassium oxide. Furthermore, the split application of potassium was initiate to be economical in the term of the net benefit as well as cost benefit ratio in terms of the higher rates of foliar as compared to the application of foliar. All foliar treatments of potassium react better growth and yield as well as attributes of the grains quality that are followed by splitting, suggested NPK at the method of fertigation of soil potassium application correspondingly.

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CHAPTER 3

AN OVERVIEW ON EINKORN WHEAT (*Triticum Monococcum* L.) AND ITS GRAIN NUTRITIONAL COMPOSITION

M Sc Dursun PARSAK*

Assoc. Prof. Dr. Şekip ERDAL**

Agricultural Engineer Gökhan KILIÇ***

*General Directorate of Agricultural Research and Policies. Depertmant of Crop Research, Ankara, Turkey. dursun.parsak@tarimorman.gov.tr
**Bati Akdeniz Agricultural Research Institute, Department of Field Crops, Antalya, Turkey. sekip.erdal@tarimorman.gov.tr
***Field Crops Central Research Institute, Department of Field Crops, Ankara, Turkey. gokhan.kilic@tarimorman.gov.tr

INTRODUCTION

The name einkorn, which means "single seed" in German, is derived from the presence of a single grain in each spike or from the husk surrounding the grain. Einkorn, which was cultivated about 12 thousand years ago, is known as the ancestor of wheat. It is one of the rare plants that has survived until today by preserving its form in ancient times. Einkorn, which is a diploid plant, takes one set of chromosomes from a male and one set of chromosomes from its female ancestor (Heun et al., 1997; Hidalgo et al., 2009).

Figure 1. Green and Matured Einkorn

Although einkorn takes different regional names (Greek: tiphe, Moroccan: skaliah, Portuguese: espelta, Romanian: alac, Dutch:

eenkoorn, Turkey: siyez etc.) in some regions it is also called a small spell (*Triticum monococcum*, syn: *T. monococcum ssp. monococcum*) (Ivancic, 2002; Zaharieva & Monneveux, 2014).,

Einkorn is in the thermal spring wheat group and has a single grain and husk structure. Its grain has a glassy and tight structure. Since it has husks, it is not separated from the husks during the harvesting and threshing processes, unlike the bread and durum wheat produced today. This provides extra protection to the grain when it is stored and when planting is performed on the field. Einkorn wheat is more tolerant of cold, heat, pests, diseases and nutrient-deficient soils (Hidalgo et al., 2009).

Einkorn, mostly Turkey, Balkan countries, Southern Italy, Southern France, Spain, Morocco is produced in marginal areas. Einkorn Wheat are grown mostly in Kastamonu region of Turkey, especially in İhsangazi, Seydiler and Devrekâni districts. Although Eincorn is used in animal feeding and in the construction of thatched houses, it has gained importance again in recent years with the increase in the importance of sustainable agriculture and nutritional values (Hidalgo & Brandolini, 2019; Ünal, 2013).

Figure 2. Spikes of different cultivated accessions (from left to right: Hungary, Armenia, Romania, Turkey and Israel) (Zaharieva & Monneveux, 2014).

Einkorn wheat (*Triticum monococcum spp. monococcum*) is one of the spruce ancestors of wheat (*Triticum ssp*.) and has important contributions to human nutrition and health (Pirgozliev et al., 2015). Eincorn processed bulgur wheat is usually consumed in Turkey. Einkorn bulgur is a product obtained by drying einkorn wheat, whose spikes are single-grain and has a spruce structure, after boiling and splitting in stone mills using completely traditional methods (Ünal, 2013).

ORIGIN

The origin of einkorn wheat (*Triticum monococcum* L.) is the Fertile Crescent region, which also includes the Euphrates and Tigris. Primitive spelltin (Single grain wheat; *T. beoticum, T. aegilopoides*-

Double grain wheat; *T. thaoudar* and *T. urartu*) and *Triticum monococcum* genetically have AA structure. Einkorn began to be harvested in the Chipped Stone Age, around 16000-15000 BC (Stallknecht, 1996). It is thought that the relationship between wheat and human started approximately 14 thousand years ago around Şanlıurfa in Southeastern Anatolia. It is accepted that einkorn, which is accepted as the ancestor of wheat, was cultured in Karacadağ in Şanlıurfa for the first time in the world 12 thousand years ago and from there it spread to the whole world (Zaharieva & Monneveux, 2014; Hidalgo & Brandolini, 2014; Emeksizoğlu, 2016). In order to determine this situation, comparative DNA analyzes were made between approximately 1400 wild hulled (*Triticum monococcum ssp. boeoticum*) wheat and hulled (*Triticum monococcum ssp.*). When the historical flow is examined, einkorn was grown in the Caucasus Mountains in the Mediterranean and in the northwest of Europe. Einkorn wheat is also the first grain grown in the Balkans. Einkorn is the most important grain grown in the barren land and temperate regions in the Middle East and Southwest Europe.

The hunter-gatherer people lived in Karacadağ started to feed by roasting these grains probably due to the easy growing of wheat and being small but satisfying (Heun et al., 1997). Wheat then spread to the Middle East, the Caucasus and the Balkans, Turkmenistan, Central and Southern Europe, North Africa, and finally to Western and Northern Europe. Today, traditional words einkorn in the Mediterranean region (Turkey, southern Italy, southern France, Morocco and Spain) and in the Balkan countries, einkorn wild *Triticum monococcum ssp.*

boeoticum grows in the east of the Euphrates and Tigris regions named as the "Fertile Crescent" region (Hidalgo& Brandolini, 2014).

Cultivation area of eincorn found in only a few regions of Europe in the 1970s. Later, it was first marketed to America to make bread (Bavec, 2000). Currently, einkorn derived products in Turkey, India and the United States are made by small enterprises. On the other hand, Organic agriculture in the world has been limited to small areas mainly in Italy, Australia, Switzerland, Germany and Slovenia (Zengin, 2015).

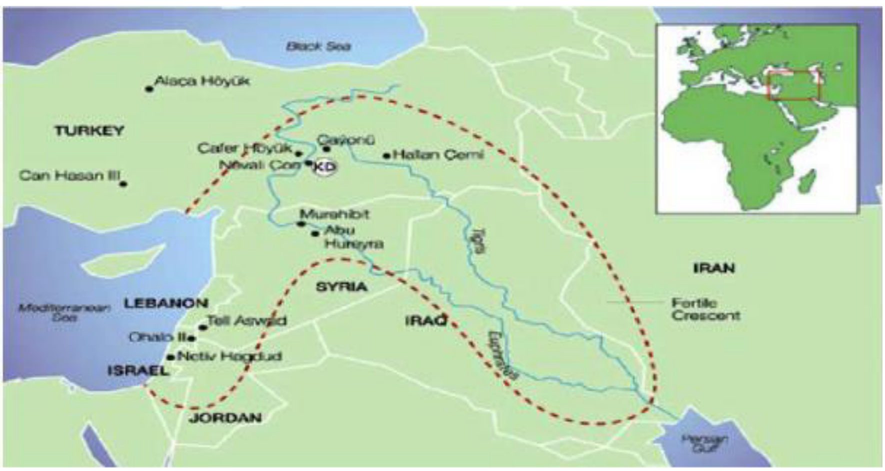

Figure 3. Fertile Crescent and Karacadag Mountains (KD) in Turkey (Salamini et al., 2002).

BOTANICAL CLASSIFICATION

Wheats are divided into three groups according to their chromosome number. These are diploid (2n = 14-AA genome), tetraploid (2n = 28, AABB genome) and hexaploid (2n = 42, AABBDD genome) (Feldman, 2001). Cultured wheat is basically divided into four groups. These groups are; one diploid einkorn wheat: *Triticum monococcum ssp. Monococcum* (2n = 14), two tetraploid wheat; *Triticum turgidum ssp.*

Dicoccoides (2n = 28) and *Triticum timopheevii* (2n = 28) and a 54exaploidy wheat; *Triticum aestivum* (2n = 42). These species can be classified in different ways according to their usage areas (Stallknecht et al., 1996).

USES OF EINKORN WHEAT

In ancient times, when it was consumed the most, einkorn was mostly cooked with water or milk and consumed in the form of porridge or simply cooked. This type of use does not require fermentation, this process was developed by the Egyptians, transformed into bread making and put into practice. More recently, einkorn has been preferably used in animal nutrition and is still used as feed. For this reason, no effort has been made to make bread from einkorn in the period from prehistory to more recent times. As a result, until recently the loaf was not considered suitable for bakery products due to its sticky dough and weak rheological properties. However, despite the dough processing difficulties, bread similar to bread wheat could be obtained in terms of loaf volume and characteristics (Zengin, 2015).

Archaeological findings show that einkorn wheat was used in making bread (with or without yeast), soups and beer. Turkey, the Middle East and the findings are consumed in the Balkans. The use of einkorn wheat differs from country to country and is used both as food and as animal feed. For example; While it is used as food in Serbia, Bulgaria and Sweden, it is used as horse and chicken feed in Romania. (Zaharieva & Monneveux, 2014).

The most important purpose of cultivation of family farming in Turkey made einkorn wheat bread in their households and to meet the needs of the findings. (Morgounov et al., 2016)

Figure 4. Einkorn Bulgur

The most important feature of Turkey's Kastamonu province İhsangazi especially wheat grown in einkorn district is entirely produced by traditional and natural methods. Siyez (einkorn) Bulgur Festival is organized with the first harvest in İhsangazi for einkorn, which has high nutritional value (Ünal, 2013).

GRAIN NUTRITIONAL COMPOSITION

There are studies showing that einkorn wheat has a higher protein ratio than bread wheat, durum wheat and barley under unfavorable conditions. Although einkorn wheat is very low-yielding, it has high nutritional properties and low cost of agriculture, its adaptability, resistance to diseases and pests, and the development of organic agriculture have led to increased interest in Eincorn (Zaharieva & Monneveux, 2014).

Protein ratio is the primary criterion used in determining the quality of wheat. The protein content of wheat varies between 6-22% depending on the variety and environmental factors during growing (Arısoy, 2005). The protein ratio of wheat is accepted as the most important indicator of the baking quality of bread and loaf volume as well as determining the bakery value of grain and flour in trade (Kihlberg et al., 2004; Mader et al., 2007).

It has been stated in the studies the protein content of einkorn wheat is much higher than the bread wheat (Borghi et al., 1996; Corbellini et al. 1999). Brandolini et al. (2008a) reported the protein content of 65 einkorn samples in dry matter as minimum 15.5%, maximum 22.8% and average 18.2%. Grausgruber et al. (2004) determined that the protein content in 25 different einkorn wheat as 15.6-22.8% and in winter emmer wheat as 12.2-24.8%.

Figure 5. Einkorn seeds

Minerals present in grain are classified as major, minor and trace elements according to their amount and significance level. When the karyopsis part of the grain is examined in terms of major mineral substances, approximately 95% of the ash consists of potassium (K), magnesium (Mg), phosphate and sulphate salts of calcium. Minor elements are those found in an amount less than about 10 mg in 100 g of DM. These are mainly manganese (Mn), iron (Fe), zinc (Zn) and copper (Cu) (Elgün & Ertugay, 2002).

In the study conducted by Emeksizoğlu (2016), the distribution of minerals detected in einkorn samples in the grain was examined. As a result, the amount of 396.76 to 558.42 mg / 100 g K, the amount of 109.36 to 527.76 mg / 100 g P and the amount of 102.68 157.05 mg /

100 g Mg was found in samples. Average values for K, P and Mg were calculated as 500.94, 357.89 and 129.07 mg / 100 g, respectively.

Abdel-Aal et al. (1995), einkorn and *Triticum* determined the phosphorus and potassium amounts of eincorn and durum wheat as 415 and 360 mg / 100 g, 390 and 305 mg / 100 g, respectively. Erba et al. (2011), in their study on the mineral content of einkorn wheat, found the amount of P (phosphorus) 309-541.1 mg / 100 g, K (potassium) 199.6-326 mg / 100 g, and Mg (magnesium) amount 112. 5-151.2 mg / 100 g.

Suchowilska et al. (2012), studied the K, P and Mg contents of *Triticum monococcum* and *Triticum aestivum*. They found K content for *Triticum monococcum* as 3.90-4.66 g / kg, the average was 4.29 g / kg. Also, it was 4.81-5.19 g / kg and 5.00 g / kg for *Triticum aestivum*. The P content for *Triticum monococcum* were 4.54 to 5.92 g / kg, average 5.20 g / kg. These contents were for *Triticum aestivum* were 4.12 to 4.24 g / kg, average 4.18 g / kg. They found that the Mg content was 1.17-1.80 g / kg for *Triticum monococcum*, an average of 1.63 g / kg, for *Triticum aestivum* 1.42-1.45 g / kg, and an average of 1.44 g / kg.

Hidalgo & Brandolini (2014) showed that mineral content of eincorn is better than bread wheat. They stated that Mg content of eincorn ranged from 1.125 to 1.51 and P content from 3.10 to 5.41 g / kg.

According to (Erba et al., 2011), trace elements (Zn, Fe, Copper (Cu) and Mangan (Mn)) and minerals (Calcium (Ca), Magnesium in Eincorn wheat and one bread wheat sample in four different fields and for two years (Mg), Phosphorus (P) and Potassium (K) concentrations were examined, and they stated that the most important factor affecting the mineral level was the year and genotype and their interaction. Einkorn samples Zn (7.18 mg / 100 DM), Fe (5.23 mg / 100 DM), Mn (at 4.65 mg / 100 DM, Cu (0.90 mg / 100 DM), Mg (151.2 mg / 100g DM) and P (541.1 mg / 100g DM) were higher than the bread wheat samples. It was emphasized that the excess amount of trace elements in einkorn samples is important in terms of nutrition.

Zhao et al. (2009) found that in a study they conducted on durum, spelled, einkorn and emmer wheats, in terms of Selenium (Se) amounts, spelled, einkorn and emmer wheats were higher than bread and durum wheats. In einkorn, Fe was found to be an average of 45.9 mg / kg, Zn an average of 22.4 mg / kg and Se an average of 278.9 μg / kg.

In a study conducted on einkorn wheat, it was determined that it is approximately 2-4 times more than other wheat in terms of carotenoid amounts and that the tocopherol content is significantly higher. (Hidalgo et al., 2006; Hidalgo et al., 2008).

Lachman et al. (2013), in a study conducted for 2 years to determine the tocol and carotenoid contents of einkorn, emmer and bread wheat types, the highest carotenoid content (lutein, zeaxanthin, beta-carotene) was determined in einkorn wheat.

Besides of einkorn wheat wholesome whole grain consumption of phenolic compounds as functional components to be higher in terms of tocopherols and carotenoids are remarkable when compared to other wheat species (Abdel-Aal et al., 2002). When compared to modern wheat, einkorn wheat has 2 times carotenoids, 3-4 times lutein ratio, 4-5 times more riboflavin and pyridoxine. It has been stated that einkorn wheat helps to reduce cholesterol level in the blood as it contains higher phytosterol than bread wheat and it is effective in preventing stomach, uterine and breast cancer (Zaharieva & Monneveux, 2014).

In addition to its protective properties against cancer, vitamin A also has important functions in preventing visual disorders and the formation of free radicals. It is a carotenoid variety that gives lutein yellow color to the flour of einkorn wheat and has been reported to be found at an average rate of 8.1 mg / kg. Vitamin E, a group of fat-soluble vitamins, consists of tocopherol and tocotrienols. Einkorn wheat is richer than bread and durum wheat in terms of total tocol content. While the total tocol content of bread wheat flour was 62.75 mg / kg, this value was determined to be the highest 115.85 mg / kg and the average 77.96 mg / kg in ehez. It has been reported that en-tocotrienol content of the tocols was the highest 61.9%, followed by α-tocotrienol 16.4%, α-tocopherol 15.6% and β-tocopherol 6.1% (Hidalgo et al., 2006).

Abdel-Aal et al. (1995) compared the chemical and nutritional properties of summer wheat, eincorn wheat and durum wheat grown in 1992 and 1993. They found that high starch and oil content was higher in einkorn and two spelled wheats in terms of protein and ash content, and other spelled wheats. They reported that einkorn wheat has a significant phosphorus level and high riboflavin and pyridoxine content. Additionally, they stated that einkorn wheat is rich in βcarotene, has a high protein content, and its gluten content is similar to other wheat types.

Brandolini et al. (2008b) examined the composition and staling properties of different wheat samples collected from different regions of Italy. Einkorn samples have high protein (18.2%) and high ash content (2.35%), low sedimentation volume (25.6 ml), high carotenoid (8.36 µg / g), and high yellow pigment content (8, 46 µg / g) reported that they have. As a result, they found that the einkorn samples collected from different regions of Italy differed in other characteristics except the amount of ash. They concluded that this type of wheat is suitable for the production of baby food and special products due to its high protein and carotenoid content and good staling properties.

CONCLUSION

Einkorn stands out with its nutritional value as well as being an important gene source for the improvement of today's wheat. The world population's demands for high nutritional value products are increasing rapidly. The fact that einkorn wheat has more nutritional value than other wheat makes it an important grain. However, the fact that einkorn has a husk and the technological difficulties in its processing are its negative aspects. It is clear that if studies on cultivation and processing are carried out in marginal areas, it will become a sought-after food in the future.

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CHAPTER 4

FALLOW APPLICATIONS IN TURKEY AND SOME SELECTED PROVINCES AND AN EVALUATION IN VAN PROVINCE

Assist. Prof. Dr. Fevzi ALTUNER*

Assoc. Prof. Dr. Erol ORAL**

*Van Yuzuncu Yil University, Gevas Voctional School, Plant and Animal Production Department, Van, Turkey. Corresponding author: faltuner@gmail.com

**Van Yuzuncu Yil University, Agriculture Faculty, Department of Field Crops, Van-Turkey. eroloral65@gmail.com

INTRODUCTION

In order to meet the nutritional needs of the ever-increasing human population and animal existence, it is necessary to use agricultural land with limited space in production. Since it is impossible to increase the area used in agriculture, there is no other way to increase production by increasing yields with a number of measures and practices. After ensuring this, it is necessary to avoid land losses caused by natural causes and artificial interventions. Efficient and sustainable use of existing agricultural land is a requirement of adequate food production. But there are a number of restrictions on the efficient use of existing land. Among the factors limiting the use of agricultural fields in the world and in Turkey, fallow practice is the most prominent.

Fallow in places where annual precipitation is insufficient and irregular, a series of tillage during the application period leaves the land empty for one season in order to ensure the accumulation of moisture in the soil for the next crop (Surek, 2004). This practice has been an agricultural culture that has found a place in Anatolia for a very long time, as in the world. As an example, farmers who did not process their field in the Ottoman State for 3 consecutive years were forced to pay a tax called çiftbozan, but fallow practice was excluded from this (Yavuz, 2005).

Since it has been known since the past that fallow practice limits productive use on agricultural land, ways to reduce it have been constantly sought. In this context, legume cultivation area and production were increased by applying legume grain system instead of fallow-grain system in a development project implemented in Çorum and Çankırı provinces in the 1970s. Since the most important reason for fallow application is the lack of annual rainfall, where the annual rainfall exceeds 450 mm on a country-by-country basis (Yavuz, 2005), the fallow areas Reduction Project (NAD) has been implemented and fallow areas in Turkey have been reduced by 3% (Gul & Isik, 2002). In this project, plants with relatively low water consumption were preferred and it was determined that the legume group was the most suitable plants that could enter alternation instead of fallow-grain system in dry agricultural areas (Guler, 2011). Because legumes bind nitrogen to the soil, they increase soil fertility when they are taken to October, contributing to the improvement of soil structure in salty soils and fallow areas (Anonymous, 2018a). In this aspect, legume group plants are included in all areas where the project is implemented. Considering the economic dimensions of the project, it was determined that lentils were the most suitable and profitable plant in alternation with cereals (Aydogan et al., 2008). But if these project-like measures applied only for a certain period are re-implemented and in larger areas, both a decrease in fallow areas and an increase in edible grain legume production can be achieved (Caliskan, 2014).

In addition to reducing land use productivity, fallow also has effects that reduce the amount of irrigation by 14%, especially in irrigation areas opened by DSI (Cimenci & Miller, 2016). With some measures taken in this regard, the fallow rate in field agriculture in the 1970s was 35%, while in the 1990s it was reduced to 21.3% (Kun, 1994). But since the 1990s, the proportion of fallow in agricultural land used in Turkey remains at 22%. In some provinces, this figure is up to 63%. For this reason, very large areas allocated to fallow cause great economic losses.

Fallow is also widely practiced today in some provinces of Central Anatolia, Eastern Anatolia and Southeastern Anatolia regions, especially in our country, where annual rainfall is less than 500 mm. Van is one of these provinces, and 55% of the land used in field agriculture is left fallow every year. This amount corresponds to a size of about 1 million decars. In this study, we tried to examine the current state of fallow application in some selected provinces and in Van province, where annual rainfall is less than 500 mm throughout Turkey, and some suggestions for reducing it were expressed.

1. FALLOW PRACTICES IN TURKEY

An agricultural system is mainly applied in the form of grain fallow in dry conditions in the regions of Turkey located in the arid and semi-arid climate zone (Ozer, 2010). Agricultural systems in the world and in our country are determined according to ecology, temperature and precipitation criteria and moist, watery and dry systems are applied (Altın, 1984). Mostly, the system of field agriculture, which has an annual rainfall below 500 mm or is applied without irrigation in places where the distribution of precipitation over months is irregular, is called dry agriculture (Kun et al., 1981). Dry agricultural system is enforced where annual rainfall is insufficient. (Altın, 1984). In our country, approximately 32% of our sown areas are left fallow every year (Demiralay, 1976).

1.1. Relationship of Annual Spatial Precipitation with Fallow in Turkey and Some Regions

Annual spatial rainfall data recorded in Turkey between 2000-2019 is given in figure 1. Accordingly, in 2009, the highest annual areal precipitation during this period (~720 mm), low areal rainfall in 2008 (~445 mm) recorded for the period and spatial rainfall averages was ~575 mm (Figure 1).

Data on spatial rainfall recorded in the Central Anatolia region during the same period is given in Figure 2. In the region, the highest spatial precipitation during the period was in 2010 (~585 mm), the lowest spatial precipitation in 2013 (~295 mm), and the average spatial precipitation during the period was ~405 mm (Figure 2).

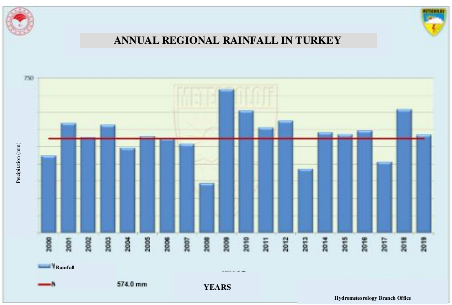

Figure 1. Annual spatial rainfall data (mm) in Turkey for the years 2000-2019 (Anonymous, 2020a).

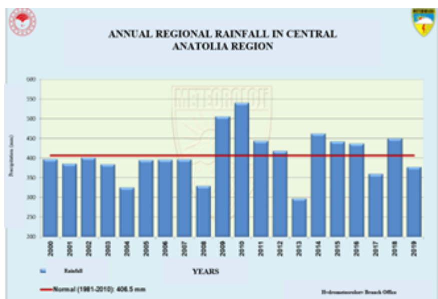

Figure 2. Annual spatial rainfall data (mm) in Central Anatolia Region for the years 2000-2019 (Anonymous, 2020b).

Again, annual regional rainfall data recorded in the Eastern Anatolia region during this period are given in Figure 3. The highest spatial rainfall recorded in the region during the period was in 2003 (~660 mm), the lowest spatial rainfall was in 2008 (~415 mm) and the average spatial rainfall was ~555 mm (Figure 3).

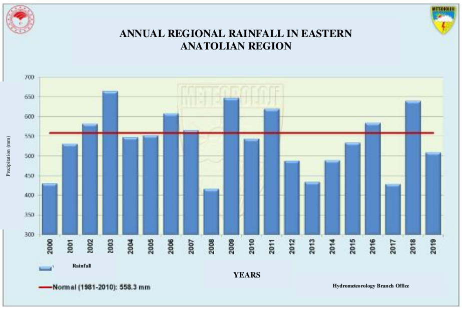

Figure 3. Annual spatial rainfall data (mm) in Eastern Anatolia Region for the years 2000-2019 (Anonymous, 2020c)

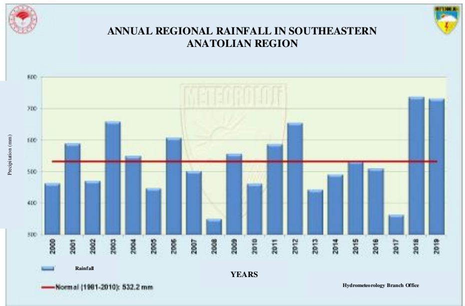

Figure 4. Annual spatial rainfall data (mm) in Southeastern Anatolia Region for the years 2000-2019 (Anonymous, 2020d).

Annual spatial rainfall data determined in the period 2000-2019 of the southeastern Anatolia region are also given in Figure 4. In this period, the highest spatial rainfall recorded in the region was in 2018 (~735 mm), the lowest in 2008 (~340 mm) and the average spatial rainfall was ~530 mm (Figure 4).

1.1. Average rainfall and fallow relation of selected provinces for many years

Selected provinces from eastern Anatolia, Central Anatolia and Southeastern Anatolia regions with annual rainfall amounts below 500 mm (between 327.70-463.60 mm) according to rainfall averages for many years between 1929-2019 are given in Table 1.

Table 1. Selected provinces rainfall average data for many years (anonymous, 2020e)

Measurement Period (1929 - 2019)

Average Monthly Total Rainfall (mm)

Cities	January	February	March	April	May	June	July	August	September	October	November	December	Annual
VAN	35.60	33.40	46.40	55.60	45.90	18.60	6.20	5.80	15.80	47.00	47.70	38.00	396.00
ERZURUM	22.10	26.00	35.10	54.10	72.40	48.90	27.10	18.10	24.20	47.80	33.30	22.30	431.40
MALATYA	42.20	40.70	48.40	55.10	45.50	17.60	3.90	3.50	8.20	35.70	41.70	40.40	382.90
SIVAS	43.10	39.10	44.90	57.00	61.10	33.90	9.70	6.70	17.80	33.70	40.40	44.80	432.00
ANKARA	40.20	35.10	39.10	42.50	51.50	34.40	14.30	12.70	18.00	27.70	31.50	44.90	391.90
KONYA	37.90	28.50	28.70	31.90	43.30	25.70	7.10	6.50	13.20	29.90	32.20	42.80	327.70
ESKISEHIR	41.40	35.80	36.90	37.20	45.40	36.00	14.60	7.90	15.30	25.20	30.40	48.10	374.20
KAYSERI	35.90	35.80	42.40	51.30	51.60	40.20	10.70	8.80	14.60	28.10	32.20	37.60	389.20
SANLIURFA	87.60	69.50	62.80	49.80	26.70	4.40	2.00	3.40	4.60	26.50	44.60	81.70	463.60
ERZINCAN	27.90	30.70	41.60	53.30	53.20	30.70	12.50	6.80	15.70	40.00	35.50	28.70	376.60
KIRSEHIR	48.40	35.20	39.30	41.50	44.80	34.60	8.30	7.90	12.90	26.70	36.40	48.50	384.50

Cool Climate cereals are generally planted in winter in all three selected regions. November, October, September begins in the favorable weather conditions and lasts until mid-November. Although the annual long rainfall averages of the provinces selected in Table 1 are close to each other, şanlıurfa has the highest annual rainfall averages with 463.60 mm and Konya has the lowest annual rainfall averages with 327.70 mm. July, August, September is the lowest period of rainfall in all of the selected provinces, on the other hand. During this period, the lowest rainfall was taken in Sanliurfa province with 2 mm. May-October 6-month period of Şanlıurfa province received a total of 67.60 mm of rainfall and this between the selected provinces in this six-month period.

February December January and 2 times more rainfall is recorded in Sanlıurfa than in other provinces (Table 1), although the lowest amount of rainfall coincides with.

Data on total agricultural areas, planted area (cereals and other field products), fallow, rainfall averages for many years and evaporation averages other than meadow pastures belonging to Turkey and selected provinces are given in table 2.

Table 2. Turkey and selected provinces field agriculture, fallow, ARMY* and evaporation data (Anonymous, 2019a-2019b).

	Cereals and other field crops products (Da)						
CITIES	**Total land**	**Sown area**	**Fallow land**	**Planted Area Fallow In (%)**	**Total Area Fallow In (%)**	**1929-2019 ARMY** mm	**1985-2019 Evaporation Average** mm
VAN	2 925 797	1 832 762	1 011 139	55.17	34.56	396.00	6.66
ERZURUM	3 472 505	2 402 060	1 043 336	43.44	30.05	431.40	5.68
MALATYA	2 799 540	1 103 092	701 200	63.57	25.05	382.90	7.15
SIVAS	7 811 593	4 771 164	2 986 122	62.59	38.23	432.00	5.68
ANKARA	11 551 947	7 879 730	2 936 645	37.27	25.42	391.90	6.66
KONYA	18 767 688	14 607 793	3 316 077	22.70	17.67	327.70	6.66
ESKISEHIR	5 549 864	3 869 235	1 533 156	39.62	27.63	374.20	5.68
KAYSERI	5 868 432	3 836 866	1 459 216	38.03	24.87	389.20	5.68
SANLIURFA	10 729 252	7 246 399	1 683 737	23.24	15.69	463.60	7.81
ERZINCAN	1 258 987	898 534	292 756	32.58	23.25	376.60	5.52
KIRSEHIR	3 250 031	2 655 985	540 950	20.37	16.64	384.50	6.17
PROVINCES SUM	73 985 636	51 103 620	17 504 334				
TURKEY	230 995 034	153 982 130	33 873 817	22.00	14.66	623.7	6.00

According to Table 2, Turkey's total agricultural area is 230.9 million, cereals and field crops are 153.9 million and fallow area is 33.8 million. In Turkey, fallow is 22% in the planted area and 14.66% in the total area. However, Turkey's average rainfall for many years is 623.70 mm and the average evaporation is 6 mm, and it is understood that precipitation fell to 617.70 mm after this loss.

* Average Rainfall For Many Years (ARMY)

Among the selected provinces, the total agricultural area is the lowest in Erzincan (1.26 million da) and the highest in Konya (18.7 million da) province. Similarly, it is understood that the area of cultivation of cereals and other field products is also located in the province of Erzincan (0.9 million da) and Konya (14.6 million da), which is the lowest. In parallel, fallow fields are lowest in Erzincan (0.3 million ha), most in Konya (3.3 million ha), fallow is highest in Malatya (63.57%) in the planted area, and the highest in Sivas (38.23%) in the total area (Table 2).

Although the total agricultural area of the selected provinces and the amount of planted area is equivalent to 32-33% of Turkey, Turkey's fallow area of 51.6% is an indicator of how dense fallow is made in these provinces. Because considering fallow rates in the planted area, the rates of Konya, Sanliurfa and Kırşehir provinces are close to the Turkish average (22.0%), while the rates of the rest are far above this average (32.58% -63.57%). However, the fallow rate in the total area is about 14.66% in Turkey, while the proportion of selected provinces ranges from 15.69% to 38.23%, and this ratio is highest in the province of Sivas (Table 2).

According to table 2, the average rainfall for many years is 623.70 mm for Turkey, while the selected provinces range from 327.70-463.60 mm, the lowest is observed in Konya and the highest is observed in Sanliurfa province. In addition, it is understood that the average evaporation rate of Turkey is 6 mm, and the selected provinces are between 5.68-7.81 mm, and this data is recorded in the highest province of Sanliurfa. In this case, it is understood that the highest average rainfall for many years (463.60 mm) and the highest amount of evaporation (7.81 mm) were recorded in the province of Sanliurfa (Table 2). In this case, on the one hand, it is understood that the rainfall averages of the selected provinces for many years are almost half that of Turkey, and on the other hand, the evaporation average of these provinces is higher than that of Turkey in general. Therefore, these provinces receive less precipitation and lose more of this precipitation by evaporation.

1.2.1 grain production and fallow applications of Turkey and selected provinces

In table 3, The selected provinces are given information about grain cultivation, production and yield in dry-watery conditions and the situation of comparing Turkey grain cultivation with these provinces.

Accordingly, 26.1 million in Turkey in the field of barley 7 million tons of production and 268 kg/da yield is obtained, 72.9 million in the field of wheat 20 million tons of production and 274 kg/da yield is obtained. In selected provinces, a total of 11.1 million tons of barley production in the area of 2.9 million and 265.4 kg/da yield, 23.8 million tons of wheat production in the area of 6.2 million tons and 262.3 kg/da yield are obtained. In this case, it is understood that 42.7% of barley cultivation in Turkey and 42.3% of its production, 32.6% of wheat cultivation and 31.2% of its production are made in selected provinces (Table 3). In other words, almost half of barley production in Turkey and 1/3 of wheat production are carried out in selected provinces. This indicates how large returns can be obtained from these provinces, especially with some improvements to be made in the field of cultivation (such as fallow) and yield.

Table 3. Turkey and selected provinces dry and watery grain data, (Anonymous, 2018b)

CITIES	Barley						Wheat					
	Dry			Watery			Kuru			Sulu		
	Cultivation (Da)	Production (Ton)	Yield (Kg/Da)	Cultivation (Da)	Production (Ton)	Yield (Kg/Da)	Cultivation (Da)	Production (Ton)	Yield (Kg/Da)	Cultivation (Da)	Production (Ton)	Yield (Kg/Da)
VAN	43858	8203	187.04	45564	10951	240.34	373299	52254	139.98	307914	55088	178.91
ERZURUM	197620	31054	157.14	96647	27499	284.53	780628	96965	124.21	344740	95911	278.21
MALATYA	345267	42921	124.31	16658	6091	365.65	311961	35150	112.67	113784	27185	238.92
SIVAS	851823	223169	261.99	52469	20889	398.12	2583718	585985	226.80	116070	38134	328.54
ANKARA	2092558	529133	252.86	49820	26325	528.40	4310474	945433	219.33	329676	147831	448.41
KONYA	2104366	531724	252.68	621274	325193	523.43	4714171	1144210	242.72	2060692	893726	433.70
ESKISEHIR	671022	159950	238.37	237923	99574	418.51	1249843	286079	228.89	572367	245042	428.12
KAYSERI	917519	249895	272.36	63467	31194	491.50	1538092	345803	224.83	163956	67479	411.57
SANLIURFA	1644726	285880	173.82	113251	52974	467.76	1023037	120653	117.94	1756654	739948	421.23
ERZINCAN	137345	28748	209.31	105047	37634	358.26	134188	25625	190.96	160893	51156	317.95
KIRSEHIR	694717	207287	298.38	52470	25003	476.52	813750	224210	275.53	60302	25295	419.47
TOPLAM	**9006104**	**2090677**		**1454590**	**663327**		**17833161**	**3862367**		**5987048**	**2386795**	
				Barley			**Wheat**					
				Cultivation (Da)	**Production (Ton)**	**Yield (Kg/Da)**	**Cultivation (Da)**	**Production (Ton)**	**Yield (Kg/Da)**	**Fallow land (Da)**		
			TURKEY	26 119 403	7 000 000	268.00	72 992 701	20 000 000	274.00	33 873 817		
			CITIES	11155411	2961291	265.46	23820209	6249162	262.35	17 504 334		

According to table 3, the total amount of barley cultivation in dry conditions of the selected provinces is 9 million, its production is 2 million tons, barley cultivation in watery conditions is 1.4 million tons and its production is 0.66 million tons. Barley cultivation in dry conditions varies between 0.04-2.1 million and is planted in the lowest province of Van (43.8 thousand) and the highest province of Konya. Barley cultivation in watery conditions varies between 0.016 million and 0.6 million and is planted in the lowest Malatya province (16.6 thousand da) and the highest Konya province.

The total amount of wheat cultivation is 17.8 million in dry conditions, production is 3.8 million tons and cultivation in watery conditions is 5.9 million tons and cultivation is 2.3 million tons. Wheat cultivation in dry conditions of the provinces varies between 0.035-4.7 million and the lowest Erzincan (134.1 thousand) is carried out in the highest Konya provinces. Wheat cultivation of provinces in watery conditions is between 0.06-2.0 million and the lowest Kırşehir (60.3 thousand) and the highest is carried out in Konya Province (Table 3).

Areas with annual rainfall of 450-500 mm is implemented in a method that is less than the fallow and planted wheat in dry conditions chosen by considering made in the field of irrigated agriculture area (17.8 million) fallow land (17.5 million) was observed (Table 3). Since fallow application significantly reduces irrigation efficiency (grass and Miller, fallow areas reduction project, such as a number of measures, if some of these areas (Rose & Light, 2002) are used in agriculture every year, both irrigation efficiency can be increased and grain or alternative product production can be increased.

2. FALLOW PRACTICES IN VAN PROVINCE

Since the average rainfall for many years is below 450 mm (396 mm), Van is one of the provinces where fallow is intensively applied (Anonymous, 2020b). In the province, except for meadow pastures, 2.9 million of the agricultural area is divided into 1.8 million decars of grain and field crops, while 1 million of the area is left fallow. Fallow area constitutes 34.56% of the total agricultural area in the province and grain and field crops constitute 55.17% of the October Area. This ratio is one of the highest in terms of land allocated to fallow among the selected provinces and is equivalent to more than 2 times the fallow rate of Turkey (22%). About 6.66 mm of precipitation received due to evaporation in the province is lost every year (Table 2).

In the province, 89.422 barley is planted in the area, including 43,858 decars in dry conditions, and 19,154 tons of production is provided from here. In this aspect, the barley cultivation area of the province is equivalent to 8% of the total of the selected provinces and 6% of the production. Similarly, 52.254 decars of wheat are planted in the area, including 681.213 in dry conditions, and 107.342 tons of production is made from here. The wheat cultivation area of the province corresponds to 2.8% of the selected provinces and 1.7% of the production (Table 3).

64.9% of the provincial land (13.5 million da) consists of meadows and pastures, 33% of the planted land (1.25 million da) is divided into forage crops and 23% is divided into grain agriculture, while 91% of it is divided into wheat cultivation. In this aspect, the largest area in the province is divided into wheat cultivation after forage crops, but the desired amount of production cannot be provided because the yield is half the average of Turkey. If fertile varieties are grown by providing appropriate maintenance conditions around the average of Turkey, it may be possible to obtain the current production in an area of half of what is divided into wheat (Altuner et al., 2019a).

On the other hand, especially with the presence of more than 2.5 million small animals, animal husbandry is intensively carried out in Van, which was the first place in Turkey. In order to meet the feed needs of all animal beings together with cattle, 2.3 million tons of eating and 2.5 million barley planting areas are needed, except for the pasture period, to produce the necessary barley. Because the area currently allocated to production is not enough for this, fallow areas, unused agricultural areas and wheat cultivation areas allocated to extra production should be used for this purpose (Altuner et al., 2019b).

One of the ways to prevent the separation of agricultural areas into fallow is to open these areas for irrigation. In this aspect, new areas are opened for irrigation in the province both naturally from stream sources and with Irrigation Investments made by the RDW[6]. In this context, information about irrigation studies carried out by RDW is given in Table 4.

Table 4. Rdw Van province land irrigation records (Anonymous, 2019c)

LAND TYPE IN TERMS OF IRRIGATION	QUANTITY (Decare)
Surveyed Land Presence	2.194.350
Irrigable Land Presence	1.965.880
Economically Irrigable Land Presence	1.176.240
Amount Of Land in The Planning Stage	268.110
Amount Of Land at Project Stage	85.870
Amount Of Land under Construction	206.650
Amount Of Land Open to Irrigible	615.561

According to table 4, the amount of land surveyed is 2.19 million, the amount of irrigable land is 1.96 million, and the amount of economically irrigable land is 1.17 million decars. While the actual

[3] Regional Directorate of Water Affairs

amount of land irrigated in the province is 615.561 decars, the entire economically irrigable amount will be irrigated with the completion of the planned, planned and under construction facilities. In this way, 2.9 million in the province (except meadow and pasture) more than 1/3 of the agricultural areas will be irrigated. More than half of the land that can be irrigated economically with current irrigation is irrigated, which is equivalent to 1/5 of the agricultural land of this province. If the new areas to be opened for irrigation are equivalent to fallow areas (1 million da), it will be possible to open half of them to watery agriculture.

3.SOME MEASURES THAT REDUCE FALLOW AREAS

In our country, since the annual rainfall is below 500 mm, reducing the fallow areas in the selected provinces where the application is intensive and in the province of Van will make a serious contribution to the economy due to the increase in the amount of grain or alternative products produced.

In this context;

- Irrigation, which also provides a significant increase in yield and production in agricultural areas, is seen as the most effective way to reduce fallow areas, it is stated that the increase in production in the Eastern Anatolia region, where fallow is intensively applied, can be up to 4 times. However, all fallow lands in our country do not have suitable properties for irrigation due to restrictions such as topography, technical deficiencies and soil, and only 14.7% of our irrigation resources (103.8 billion m^3) are used (Yasar, 1999). The GAP project is an example of irrigation significantly reducing dry farming practices, with the project reducing fallow areas by over 35%.

-Apart from the regions where fallow practice is mandatory due to climate restrictions, there are currently areas where fallow areas can technically be reduced by a number of cultural practices. In this context, chickpea and lentil farming was carried out in fallow areas with the Çorum-Çankırı Rural Development Project and fallow areas were reduced by 17% (Yasar, 1999).

-It was determined that more wheat was produced from tillage-free agriculture (Ergul, 2011; Halal & Ferhatoglu, 1989) than tillage methods (Ergul, 2011), especially during periods when rainfall was low. For this reason, it will be possible to reduce fallow areas by providing organic matter and moisture accumulation in the soil (Ergul, 2011) by popularizing tillage methods without tillage or reduced tillage (Yur, 2018). In addition, operating expenses such as fuel labor can be significantly reduced by non-working and reduced tillage methods (Zeren et al., 1993).

-Fallow-wheat without tillage and lentil without tillage-wheat sowing alternation systems have seen an increase in wheat production (Ergul, 2011), but it is understood that annual production will be less than the lentil-wheat when production is divided into two years in fallow-wheat alternation. However, an alternative production such as lentils can be realized in the last year according to the fallow-wheat system in the lentil-wheat alternation. It is clear that this system can also be used to reduce fallow areas.

- Also Oil Seed Plant (rapeseed, safflower, etc.) by agriculture method protected from Fallow application in semi-arid regions.) and legumes (lentils, chickpeas v.b.) (Larney & Lindwall, 1995).

It was determined that fallow application in places where annual rainfall exceeds 400 mm did not constitute a serious change in production. But fallow is not only a practice due to precipitation, but also occurs through the interaction of soil, climate and plant desires (Yasar, 1999).

RESULTS

Fallow is the fact that agricultural land that should be used in production is left empty for a year due to lack of precipitation or irregular precipitation during the year. Although this practice is mandatory, it quite restricts the efficient use of agricultural land in production. Agricultural land tends to decrease continuously with the fact that natural causes and human intervention techniques and measures that would reduce fallow has become vitally important today to find and apply.

Some studies conducted from time to time against this practice, which has existed in the world and in our country for many years, have been able to reduce the amount. However, since projects such as the narrowing of fallow areas (NAD) laid out in this framework in our country have been implemented temporarily, their positive effects have remained periodic.

Currently, there is a fallow area of 22% in Turkey, and this amount has been constant since the nineties. In some provinces of Turkey, the fallow rate is up to 63%. In the province of Van, the fallow rate in the cultivation of field crops is about 55%. However, as in many places, not all fallow practices in this province are caused by meteorological restrictions. In this case, some of the land left fallow arises from lack of technical knowledge and traditional agricultural culture practices. One of the most important reasons for this is that irrigation resources are not used adequately and consciously.

For some time, some legumes with agricultural cultures without tillage or reduced tillage have been introduced to sowing with wheat and fallow practice has been abandoned. Currently, due to both land decline and restrictions on its efficient use, some measures are sorely needed to reduce the practice of fallow. Switching from dry agriculture to watery agriculture culture by activating irrigation resources, placing low water consumption legume group plants in the sowing alternation of grain agriculture and increasing the areas grown by protected agriculture method of oilseed plants can be listed as effective measures.

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CHAPTER 5

THE IMPORTANCE OF GENETIC RESOURCES AND THEIR USE IN WHEAT BREEDING

Assoc. Prof. Dr. Mehmet KARAMAN*

*Muş Alparslan University, Faculty of Applied Sciences,
Department of Plant Production and Technologies, Muş, Turkey
E-mail: m.karaman@alparslan.edu.tr, ORCID: 0000-0002-6176-9580

INTRODUCTION

Wheat is considered to be the most cultivated grain in the world, dating back to 8-10 thousand years BC. (Kan et al., 2015). Wheat is rich in terms of B, E vitamins, selenium mineral and micro elements. While this aspect of wheat causes it to be an important energy source in human nutrition, it has been reported that this rich content wheat corresponds to 20% of the energy need of the world population (Cummins & Robert-Thomson, 2009).

Turkey, one of the important centers that grows naturally of the wild species. Wild species are the ancestors of modern wheat varieties cultivated today (Figure 1). Famous Russian scientist Vavilov identified eight centers of origin where wild forms of plants cultivated around the world are found.

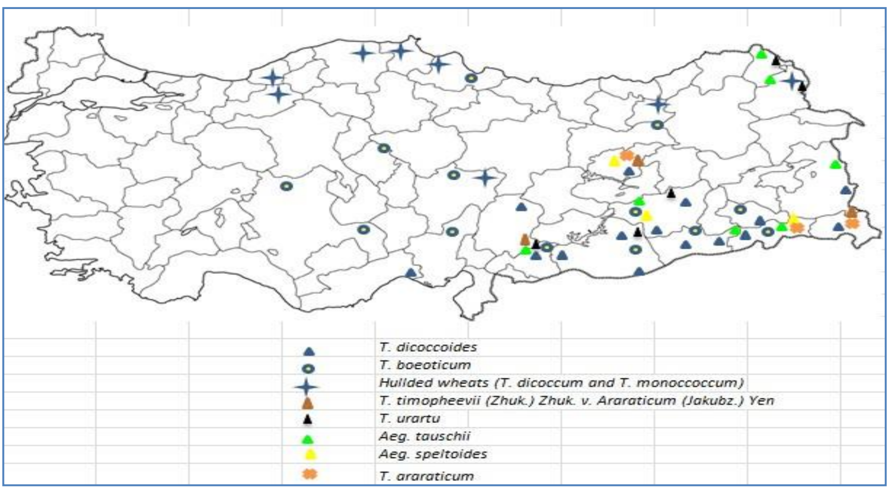

Figure 1. Turkey Map Showing the Distribution of Wild Wheat Species (Aktaş et al., 2017).

In terms of origin and variation of agricultural products, Near East and Mediterranean Origin Regions are among eight origin centers. This region has a very rich vegetation has been reported to take place in Turkey (Vavilov, 1987; Özberk et al., 2016b).

Wild and landraces wheat grown in different locations in Turkey's natural environment; It is the main source of the genetic progress achieved in increasing the adaptability of wheat, developing and spreading modern varieties with different breeding methods (Özberk et al., 2016b).

Figure 2. The Fertile Crescent (Mesopotamia), The Map Showing the Area Covering Turkey (Özberk et al., 2016b)

In the light of the data obtained from archaeological excavations, wheat farming in Turkey Neolithic age (about 10,000 years ago) it was determined to hang on. However, the region known as the homeland of wheat (Fertile Crescent) encompasses the Southeastern of Turkey too (Figure 2).

It is accepted that the wheat spreads from the Fertile Crescent Zone to the world. In the past centuries, people used wild wheat species such as *T. monococcum* (Siyez) and *T. dicoccum* (Gernik), which are the ancestors of modern wheat, by directly gathering them from the nature in the periods when they suffered from food shortages. It has been reported that in the past, when people started agricultural activities, these wild species were grown and taken into culture by farmers (Karagöz et al., 2010).

The aim of this study is to draw attention to the wild wheat species and wheat landraces, which are the ancestors of wheat and also have great importance as genetic resources, and to contribute to the wheat breeding programs for the use of these genetic resources in breeding.

TRANSITION FROM WILD FORMS TO CULTURE FORMS

When the evolution process of wheat is examined, it is understood that the A genome donor is Triticum urartu and the B genome donor is Aegilops speltoides. Also, T. dicoccoides was formed by cross of T. urartu and Aegilops speltoides under natural conditions (Figure 3, 5). In addition, it is known that Aegilops tauschii as the DD genome donor plays a role in the formation of bread wheat (Figure 3, 5). The visual presentation of some of the ancestors of wheat is given in Figure 3.

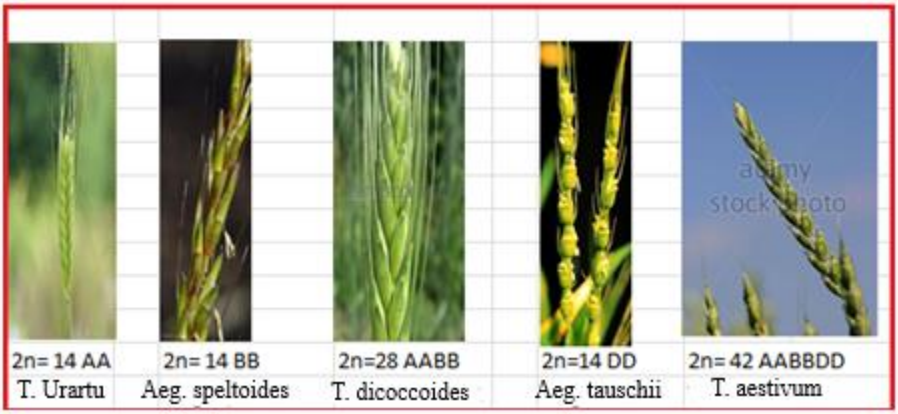

Figure 3. Wheat Ancestor Some Wild Species and Bread Wheat (Anonymous, 2020b)

Culture varieties can be divided into 2 groups as spa and bare wheat. Wheat in the spa group is difficult to separate from its shell by blending. For this, pre-treatments such as boiling the grain are applied. The ancestor of Siyez (*T. monococcum*) is *Triticum baeoticum*, a wild species (Figure 6). Again, from another spa group, the gernik (*T. dicoccum*) is a tetraploid species and is derived from its ancestor *T. dicoccoides* (Karagöz, 1996; Kan et al., 2015). With the evolution of *T. dicoccum*, today's modern wheat *T. durum* has emerged (Figure 4).

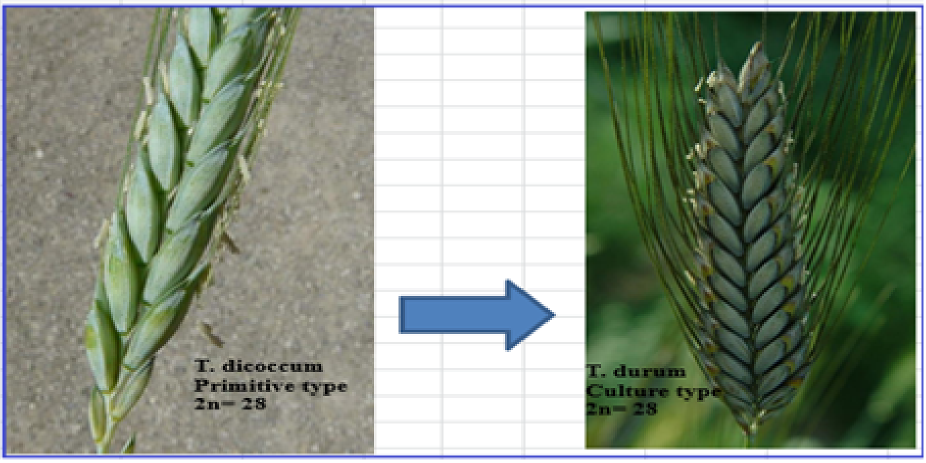

Figure 4. Primitive and culture types of durum wheat (Anonymous, 2020b)

Southeast of Turkey and Syria's northern regions are considered of the first places where agricultural activities.

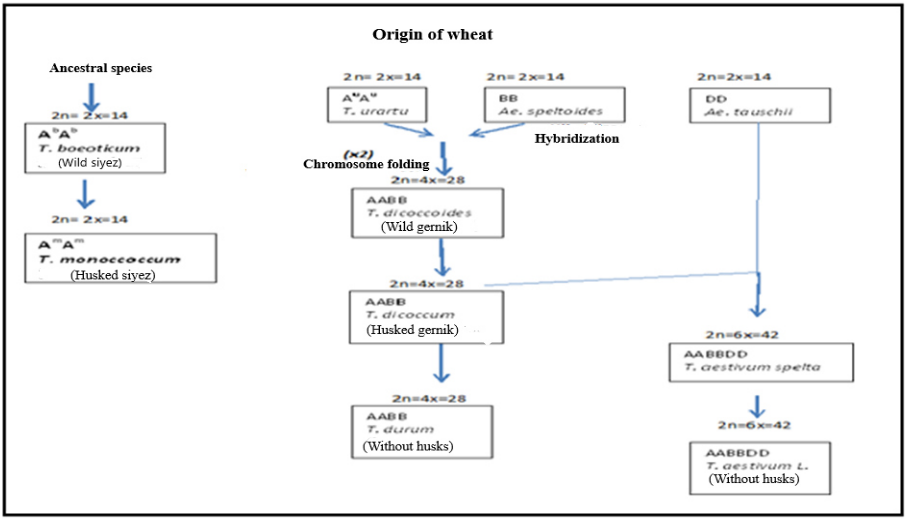

Figure 5. From Wild Wheat to Modern Wheat the Development Process of Wheat (Chantret et al., 2005).

In addition, these areas are considered rich in terms of wheat's ancestors. It has been determined that the wild wheats grown in these regions are the species closest to today's modern wheats in terms of genetic basis. Also, there is more genetic diversity in these areas (Lev-Yadun et al., 2000; Alsaleh et al., 2016; Aktaş et al., 2018).

Many of the physiological and morphological characteristics of wild wheats, which are the ancestors of today's culture wheats, have been modified according to the needs of people with natural and artificial selection (Nesbitt et al., 2001).

Figure 6. Primitive and wild types of wheat (Anonymous, 2020b)

In particular, spike crushing and blending feature are the leading features that are changed by selection. While it is seen that wild wheat species have high spike breaking, it is low in modern forms. For example, *Triticum monoccum*'s spike breaking is lower than its ancestor *Triticum boeoticum* (Chantret et al., 2005).

PURPOSES OF WHEAT BREEDING

Sowing of bread wheat in the world and Turkey constitutes of total wheat cultivation approximately 90%. When Turkey's wheat production examined in the Southeastern Anatolia Region and the coastline is determined that cultivated varieties of spring. In addition, facultative (alternative) or winter varieties are grown in Central, Eastern Anatolia and transition regions. In particular, the Southeastern Anatolia Region ranks first in quality durum wheat cultivation (Özberk et al., 2010).

In wheat breeding, by using breeding methods such as cross, selection and mutation, it is the main objectives to contribute to agricultural production by developing high-yielding and high-quality varieties with high adaptability to ecological conditions, resistant to diseases and pests.

2020 in Turkey, Seed Registration and Certification Center according to the records; 346 bread wheat and 87 durum wheat varieties were developed by using different breeding methods through the Research Institutes of the Ministry of Agriculture and Forestry and the private sector (Anonim, 2020).

CURRENT STATUS AND FUTURE OF WHEAT LANDRACES FROM GENETIC SOURCES IN WHEAT BREEDING

Wheat landraces has been developed by natural or artificial (by human intervention) selection in the world and Turkey. Although there are no official statistical records, the cultivation areas of landraces have shrunk mostly for economic reasons. In addition, it is believed that about 565.312 hectares area belongs to landraces in Turkey (Karagöz, 2014; Özberk, 2016a).

Among the wheat landraces, mostly cultivated varieties; Karakılçık, Kırik, Şahman, Ak, Siyez, Koca, Zerun, Sarı, Kırmızı, Topbaş, Üveyik and Göderedi landraces are reported. In addition, it was emphasized that Zerun, Red Wheat and Kırik varieties of these landraces are generally used in bread making, while Siyez, Şahman, Yellow Wheat varieties are used in making bulgur. The image of some wheat landraces cultivated intensively is given in Figure 7.

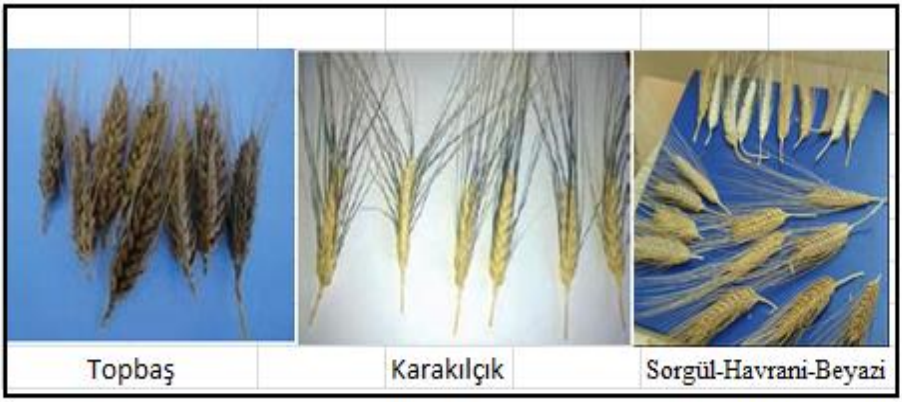

Figure 7. Some Wheat Landraces (Anonymous, 2020b)

In Turkey, when the state of the natural environment are evaluated on the basis of wheat landraces in the Southeastern Anatolia Region is determined that the highest variation (Kan et al. 2017).

Although not widely cultivated, wheat landraces with a small amount of production are; Çalıbasan, Şahman, Antik Hitit, Zı, Zerun, Sorgül, Beyaziye, İskenderi, Misri, Polatlı Kösesi, Kobak Buğdayı, Akçalıbasan, Erzurum Kızılcası, Kamçı, Beyaz Kelle, Mor Buğday, Aşure, Menceki, Yayla-305, Şigon, Gülümbür, Sünter, Deli Hüseyin Buğdayı, Tir Buğdayı, Bagacak, Havrani, Kavılca, Havran Red Corn, Göremez, Karabuğday, Dede buğday, Yerli buğday, Kunduru, Sarı Bursa (Morgounov et al., 2016).

Due to the high straw yield of wheat landraces, it is preferred by farmers in family business. In addition, it is accepted that products such as bread, bulgur and baklava obtained by using landraces are of higher quality and natural, although their prices are high, some consumer groups prefer them. It is predicted that the increase of these products obtained from wheat landraces will contribute to the spread and continuation of the agriculture of these varieties (Kan et al., 2015).

In the studies conducted on wheat landraces, it was observed that the cultivation areas decreased day by day, as well as the number of morpho-types (different phenotypes representing the same variety) of each variety. It was previously determined that the number of 3.7 morpho-types representing each variety is 2.3 today (Morgounov et al., 2016). In studies based on previous years, it was observed that landraces lost with the widespread use of culture (modern) varieties, and 75% of the variation in cultivated species disappeared (Hammer 1996; Witcombe et al. 1999; Salantur et al., 2017).

Since the yield of landraces is low compared to culture varieties, they cannot compete with culture varieties commercially. In addition, the cultivation areas are decreasing due to their tendency to lying due to their tall height and their low response to nitrogen applications. (Özberk et al., 2010).

Therefore, landraces are not preferred commercially by the producers and their production areas are decreasing day by day. However, landraces are disappearing due to lack of sufficient incentives for the conservation of landraces. In order to prevent the extinction of wheat landraces, it is important to preserve the seeds of these varieties in-situ or ex-situ (gen bank). The biggest advantage of in-situ conservation is that plants continue to evolution. In addition, genetic diversity is preserved in in-situ conservation due to excessive sampling. Therefore, in-situ conservation is of great importance for the sustainability of our genetic resources.

Today, the demand for organic products is high and the demand is increasing day by day. Global warming, temperature, precipitation amount and the instability of precipitation on the basis of months affect modern varieties very negatively. Wheat landraces are well resistant to biotic and abiotic stress factors. Therefore, their conservation to enrich the genetic base will be the determining factor in enriching the genetic base of modern varieties. Therefore, it is very important that the Ministry of Agriculture and Forestry includes the landraces support program and supports the projects developed in cooperation with universities in order to prevent the extinction of wheat landraces.

USE OF GENETIC RESOURCES WHEAT BREEDING

Reclamation work done over many years to develop high-yielding wheat varieties in the world and in Turkey caused the genetic base of culture varieties very constriction. This situation has caused the cultivars to be sensitive to disease, pest and stress factors.

Genes are needed to eliminate these factors limiting yield. Wild species and landraces, which are the ancestors of today's culture wheat, have been exposed to biotic and abiotic stress factors for many years and have reached the present day by natural or artificial selection. These genetic resources; It has an important potential for breeding genotypes resistant to disease, pest and stress factors. In recent years, many characteristics have been transferred from landraces and wild wheat varieties to culture varieties in breeding studies focused on variety development (Cox et al., 1995; Hajjar & Hodgkin, 2007; Aktaş, et al., 2018).

Today, modern wheat varieties are cultivated in large areas. Gene pool theory (Harlan & De Wet, 1971), guides the utilization in classical breeding programme of gene resources to develop wheat varieties that tolerate biotic and abiotic stress factors. Accordingly, there are 3 different gene pools linked to each other:

- In the 1st gene pool, there are landraces (village varieties) and culture (modern) varieties that give fertile offspring when crossed with each other.

- There are wild relatives in the 2nd gene pool. Wild relatives give largely non-fertile (sterile progeny) offspring when crossed with varieties in the 1st gen pool.

- There are relatives distant of wheat in the 3rd gen pool. When the gene transfer is made from the 2nd gen pool to the 1st gene pool, the gene can be transferred by the following methods:

a-) Directly select varieties with the same or different chromosome number

b-) Using the bridge crossbreeding method (eliminate the possible fertility barrier between X and Y varieties to be crossed crossbreeding X with Z first, then crossbreeding the resulting hybrid progeny with Y in order to) c-) Vaccination and embryo recovery can be done gene transfer with physiological manipulations such as.

d-) Gene transfer can be performed by chromosome adisyon and substutisyon lines or chromosome manipulations such as chromosome translocations and matching control.

Although the yield and quality of today's modern varieties are higher than the primitive varieties (wild and landraces), the genetic base has narrowed. Many of the registered varieties have been similar to each other. In order to enrich the genetic base of modern varieties, genetic resources can be used directly as genitor by crossbreeding.

It has also been stated that genetic resources can be used in bridge cross to eliminate biotic and abiotic stress factors that significantly affect yield and quality (Şehirali & Özgen, 1987).

CONCLUSION AND RECOMMENDATIONS

Although there are many modern (culture) wheat varieties today, most of them show similar characteristics. This indicates that the genetic base has narrowed considerably. The separation of marginal agricultural lands into housing construction, industry or other different sectors further restricts the habitat of landraces and wild species. It is necessary to take legal protection measures at the state level to protect our cultural and historical heritage, genetic resources.

In addition, it is important to include this legacy in the scope of state support in order to increase the production areas and to support the projects that encourage their cultivation. The conversion of pasture areas, which are natural habitats of genetic resources, to agricultural production areas should be prevented. In addition, unconscious use of pesticides should be avoided so that genetic resources are not destroyed.

Awareness raising activities should be carried out at the country level in order to preserve our genetic resources. To increase variation, local varieties and wild species should play a greater role in the development of modern varieties.

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CHAPTER 6

THE EFFECT OF DIFFERENT DOSES NITROGEN AND FARM MANURE APPLICATIONS ON THE YIELD AND YIELD COMPONENTS IN WHEAT (*Triticum aestivum* L.) *

M Sc Abdullah EFE*

Assoc. Prof. Dr. Necat TOĞAY**

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*GAP International Agricultural Research and Training Center, 21280 Diyarbakir Turkey. abdullah.efe@tarimorman.gov.tr

**Fethiye ASMK Vocational High School, Mugla S. K. University, 48300 Mugla, Turkey. necattogay@mu.edu.tr

* The study is part of the master's thesis.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in world and is the staple food for humans. Wheat is cultivated on 30.2 million ha area with production of 95.4 million tonnes, with a productivity of 3.158 kg/ha (Agricoop.nic.in, 2018). Nitrogen is the major nutrient added to increase crop yield (Camara et al., 2003). Nitrogen is the major element of chlorophyll, protein and amino acids and play an important role in wheat productivity. Wheat growth and lodging were recorded due to under- and over-application of nitrogen respectively than the optimum level (Hawkesford, 2014). Nitrogen enhances spike population and has a greater contribution in yield components (Maqsood et al., 2014), increased leaf area index and grain yield. Research on synthetic nitrogen fertilizers depleted soil nitrogen (Mulvaney et al., 2009) showed that inorganic N fertilizers mainly in ammonium form reduced the mass of organic carbon due to more consumption through microorganisms and decreased total nitrogen within the soil because of more nitrogen uptake by the grains. Chaudhary et al. (2009) have reported that high cost, degradation of soil and environmental pollution are the major problems of commercial fertilizer applied alone. Organic manures have direct and indirect effects. Organic manures are considered to produce higher crop productivity for sustainable agriculture. It adds organic matter, improves soil and water quality, increases infiltration, decreases run-off and pollution in addition to less soil disturbance and lesser erosion. It optimizes water-storage capacity in the soil profile. Protective tillage provides a good environment for growth and development of crop, thus resulting in increased wheat yield because of improved soil water and thermal status (Yang et al., 2017). In the recent years, there is much concern about soil health, pollution and healthy food. The organic sources of nutrients supply micro-nutrients in addition to macronutrients to the crops. Organic sources like vermicompost and farm yard manure are environment friendly, rich in nutrients and enzymes, add organic matter into the soil and help conversion of waste into manures. They are also cost effective and food grown through these manures are safe to eat. Continuous application of farm yard manure and green manure improves the soil fertility, soil health, adds organic matter, enhances micro-organisms, increases moisture-retention capacity of soil and also soil organic carbon content and photosynthetic rate (Biswas et al., 2014).

The aim of this study was to elucidate the effect of different doses nitrogen and farm manures applications on the yield and yield components in wheat**.**

MATERIALS AND METHOD

Ceyhan-99 cultivar was well adapted wheat in Mardin ecological conditions. Farm manure used in this research includes organic matter, nitrogen, phosphorus and potassium in level % 0.85 N, % 0.66 K ve % 0.14 P respectively.

In 2012-13 precipitation throughout the season was 981.6 mm and the average over the long-term for the same period was 660.8 mm. Average temperature was 13.2ºC in 2013-2013 an increase in average temperature relative to long term average of 11.9 ºC. Average relative humidity was 51.6%, (TSMS, 2013).

The soils are classified as entisols according to soil taxonomy (Soil Survey Staff, 1999). The results of calcareous soil analysis were as follows: sandy loam texture, very low in organic matter and moderate in available phosphorus (Table 1).

Table 1. Some properties of the <2 mm fraction of the top 20 cm of soil used for site

Soil properties	2012-13
Texture	Clay
pH[A]	7.62
Clay (%)[B]	50.3
$CaCO_3$ (%)[C]	31.6
Olsen soil test P (ppm)[D]	6.23
Total Salt (%)[E]	0.062
Organic matter (%)[F]	1.68

[A] 1 : 2.5 soil : water, [B] Bouyoucos (1951), [C] lime by calcimetric methods, [D] Olsen et al. (1954), [E] Richard (1954), [F] Jackson (1962).

The study was designed as Split Plots Design in Randomized Blocks with three replications. The plot was $5m^2$ (1 m x 5 m) and included five rows and sown wheat manually in rows 20 cm apart and not irrigated. Winter wheat was seeded at 500 seeds per square meter sown on 22 October 2012. The effects of nitrogen doses (0, 40, 80, 120 and 160 kg N/ha with sowing and 60 kg N/ha top fertilizer with tillering season except control plots in total (0, 100, 140, 180 and 220 kg/ha N) under the condition with farm manure (20 tones/ha) and without farm manure on yield and yield components of Ceyhan-99 wheat cultivar was investigated. At sowing, 90 kg ha^{-1} P_2O_5 was uniformly applied in the trial area.

Wheat was manually harvested on 07 July 2013. Harvest area was 2.4 m^2 which excluded one row from both sides of each plot and 50 cm from both ends. Data on grain and biological yields of wheat were recorded from the whole plot, but the yield components data were recorded from randomly 10 plants selected in each plot. Sub samples of the harvested grain and shoot were used to measure total Nitrogen by the Kjeldahl method (Bremner 1965). Total N was multiplied by 6.25 to obtain % crude grain protein.

The effect of treatments on wheat were analyzed using analysis of variance procedures for a Split Plots Design in Randomized Blocks with the COSTAT statistical package. The means related with yield and yield components in wheat were evaluated with Duncan's Multiple Range Test statistical analysis.

RESULTS AND DISCUSSION

The effect of different doses nitrogen and farm manure applications was statistically significant. The tallest plants were obtained from 220 kg N ha–1 with 81.60 cm and 20 tones/ha farm manure with 78.57 cm. The differences between 220 kg N ha–1 and 180 kg N ha–1 were not significant for plant height. The shortest plants were found in control (Table 2). These findings agreed with those reported by Kiani et al. (2005) and Abbas at al. (2000).

While the average spike length obtained from the parcels without farm manure was 11.80 cm, the average spike length obtained from the parcels where farm manure was applied was 13.38 cm. The lowest average spike length obtained from nitrogen dose applications was obtained from the parcel treated with 11.66 cm and 0 kg / da of nitrogen. The highest average spike length was obtained from 13.33 cm and 22 kg / da nitrogen application. The findings of the Başar et al. (1998) the findings obtained in the study are similar.

While the average number of spikelets obtained from parcels without farm manure was 15.16 number, the average number of spikelets obtained from parcels with farm manure was 17.39 number. The average number of spikelets obtained from nitrogen dose applications varied between 13.83-18.66 numbers. The number of spikelets is a feature that directly affects the yield. Kiani et al. (2005) reported that the effect of farm manure applications on the number of spikelets is not significant. It is thought that this difference may be due to the variety used, the difference in climate and soil conditions.

Grain number per spike is a feature that has a direct impact on yield. While the average number of grains per spike obtained from parcels without farm manure was 29.73, the average number of grains per spike obtained from parcels where farm manure was applied was 34.16. The average number of grains per spike obtained from nitrogen dosage applications varied between 27.06-37.03 pieces. Başar et al. (1998) reported that the effect of nitrogen application on the number of grains per spike was 1% effective.

Table 2. Effect of different doses nitrogen and farm manure on the yield parameters of wheat

Treatments	Plant height (cm)	Spike length (cm)	Number of spikelet (plant^{-1})	Seeds per spike (plant^{-1})	1000 seed weight (g)	Biological yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Protein ratio in seeds (%)
Doses Nitrogen								
0 kg/ha	71.50 d	11.66 d	13.83 d	27.06 e	33.20 c	11561 c	3799 d	12.02 b
100 kg/ha	74. 80 c	12.21 c	14.66 c	28.78 d	34.11 b	11695 bc	3964 c	12.46 ab
140 kg/ha	76.88 b	12.73 b	16.13 b	31.36 c	34.66 b	12053 b	4211 b	12.61 a
180 kg/ha	80.61 a	13.01 ab	18.08 a	35.48 b	35.88 a	13162 a	4703 a	12.61 a
220 kg/ha	81.60 a	13.33 a	18.66 a	37.03 a	36.50 a	13309 a	4812 a	12.88 a
Farm Manure								
0 kg/ha	75.58 b	11.80 b	15.16 b	29.73 b	34.3 b	11843 b	4044 b	12.28 b
20 tones/ha	78.57 a	13.38 a	17.39 a	34.16 a	35.44 a	12860 a	4551 a	12.75 a

Biological yield can also be defined as total yield or stem + grain yield. Ecological conditions, breeding techniques and genotype affect biological yield. While the average biological yield obtained from 0 kg /ha farm manure application was 11843 kg /ha, the average biological yield obtained from 20 ton / da farm manure application was 12860 kg / ha. Shah & Ahmad (2006) stated that at the end of the study they applied urea and farm manure to wheat, the highest biological yield was obtained from farm manure application with urea compared to the control. Biological yield averages obtained from nitrogen applications varied between 11561- 13309 kg /ha. Erdem et al. (2010) reported that different nitrogen applications in wheat increased the dry matter yield. While the average grain yield per unit area obtained from farm manure-free application was 4044 kg /ha, the average grain yield per unit area obtained from farm manure (20 tons / da) application was 4551 kg /ha. Kiani et al. (2005) reported that the application of barn manure alone and in combination with mineral fertilizers increased the grain yield compared to the control. The average grain yield per unit area obtained from nitrogen applications varied between 3799-4812 kg / da and the lowest unit area grain yield was obtained from control plots and the highest unit area grain yield was obtained from the application of 220 kg / ha nitrogen, and the parcels with 180 kg / da nitrogen were the difference between were not statistically significant. Sağlam et al. (2004) reported that increasing nitrogenous fertilizer doses increased yield in wheat.

While the average protein rate in the grain obtained from 0 kg / da farm manure application was 12.28%, the average protein rate in the grain obtained from 20 tons / ha farm manure application was 12.75%. Shah & Ahmad (2006) reported that the highest nitrogen content in the grain was obtained from farm manure application. The average protein ratio in the grain obtained from nitrogen applications varied between 12.02 and 12.88%, while the lowest protein ratio in the control plots and 10 kg / ha nitrogen application, the highest protein ratio in the grain was obtained from 14, 18 and 22 kg / ha nitrogen application. Zhao et al. (1999) findings are consistent with those in our study.

CONCLUSION

In the final course of the study, it is concluded that, for soils of this region, which have poorer nitrogen content and which are highly alkaline, 20 tones/ha farm manure + 220 kg/ha nitrogen application would bring good results and thus could be beneficial in order to have adequate wheat farming. Application of farm manure at optimal doses together with nitrogen fertilizing may provide balanced significant increase of crop productivity and the important of production quality. In addition, remove lack of roughage will be contributed by used as roughage of cereals, because there is too lacking roughage in Turkey. Information gained from this trial will be utilized to develop more efficient farm manure nitrogen fertilization in winter wheat.

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CHAPTER 7

OATS IN A GLOBAL IMPORTANCE, PRODUCTION AND IMPROVEMENT TRENDS

Dr. Muhammad IKRAM*
Assist. Prof. Dr. Haseeb UR REHMAN*

*Department of Agronomy Faculty of Agricultural Sciences and Technology Bahauddin Zakariya University, Multan Pakistan, r4rana88@gmail.com

INTRODUCTION

The oat (*Avena sativa*), commonly known as "oat" belongs to the family *Poaceae*, as a cereal grain crop, majorly cultivated all over the world. Moreover, it is suitable for wide variety of soil shapes, elevations and precipitation circumstances. A moderate and subtropical environment is a perfect choice for development. The optimum temperature during the growing period is 16-32°C and the good distribution of precipitation is 400 mm, which is abundant to fulfil its demand as a forage as for the quality of the oats (Bhatti, 1992). It contains calcium 0.82%, phosphorus 0.27%, protein 9.23%, fat 3.56% and fiber 30.44% (Chaudhary, 1994). Oats provide nutritive food during hot time of March and are popular with animals. It is the delicious food of all animals and its straw is softer than wheat and barley.

Oats are used as grain, fodder and fodder, as straw, hay and transport for fodder. Silage and chaff, dietary uses of oats include oatmeal, used as breakfast cereal, and other food ingredients. They are basically nutritious grains, with a high content of fiber and protein. The protein content in oat meals has generally higher than grains. Many of the minerals with vitamins in oats are incorporated into bran and germ. Most oatmeal foods used whole grain to make it a highly rich minerals grain. Oats have a 2000-year history and are used for mammals feed and human porridge. With comparing of barley and wheat, oats are more sensitive in different climatic conditions, but they have few resistances to cold and drought, improving oat varieties and limited agronomic research are other factors that reduce oat yield.

Oat plays imperative role in world-wide agriculture to manage the expanded interest for food achieved by populace development. Oats speak to over 60% of the total populace. Oats are utilized for food because of the nourishing nature. It produces 21% of the world's energy and 15% of protein. In 2017, the absolute total planting area of oats was approximately 158.5 million hectares, with a yield of 478.3 million tons, an increase of 2.06% over the previous year (FAO, 2017). Oats are the main staple food, one of profitable cash crops in kharif season. Farmers based on oat farming as primary source of income. It pays 3.0% to value added and 0.6% of GDP. China is third main oat producer in the world. In that year (2016-2017), in Pakistan cultivated area of oats was 2.724 million hectares, most of which was planted on production land in Sindh and Punjab, a decrease of 0.6 % compared to last year. The decrease in the area under oat cultivation is due to the decrease in the number of domestic oats. In addition, water is scarce and energy consumption increases. Since there is no water nearby, most of the area has become desolate.

In addition, the groundwater level is insufficient to meet the demand for crops (GOP Economic Survey, 2016-17). Mahmood *et al.*, 2014 noted that oats are the only crop that requires a lot of water to increase productivity. It is estimated that to produce a single kilogram of oats, approximately 2.300 to 2.500 litters of water are used. It is predicted that in 2025, the productivity of irrigated oats will be endangered due to water scarcity. Freshwater availability is threatened with extinction, so farmers pump large amounts of water, which lowers groundwater levels. A large amount of water pumping increases the cost of inputs for farmers (Priyanka et al., 2012). In order to reduce the demand for water, a new concept is needed to grow oats under aerobic conditions.

Nutritive Profile:

Nutritional value per 100g(3.5cm)	
Energy	1.628kJ(389Kcal)
Carbohydrates	66.3g
Dietary fiber	10.6g
Protein	16.9g
Vitamins	
Thiamine(B1)	(66%)
Riboflavin(B2)	(12%)
Minerals	
Calcium	(5%)
Iron	(38%)
Magnesium	(50%)
Potassium	(9%)
Zinc	(42%)

Table1: Oat Nutrition and Technology (YiFang Chu, (2013).

The agricultural sector plays a central role in the Pakistani economy. It represents 19.5% of GDP, which has a significant impact on national economy (GOP Economic Survey, 2016-17). In order to reduce water and labour requirements, farmers have switched to aerobic oats instead of puddle oats. Aerobic oats are new growing strategy that maintains the level of humid. Cereal crops have much importance because these are cultivated on greater quantities around the world and used as a greater source of food feasting. Cereals are good source of vitamins, protein also have high nutritional value.

Oats are mainly used as forage crops and feed grains. Pliny, who reported on human consumption of oats, said in "Natural History" that the first-century Germanic tribes made "their porridge." Later, oats were widely recognized in Ireland and Scotland, where people made all kinds of porridge. In the 19th century in the United States, oatmeal was sold almost exclusively in drugstores and was recommended as a food to treat the infirm. At the end of the 19th century, German immigrant Ferdinand Schumacher helped make oats the best-selling grain in the United States. Its innovations include large-scale domestic flour production, the production of oatmeal from pharmacies to grocery stores, and the development of packaging, brand names and promotional literature.

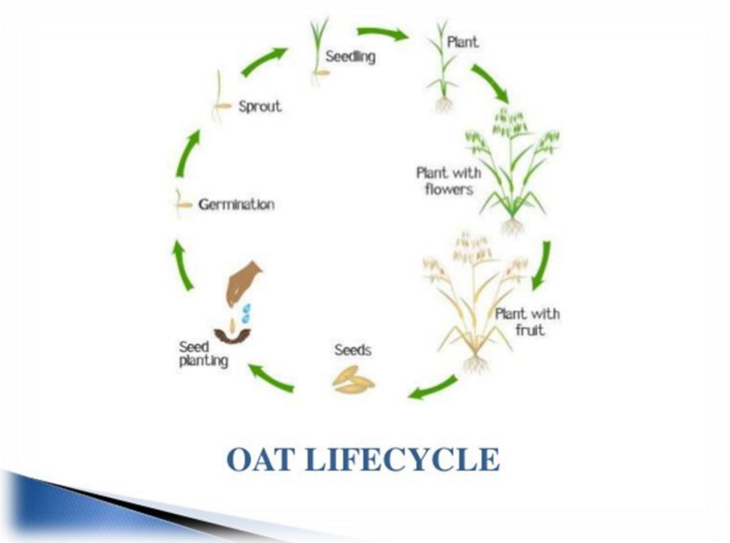

Fig2: Oat life cycle (Breanne D, 2016).

Scarcity Period:

Forage shortage became a serious problem in Pakistan. The most serious shortage period is from December to January, and the critical period is from May and June. At that time, the summer pasture of Sudan's corn, millet, sorghum and sorghum hybrid grass has just begun to grow, but the winter pasture is consumed. Seeds that are not used to improve feed, especially oat seeds, lack forage in quantity and taste.

Incapability to attain qualitative seeds, improper fertilizer application, irrigation are other reasons for planting delays. Another reason for the low yield is the small plant population, because the number of plants planted per unit area determines the yield of the crop. January 22, 2007.

WORLD OAT PRODUCTION

Oats ranked 6thin cereal yield after wheat, maize, barley and sorghum in Pakistan. In globally oats decreased as on farm mechanization highly between 1930 and 1950. It remains a beneficial seed for farmers in ecologies of country. In developing countries and developed countries have economies for specialized purposes. In different areas of world, it was cultivated for grain purpose as well as fodder, litter, hay, silage and chaff. Cereal feed for livestock remains the main use of oat crops, averaging 74% of total world consumption from 1991 and 1992 (Welch, 1995).

Oats have capability to grow in different soil types and may perform better on acidic soils than other small grain cereal crops. Oats are mainly cultivated in rabi seasons, which have high ratio of humid in environments, but it can be performed better in high temperature, dried environment from sowing to harvest. According to all situation, world oat production is generally placed from latitudes 20-46 ° S and 35-65 ° N, for example Finland and Norway. In spring season sowed cultivars gave world highest production of seed oat, but fall sowing is practiced along the higher elevation regions, including the Himalayan range of the Hindu Kush and in areas with hot summers. and dry. In severe winters, in Scandinavia, the northern states of United States, Canada, highest elevation areas of tropics, short-season oat cultivars to in areas with severe winters, such as Scandinavia, the northern states of the United States, Canada, higher elevations in the tropics, short-season to mid-ripening varieties of oats are usually sown.

In mild climate regions, based on seasonal climatic conditions, requirement for crop managements, with the help of different management techniques, oat sowing techniques in spring, winter and / or fall vary. In warmer areas, spring oats can be planted in the fall to estrain the drought and heat waves of summer.

In the United States, oats consumed as food are becoming a special food for horse racing, hobbyist breeders and breeders. The main exporters of oat grains are Canada, Finland, Sweden, Australia and Argentina. The United States, former Soviet Union, Japan, Switzerland and European Union are main importers of oat grains.

IMPROVEMENT OF OAT VARIETY

European white oats and yellow oats *A. sativa* and planted red oats *A. byzantina* are self-pollinating hexaploid varieties of oats and are compatible with hybridization techniques. Recently, plant breeders have crossed these species to select cultivars of seeds and feed types that are primarily adapted to a variety of environmental conditions. Most of the investment in plant breeding has been and still is to improve the yield of oat kernels for food, of which white kernel types are generally preferred. As a result, grain color of both oats becomes more similar to *A. sativa*, and no longer to *A. byzantina*.

According to research by Coffman (1977) in Argentina, Byzantine bacteria were once the most popular species and the alfalfa type now dominates. In the United States, most spring oats are *A. sativa*, while southeast and southwest winter oats are from *A. sativa*. Byzantina through the development of improved varieties. The appearance of Byzantine has become more like alfalfa. Modern technologies for developing new varieties are mainly focused on oats for grain production rather than on animal feed production.

SOWING DATE

Sowing date for better yield of a crop is utmost important thing. In underdeveloped nations where food is very infrequent, time of food supply during the period of scarcity is very important. In Pakistan, the recommended sowing season for feed oats is October 15 to November 15, although altering climate scenario yield of oat was distracting critically. Nevertheless, changing sowing dates reflect several issues: farmers' special needs for livestock, the magnitude cattle herd, land ownership, expected duration of rainfall, availability of fallow land and irrigation water. In order to enhance the forage yield and improve the forage collection time, sowing experiments were carried out on oats with high feed yield under the appropriate sowing date.

Scott has studied the role of spermidine under water stress in various agro-ecological research institutions across the country, and believes that the application of spermidine under aerobic conditions can increase the productivity of oats

Importance:

1) Cereal crops are of great significance because cereals are grown in larger quantity throughout the world and used as greater source of food for human consumption. Cereal crop like wheat, oat and per millet are used as a source for food more than another crop. They have a great nutritional value. Cereals are their natural forms are rich source of vitamin, protein.
2) Oats are used for feed, forage, straw used as forage, hay, silage and chaff. The food uses of oatmeal include oatmeal, oat flour, and oatmeal as breakfast cereals and other food ingredients. Oats are one of the most nutritious grains, rich in protein and fiber. The protein in oatmeal is usually greater than that in other grains. Many of the vitamins and minerals found in oats are incorporated in the bran and germ. Most oatmeal products use the whole filling, making it a nutritious grain.

3) Oats have been cultivated for about 2000 years and are used in animal feed and human food. Compared with wheat and barley, oats are more sensitive to environmental conditions. Because of their resistance to cold and drought, breakage and lodging, the improvement of oat varieties and the limited research on agronomy are other factors that reduce oat yield.
4) Cardiovascular diseases, Diabetes (Type-II), and Cancer, and Obesity are major health concerns in the western nations especially in United States and developing countries around the World (Penny, 2013) Cardiovascular diseases (CVDs) It is the leading cause of death in the world, accounting for 30% of the global death toll. According to estimates, the global death toll due to CVD was 17.5 million in 2005 and will increase to 20 million by 2015. WHO estimates that between 2000 and 2030, the world's population will increase by 37% and the number of diabetic patients will increase by 114%. Blood cholesterol is the main risk factor for CVD. In addition, calorie-rich diet intake and lack of exercise have caused a surge in obesity worldwide, and insulin resistance has also been identified as a major risk factor.

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CHAPTER 8

FERTILIZATION IN WHEAT AGRICULTURE

M Sc Uğur BİLGE[*]

Assoc. Prof. Dr. Abdullah EREN[**]

[*]GAP Internatıonal Agrıcultural Research and Traınıng Center, Diyarbakir Turkey. ugrbilge@hotmail.com

[**]Mardin Artuklu University, Kızıltepe Vocational School/Department of Organic Agriculture Mardin Turkey. abdullaheren@artuklu.edu.tr

INTRODUCTION

Wheat with the highest productivity in our country is a plant that can be grown in many types of land. Despite the fact that, at the request of pH, soil is grown under conditions of strong alkaline from light acid (6.5-8.7), the best pH development environment is 7.0-7.7 (Anonymous, 2016). This is the amount of precipitation and the distribution of precipitation over the years. Of great importance is the amount of precipitation and the optimal amount of pure nitrogen that must be added to the decare during the development of the plant.

Sub-ground (Basic) fertilisation can be given with the last soil processing done before seed cultivation, or it can be given in the cultivation of seeder (Seed and Fertiliser) with seed cultivation. The depth of fertiliser should be applied to the right or left of the seed 5-6 cm in the soil and 6-8 cm below. Top fertilisation is fertilisation from the beginning of brotherhood to the period of lift. In areas where precipitation is low, top fertilisation should be done at once with cultivation without irrigation, and top fertilisation should be done ~~at~~ twice if the precipitation is sufficient in the irrigation areas. The amount of upper fertiliser nitrogen (N) to be laid to rest according to precipitation or irrigation status varies (TG, 2016).

During the development periods of wheat, depending on the amount of N intake, it is possible to apply in three periods. The first period is from output to brotherhood and nitrogen intake is low (5-20%). Research has shown that wheat is most intense in the period of brotherhood and spike (Zadoks' 25-58) (Figure 1) compared to N's Zadoks' growth period

(Figure 2) (Brown et al., 2005; Alley et al., 2009; Orloff et al., 2012). During this period, N was found to have contributed positively to the number of siblings directly affected by yield and the number of grains in the spike, preventing N deficiency in the fraternity period from reaching yield potential (Pumphrey & Rasmussen, 1982). As shown in Figure 1, the third period is the period from spike to harvest, during which N intake is slow. However, fertilisation during this period has an effect on protein ratio. The main purpose of fertilisation is to have the wheat plant ready in the soil at the time of N needed during the growth and development periods. Therefore, fertilisation according to development periods, N usage efficiency can be increased.

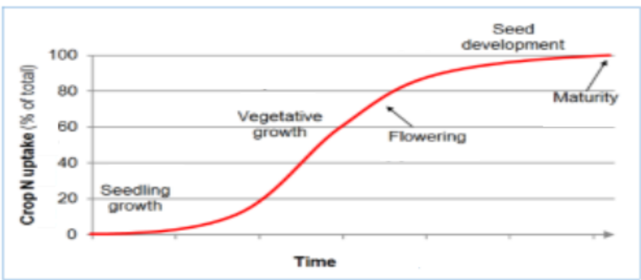

Figure 1. Nitrogen Intake Rates During the Growth Period of Wheat

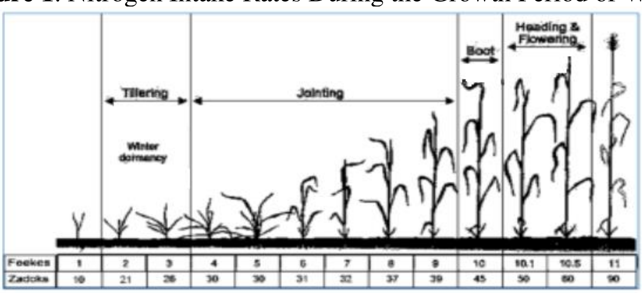

Figure 2. Growth Periods of Wheat According to Zadoks and Feekes Scale (Large, 1954; Zadoks et al., 1974)

1. FERTILIZERS USED IN WHEAT AGRICULTURE

The 3 main macro nutrients that can be used in wheat farming (nitrogen (N), phosphorus (P) and potassium (K)) and composite fertilizers and leaf fertilizers.

1.1. Nitrogenous Fertilizers

Ammonium Sulfate (AS 21% N), urea (46% N) and Calcium Ammonium Nitrate (CAN 26% N); all of which are fertilizers, provide the plant's N needs, but due to its properties as in salty or alkali soils, 21% N should be preferred before planting or with cultivation, and urea should be used in other neutral or acid-reacted soil characters (Anonymous, 2019).

1.1.1. Ammonium Sulphate (%21 N)

AS (21% N), which is used as a source of nitrogen, is a substance usually obtained by the reaction of ammonia with sulphuric acid or ammonium carbonate with gypsum. Ammonium sulfate is a fertiliser containing 21% N. It also contains sulfur (S) in the SO_4 form at a rate of 24%, so it can be used as an S source where S shortages can be seen. It can be used successfully in aqueous agriculture as it is prevented from washing by holding soil colloids. Because physiological acid is a fertiliser of character, its pH can be easily used in high soils. It can acidify the soil when used one-sided for a long time. When stored in humid environments, clodding can be seen (Güneş et al., 2013).

1.1.2. Urea (%46 N)

Urea is a white coloured, round grain fertiliser that dissolves completely in water and its production is based on the synthesis of ammonia (NH_3) and CO_2. Since its nitrogen content is higher than other nitrogenous fertilizers, it provides convenience in transportation, storage and application. Unit nitrogen amount is cheaper than other fertilizers. It is hygroscopic and contains 46% Nitrogen in amide form. As a result of heating urea (NH_2CONH_2), NH_3 loses and biurea is formed. Biuret, the heating of urea caused by cyanide exchange occurs and the thermal acid-urea results in degradation is called, causing bad quality because the identification of the urea fertiliser. Biurea negatively affects germination and protein metabolism, as a result, leaves turn yellow and fall off. Urea fertiliser has a negative effect on germination if the biuret content is more than 1.2% and the urea is applied to the seed bed just before or during sowing. If urea is to be used as a foliar fertiliser, the biurea content should be less than 1%. Due to its high solubility, it is also used in liquid fertilizers and foliar fertilizers. Its effect on soil pH is slightly acidic. To prevent this acidity, 80 kg of lime can be applied to 100 kg of urea (Güneş et al., 2013).

1.1.3. Calcium Ammonium nitrate

It is one of the most widely used top fertilizers for fertilisation of almost all plants except rice. It has 26% nitrogen (N) in its structure, half of which is 13% N ammonium (NH_4) and the other half is 13% N in nitrate (NO_3). Nitrate nitrogen is quickly taken by plant roots during periods of rapid development of plants and during bedtime. Most of the N in the form of NH_4 is translated into NO_3 form nitrogen by N bacteria in the soil, depending on soil conditions, and plants do not show N deficiency. 75% of the total N taken by all cultural plants except rice during the development periods is in NO_3 form (Güneş ve ark., 2013).

1.2. Phosphorus Fertilizers

As a result of the soil analysis carried out before planting, if fertiliser is needed depending on the favourable amount of P in the soil, it should be mixed by applying it to the soil before planting. There is no loss of phosphorus from the soil that we soil with phosphorous fertilizers. For this reason, unnecessary phosphorous fertiliser and unnecessary costs should be avoided every year without soil analysis. The most appropriate economic dose of phosphorous fertiliser in wheat farming varies purely at approximately 4-7 kg/da P_2O_5 (Güneş ve ark., 2013).

1.2.1. Super Fosfat

Normal super phosphate is a fertiliser containing P_2O_5 at a rate of 16-18%. Most of the phosphorus it is in (90%) is soluble in water. The fertiliser sacks may have NSP, the abbreviated form of Normal Super Phosphate. Normal super phosphate fertiliser does not contain nitrogen, caution should be taken here should not be used as if there is nitrogen. The most important consideration in the use of superphosphate is that the fertiliser is given just before planting or planting and buried in as much seed or root depth as possible.

1.2.2. Triple Super Fosfat (%43-44 P_2O_5)

Triple superphosphate (43-44% P_2O_5) fertiliser is the most well-known fertiliser in wheat farming because it contains only phosphorus (P). In short, the structure of TSP fertiliser, known as TSP, has phosphorus equivalent to P_2O_5 at a rate of 43-44% as an effective substance. All phosphorus in TSP fertiliser is in the form of -1 value H_2PO_4, which is in the form that can be taken by plants. Plants can get H_2PO_4-form phosphorus better from soil between 6.5-7.5 pH values. In soils with very calcified and high pH values, the taking and effectiveness decreases. Soil pH can be used in all plants grown in soils with mild acid and neutral value, especially in hazelnut, tea, tobacco, fruit and vegetable gardens (Karaman, 2012).

1.3. Potassium Fertilizers

Potassium is commonly found in the earth's crust as the building agent of rocks and minerals. The majority of the raw materials required in the production of potassium fertilizers are obtained from underground deposits (Karaman, 2012). Potassium development in wheat plant is a plant nutrient that has an effect on yield and quality and also reduces the negative effect of nitrogen in the environment. The use of potassium for wheat is low at the beginning of the development period; towards the end of the period of rise and the highest level at the beginning of flowering. Therefore, when using potassium fertiliser, it will be correct to apply it in cultivation, fraternity period or up-and-down periods. The most commonly used potassium fertilizers are Potassium nitrate (13%

N, 44% K_2O), Potassium sulfate (50-53% K_2O) and Potassium chloride (60% K_2O) (Güneş ve ark., 2013).

1.3.1. Potassium chloride (%60 K_2O- %45-48 Cl)

Potassium chloride fertiliser is the most used fertiliser type of potassium fertiliser in the world. In general, it is white crystalline and contains between 40-60% K_2O depending on the average purity rating. It is located in 3 different types of standard, coarse and granule shape on the market (Kacar & Katkat, 2007).

1.3.2. Potassium Sulphate (%50-53 K_2O- %18 S)

Potassium Sulfate fertiliser is found in crystal particles. The content of potassium is high (Karaman, 2012). It includes between 50-53% K_2O and 18% S in its content. It is a fertiliser that can be applied to all agricultural lands and plants. It is a suitable fertiliser for greenhouse cultivation salty soils and with chlorine excess (Güneş et al., 2013).

1.3. Compound Fertilizers

Composed fertilizers are obtained by mixing N, P and K in certain proportions. In our country, farmers use most commonly 20:20:0, 18:46:0, 26:13:0 and 15:15:15, compost fertilizers. Plant nutrients in compost fertiliser are expressed as % in order of N, P and K. Especially in wheat farming, if our soil needs P, 18:46:0 fertiliser can be used with a decare 25 kg account before planting or with cultivation. As a result of the continuous use of composed fertilizers by farmers in our country, P excess is seen in the field lands. Therefore, if there is no need for P as a result of soil analysis, it will be more economical and efficient to use the appropriate one from other N fertilizers instead of the composed fertilizers (Güneş et al., 2013).

1.4.1. 20.20.0 (%20 N - %20 P_2O_5)

It is known as the most preferred type of composed fertiliser in our country. The 20-20-0 abandoned composed fertiliser contains 20 kilos of pure nitrogen and 20 kilos of pure phosphorus at 100 kilos. granules. It can be stored for a long time under favorable conditions and can be used in all kinds of soils. It is easily taken by plants as it can be dissolved in water close to all of the N and P_2O_5 it has. Content N; it is in the form of NH_4 and urea, are not easily washed from the soil by precipitation or irrigation. In addition, 20.20.0 is found in S due to ammonium sulfate, which is the source of N in composed fertiliser, and the S needs of plants can be met with this fertiliser. 20.20.0 fertiliser can be easily used in many different types of soils rich in K but poor in P and N (EG, 2015a).

1.4.2. DAP (%18- %46 P_2O_5)

DAP fertiliser contains 18% N and 46% P_2O_5 in its composition. It is a type of composed fertiliser that contains the most nutrients in the fertilizers produced in our country. After being laid to rest due to the fact that most of the P in its composition can melt in water and N is present in NH_4 form, as soon as proper temperature and moisture is formed, plants immediately start to take advantage of nitrogen and phosphorus in DAP fertiliser. In addition, if precipitation and irrigation are too much, there is no loss of N due to the fact that it is in the form of N NH_4 in the soil.

DAP fertiliser is a composated fertiliser type, but it is generally used as a source of phosphorous fertiliser. Due to the accumulation of P in the soil resulting from the application of a large amount of P, this accumulation has a negative effect on the intake of zinc (Zn) by the plant. For this reason, it is important to fertilise DAP fertiliser at the most appropriate time and against the required amount of P needs for the plant. The application to be made before time will cause phosphorus to become useless by being united with lime in the soil, while in late applications phosphorus will remain on the soil surface and will not benefit the plant again (EG, 2015b).

1.5. Foliar Fertilizers

With the technology that has developed in recent years, leaf plant nutrients applications have started to be used in our country. It contains one or more nutrient elements (Macro and Micro) in the composition of leaf fertilizers. The filler of leaf fertilizers is usually water. Therefore, they do not leave residue in the soil and leaves. If the ground water is too high in the field soil and cool in the climate, the lowness of any nutrients such as N, P and Zn may be observed depending on the cold soil conditions. Since the intake of these nutrients with wheat roots will be difficult under stress conditions, poor plant growth and chlorosis on leaves can be seen in the plant If the symptoms of chlorosis are not due to root disease, this problem is most likely a micronutrient deficiency (MEGEP, 2012).

In order to eliminate macro and micro-shortcomings, leaf application is cheaper for producers and given with water, there is no need for emergency precipitation during the periods when necessary, which makes it easier to get over the stagnation caused by plants when mixed with herbicides and positively affects grain largeness, so in recent years leaf fertilisation has been increasing (Danışman &Bellitürk, 2006).

If the plant nutrients cannot be taken by the plant due to the climate and soil conditions and lack of plant nutrients in the soil, the necessary nutrients can be given to the plant from the leaf to the plant, which is the body of photosynthesis. In this way, conscious fertilisation can provide farmers with significant economic gains (MEGEP, 2012).

2. APPLICATION TIME OF FERTILIZERS

When implementing the fertiliser in wheat, some considerations should be considered. The first is the state of mobility of the plant nutrients in the soil, and the other is what level of plant nutrients the plant needs during what development periods. N, one of the plant nutrients, is active in the soil, and the wheat plant needs different proportions of nitrogen during different periods of development. Therefore, the application of Nitrogen in different periods increases its effectiveness. Other nutrients P and K are immobile in the soil. Since 3/4 of phosphorus and potassium were taken by the plant in the first period of development, it should be left under and next to the seed bed with cultivation. In wheat, it is useful to sort the points to be considered in the application of plant nutrients according to the elements. Wheat plant Nitrogen is in the form of ammonium and nitrate. Wheat uses the grass it received during the early development periods in the formation of leaf formation, tillering and spike drafts. The application of nitrogen after the start of the handle negatively affects the largeness of the spike. In order to prevent nitrogen losses due to rains in spring, it is useful to give nitrogen in pieces. The first fertiliser application should be given before the end-of tillering period (Figure 3).

Figure 3. First Nitrogen Application from Above (End of Tillering-Bolting Period (Progen, 2011).

The second fertiliser application should be done when the first nodule is seen during the lift period (Figure 4. If nitrogen application is to be done at once, it should be applied immediately before it can be lifted. Excessive use of nitrogen during planting in winter plantings can lead to excessive development of plants and increased winter damage. Therefore, the amount of nitrogen to be given by cultivating should not be more than 1/3 of the total amount of nitrogen.

Figure 4. The Second Nitrogen Application from Above. The Period When the First Knuckle is Seen in the Saping Period (Progen, 2011).

Urea, Ammonium nitrate and Ammonium sulphate fertilizers are widely used in wheat cultivation. Ammonium nitrate fertilizers, which have more solubility than urea and ammonium sulphate, can melt even at a very low humidity and become suitable for the plant's intake. While this situation is advantageous in years when rainfall is low, the problem of washing with rain occurs in years when rainfall is high. If wheat cultivation is carried out under wet conditions, half of the nitrogen fertiliser to be given as top fertiliser as urea in early spring; the remaining half should be given as ammonium nitrate during the stalling period. In dry conditions, all of the top fertiliser should be given as urea in early spring. It should be kept in mind that the use of ammonium nitrate and ammonium sulphate fertilizers in early spring may cause the temperature to decrease in the root area of the plant and increase the effect of cold damage during the melting of these fertilizers. Phosphorus is an inert nutrient element in the soil and wheat plant receives a significant portion of the total phosphorus it needs to take in the pre-tillering period. Therefore, phosphorus should be applied under the soil before or during planting. It is beneficial to give the base fertilizers such as Diammonium phosphate (DAP) and Triple Super Phosphate (TSF), which are used as phosphorus sources in wheat agriculture, about 3-4 cm side and below the seed in order not to damage the germinating seed. Potassium is a plant nutrient that has an effect on the growth, yield and quality of wheat plants and also reduces the negative effects of excess nitrogen. The potassium use of wheat reaches its lowest level at the beginning of the development period, and reaches its highest level towards the end of the stem growing period and at the beginning of flowering. For this reason, the application of potassium fertilizers should be done in sowing, tillering period, or during stalking periods (Progen, 2011).

3. WHEAT IN PLANT NUTRIENTS AND SYMPTOMS OF DEFICIENCY

3.1. Nitrogen Deficiency

Deficiency symptoms are most severe in old leaves emerging first (bottom). Starting from the tip of the leaf towards the leaf sheath, instead of the green color, light green and then yellowish green color occurs (Figure 5.). The internodes of the wheat plant get shorter, short plants are formed, the grains are not fully filled, they remain wrinkled. Flour yield and quality (bread or durum wheat) are reduced. The excess nitrogen from the nodes is longer, the wind is seen bedtime and rainfall, plant water consumption increases, particularly reduced wheat quality in durum wheat (Anonymous, 2016).

Figure 5. Nitrogen Deficiency (Progen, 2011)

3.2. Phosphorus Deficiency

It is more common in the early stages of development and especially in regions where winter is harsh. In the old (lower) leaves, bluish green occurs between the vessel and purplish color occurs in more advanced areas. Seed bonding decreases and yield becomes very low (Figure 6.)

Figure 6. Phosphorus Deficiency (Progen, 2011)

3.3. Potassium Deficiency

Except for the very sandy and lightly structured soils, there are not many signs of deficiency. The symptoms of deficiency occur in aged (lower) leaves first as in nitrogen and phosphorus. From the tip of the leaf, the vein slurry turns brown in later stages and the tip of the leaves dries (Figure 7.).

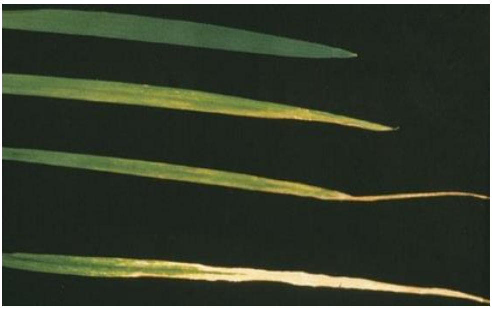

Figure 7. Potassium Deficiency (Anonymous, 2016).

3.4. Zinc Deficiency

The symptoms of deficiency are more pronounced during the period of lift-off. Young (peak) leaves show signs of a small light yellow green grain between the veins. In some cases, the leaves shrink and remain small, the yield is much reduced (Figure 8.).

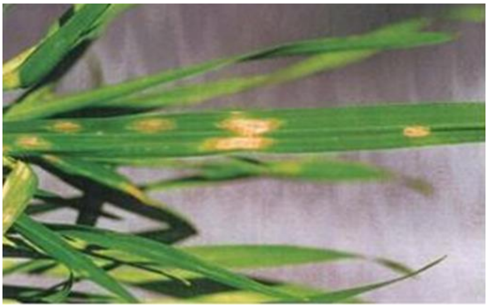

Figure 8. Zinc Deficiency (Progen, 2011)

3.5. Iron Deficiency

The most typical symptoms are that even thinnest veins remain green in the young leaves and the color between the veins is completely yellow. Thus, due to the lack of sufficient chlorophyll, the youngest leaves take on white color. Symptoms of iron deficiency are more common in plants that grow in calcified alkali soils. In iron deficiency, various amounts of pigment substances such as carotene, xhantine and lutein are also reduced in parallel with chlorophyll-a and chlorophyll-b amounts. There is a similar decrease in photosynthesis rate in plants. Chlorosis (yellowing) due to typical iron deficiency is observed (Figure 9.).

Figure 9. Iron Deficiency (Progen, 2018)

3.6. Calcium Deficiency

It can be seen in areas with very high rainfall. Folding and twisting are seen in young leaves. In calcium deficiency, the growth of meristem tissues slows down, deficiency symptoms first show up in growth points and young leaves. Young leaves are deformed and black and brown necrosis occurs on the leaf edges. When the cell walls of the tissues damaged by deficiency dissolve, these areas take a trapezoid structure (Figure 10.).

Figure 10. Calcium Deficiency (Progen, 2018)

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CHAPTER 9

THE EFFECT OF DIFFERENT SOWING DENSITIES AND SOWING METHODS ON THE YIELD AND YIELD COMPONENTS IN KIRIK WHEAT (*Triticum aestivum* L. var. Delfii.) *

M Sc Tuğba DOĞRU AKINCI*

Assoc. Prof. Dr. Yeşim TOĞAY**

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*Ministry of Food, Agriculture and Livestock of Turkey, Besni/Adiyaman Turkey. tuba.akinci@tarimorman.gov.tr

**Mugla Sitki Kocman University, Fethiye ASMK Vocational High School, Mugla, Turkey. yesimtogay@hotmail.com

*This study is part of the master's thesis.

INTRODUCTION

Kırik wheat is systematically classified as *Triticum aestivum* L. var. Delfii. It is grown for summer and winter. (Gökgöl, 1939). Made in research on wheat Turkey, it is reported that Kırik wheat is one of the varieties with high protein content and good bread flour quality (Seçkin, 1971).

In order to get high yield in a certain region in our country, important studies are carried out on growing methods. These studies cover all the processes that need to be applied from soil tillage to harvest. Sowing density and sowing method are among the most important factors that can directly affect the cultivation techniques.

In cereals, factors such as number of spikes per unit area, tillering, number of grains per spike and grain weight directly affect the yield per unit area, and are values that vary according to plant density.

For this reason, ıt is necessary to determine the most suitable plant number according to the variety and environment. However, together with the amount of seed to be thrown per unit area, sowing methods and the distribution of the seeds to the field are also important. Different results can be obtained in different sowing method is as important as the amount of seed thrown per unit area.

In this study, three different sowing densities and four different sowing methods were applied to Kırik wheat and its effect on yield and yield components was examined and the most suitable sowing density and method for this variety was tried to be determined.

MATERIAL AND METHODS

This study was carried out to determine the most suitable sowing density and sowing methods for yield, some yield and quality components wheat (*Triticum* aestivum L. Delfii) cultivar Kırik which is well-adapted to the Eastern Anatolia Region" in 2012-2013 growing seasons in the fields of Agricultural Faculty of Yuzuncu Yıl University (longitude 43°17′E′, latitude 38°33′N′, and altitude 1655 m).

Table 1. Some properties of the <2 mm fraction of the top 30 cm of soil used for each site

Soil properties	
Texture	loam
pH[A]	8.88
$CaCO_3$ (%)[B]	6.6
Olsen soil test P (ppm)[C]	41.84
Total Salt (%)[D]	0.01
Organic matter (%)[E]	1.89

A 1 : 2.5 soil : water, B lime by calcimetric methods, C Olsen et al. (1954), D Richard (1954), E Jackson (1962).

While the average temperature of growing season of trial was measured as 8.71 °C, total precipitation was 364.4 mm and the relative humidity was % 60.37 The soils are classified as entisols according to soil taxonomy. The soil of experiment area was loamy in structure and strong alkaline in reaction, low in organic matter, available phosphorus content and lime are medium, high in available potassium and moderate salt (Table 1).

In the trial, three different sowing densities (450, 550, 650 seed /m^2) and four different sowing methods (broadcasting, row, 450 and 900 cross) were applied to Kırik wheat. The trial was conducted in a randomized complete block design with three replications. The row spacing was arranged as 20 cm. Plot size; It has been arranged as 1 m x 5 m = 5 m². The amount of seed to be thrown into the plots has been determined to equal 450, 550 and 650 seeds per m2. In the trial; broadcasting, row, 45 ° cross sowing and 90 ° cross sowing were applied.

Seeds were sown on 17/10/2012 by hand. In the row sowing application, the seeds were sown by opening the lines with a marker at a distance of 20 cm, ın 45 ° and 90 ° cross sowing, half of the seed to be sown in the plot has been applied in the same way as the row sowing is done and in the planted rows, the marker was drawn again at an angle of 450 and 900 (according to the cross sowing shape intersecting with the 450 and 900 angle applied) and the other half of the seeds were sown in the opened cross rows. In broadcasting sowing, the seeds are spread over the plot according to the plant density and the seeds are covered by mixing the soil with a rake. DAP fertilizer was applied at sowing at 15 kg per decare, Ammonium sulphate fertilizer, equivalent to 6 kg /da pure nitrogen, was given to the soil during tillering. At harvest, two outer rows for each plot and 50 cm from each end of the plots were left as borders and the middle 3 meters of the central rows were harvested. And the plants were harvested on 05/07/2013 by the sickle. All calculations and measures were conducted as based on the procedures and methods used by Kün. Calculations and weighting pertained to yield components were made within the context of 10 plant samples randomly chosen after the margin effect was omitted from each plot. Crude protein ratio in the grain was determined by Kjehldahl method. The obtained values were subject to variance analysis according to randomized complate blocks design and the difference between averages were tested at 1 % significance level in accordance with Duncan Multiple Comparative Method. SAS (13) by using PROC GLM and Düzgünes et al. (14) were used at the significance controls of results and averages.

RESULTS AND DISCUSSION

The average values and the groups formed regarding the effect of different sowing densities and methods on yield and yield components in wheat are given in the Table 3. In the study, the effects of different sowing densities and sowing methods on yield and yield components were found to be significant, while their effect on quality criteria was found to be insignificant.

The average plant height in wheat of different sowing density practices varied between 83.26-86.83 cm.

The highest plant height was obtained from 650 seed/m^2 (86.83). On the other hand, the lowest value was obtained from 450 seed/m^2 (83.26 cm). The reason why the tallest plant height was most frequently obtained from sowing may be that as the frequency increases, the plants increase their height due to the competition to take advantage of the sunlight. Pavez (1991) reported that the plant stem length increased as the sowing frequency increased. The average plant height in wheat of different sowing methods varied between 84.33-85.68 cm. The highest plant height was obtained from row sowing with 85.68 cm, while the lowest plant height was obtained from broadcasting sowing method with 84.33 cm, but the difference between applications was found to be statistically insignificant (Table 2). Hışır and Çölkesen (2004) stated that plant height was significantly affected by sowing methods, Abbas et al. (2009) reported that the highest plant height was obtained from seeder planting and the lowest plant height was obtained from broadcasting sowing method. The findings of the researchers and the findings obtained in this study are similar.

While the highest spike length was obtained from the sowing densities application with 6.85 cm with 550 seeds / m^2, the lowest spike length was obtained from the sowing densities application with 6.46 cm and 450 seeds / m^2. Bayram et al. (2008) reported that the higher the frequency, the shorter the spike length. The average spike length in wheat of different sowing methods varied between 6.56-6.70 cm. While the highest spike length was obtained from row sowing with 6.70 cm, the lowest spike length was obtained from 450 cross sowing with 6.56 cm, but the difference between the applications was statistically insignificant.

The highest number of spikelets was obtained from 10.85 with 650 seeds / m^2 sowing frequency application, while the minimum number of spikelets was obtained from 10.24 with 450 seeds / m^2 sowing frequency application. Pavez (1991) and Lafond (1994) reported that the number of spikelets increased as the densities of sowing increased. The findings of the researcher and the findings obtained in this study are in agreement. The average number of spikelets in wheat of different sowing methods varied between 10.41-10.82. The highest number of spikelets was obtained from 10.82 and 450 cross-sowing, and the difference between rows sowing was statistically insignificant. Although the minimum number of spikelets was obtained from broadcasting sowing with 10.41, the difference between the 900 cross-sowing application was statistically insignificant (Table 2). Soomro et al. (2009) reported that the highest number of spikelets was obtained from sowing with a seeder, and the least number of spikelets was obtained from broadcasting sowing. The findings of the researcher and the findings obtained in this study are partially similar.

The average number of grain per spike of different sowing density applications varied between 20.64-22.52 pieces. While the maximum grain number per spike was obtained from 22.52 seeds with 650 seeds / m^2 sowing densities application, the minimum number of grains per spike was obtained from the sowing frequency application with 20.64 seeds and 450 seeds / m^2, but the difference between the application of 550 seeds / m^2 sowing densities was found to be statistically insignificant. Khan et al. (2000) reported that the amount of seed thrown up to 17.5 kg / da increased the number of grains per spike and that the seed planted in higher amounts decreased the number of grains per spike. The average number of grain per spike of different sowing applications varied between 18.80-23.26. The highest number of spikelets was obtained from row sowing with 23.26 pieces, while the minimum number of grain per spike was obtained from broadcasting sowing with 18.80 pieces (Table 2). Abbas et al. (2009) reported that the number of grains per spike in wheat is higher in broadcasting sowing than row sowing.

Biological yield averages of different sowing density applications in wheat varied between 476.95-582.50 kg / da. Although the highest biological yield was obtained from the sowing densities application with 582.50 kg / da with 550 seeds / m^2, the difference between the sowing densities application of 650 seeds / m^2 was found to be statistically insignificant.

Table 2. Effects of different sowing densities and sowing methods on yield and yield components of wheat.

	Sowing Methods					Sowing Methods				
	Plant height (cm)					Spike lenght(cm)				
Sowing Densities	Broadcasting	Row	45^0	90^0	Mean	Broadcasting	Row	45^0	90^0	Mean
450 seed /m^2	81.7 f	84.9 bcd	82.7ef	83. 7 de	83.2C	6.21f	6.56cf	6.40ef	6.66be	6.46 C
550 seed /m^2	82.7ef	85.3 bcd	84.3 cde	85.8 bc	84.5 B	6.80 ad	7.03a	6.66be	6.90abc	6.85 A
650 seed /m^2	88.5 a	86.8 b	87.3 bc	84.6 cd	86.8A	7.00ab	6.50def	6.63cde	6.46def	6.65B
Mean	84.3 B	85.6 A	84.8 AB	84.7 AB		6.67	6.70	6.56	6.67	
	Number of spikelet					**Seeds per spike**				
450 seed /m^2	9.43 f	10.16 e	10.80 b	10.56 bc	10.24B	10.96 e	21.53bc	22.76 b	21.30 bc	20.64 B
550 seed /m^2	10.40cde	11.36 a	10.86 b	10.23 de	10.71A	18.90 d	22.83 b	22.13 bc	20.36 cd	21.05 B
650 seed /m^2	11.40 a	10.76 b	10.80 b	10.46 cd	10.85A	20.53 b	25.43 a	22.30 b	21.83 bc	22.52 A
Mean	10.41 B	10.76 A	10.82 A	10.42 B		18.80D	23.26 B	22.40 B	21.16 C	
	Biological yield (kg/da)					Seed yield per unit area (kg/da)				
450 seed /m^2	359.66 f	482.00 e	527.5de	538.0 d	476.95 B	98.3 e	134.6 d	158.5 b	145.1 cd	134.14B
550 seed /m^2	459.33 e	594.33 c	727.33 a	549.0 d	582.50A	99.8 e	152.5bc	183.6 a	154.6 bc	147.6A
650 seed /m^2	461.66 e	582.66 c	628.6 b	615.6bc	572.16 A	103.6 e	183.6 a	157.6 b	154.3 bc	149.8A
Mean	426.88D	553.0B	567.7B	627.8A		100.5C	156.9B	166.0A	151.3 B	
	Harvest index(%)					1000 seed weight				
450 seed /m^2	27.00 cd	30.00 b	32.00 a	26.3cde	28.83A	37.50	37.50	37.50	37.50	37.50
550 seed /m^2	21.66 f	25.33 de	25.33 de	28.0 c	25.08C	39.16	39.16	37.50	38.33	38.54
650 seed /m^2	22.66 f	31.00ab	25.00 e	25.33de	26.00B	40.00	37.50	40.00	39.16	39.16
Mean	23.77C	28.77 A	27.44 B	26.55 B		38.80	38.05	38.33	38.33	
	Protein ratio (%)					Hectoliter weight (kg)				
450 seed /m^2	10.36	10.76	10.70	10.76	10.65	80.66	83.00	80.00	80.66	81.08
550 seed /m^2	11.00	10.96	10.76	10.76	10.87	82.33	81.00	81.00	81.00	81.33
650 seed /m^2	10.70	11.06	10.26	10.50	10.63	80.33	76.00	81.00	80.00	79.33
Mean	10.68	10.93	10.57	10.67		81.11	80.00	80.66	80.50	

The lowest biological yield was obtained from a sowing density of 476.95 kg / da and 450 seeds / m^2. The biological yield averages of different sowing applications in wheat varied between 426.88-627.83 kg / da. While the highest biological yield was obtained from 90^0 cross-sowing with 627.83 kg / da, the lowest biological yield was obtained from broadcast cultivation with 426.88 kg / da. Khan et.al. (2000) reported that biological yield was affected by different sowing frequencies and methods, and that the highest biological yield was obtained from 250 kg / ha seed application and row sowing method. Abd El-Lattif (2011) reported that the interaction of sowing method x seed amount is important in terms of hay yield.

The average seed yield per unit area in wheat of different sowing density applications varied between 134.14-149.83 kg / da. Although the highest seed yield per unit area was obtained from the sowing density application of 149.83 kg / da with 650 seeds / m^2, the difference between it and the sowing density application of 550 seeds / m^2 was found to be statistically insignificant. The lowest seed yield per unit area was obtained with a sowing density of 134.14 kg / da and 450 seeds / m^2. Akkaya (1994) stated that the yield increased in dense sowing, Bulut (2005) stated that the grain yield was affected by the sowing frequencies and that the grain yield increased up to 575 seeds / m^2, and that the decrease in the sowing density of 625 seeds / m^2 was insignificant, Kaydan et al. (2011) reported that the highest yield was obtained from a sowing frequency of 650 seeds / m^2. The findings of the researchers and the findings obtained in this study are similar. The average grain yield per unit area of wheat for different sowing applications varied between 100.56-166.01 kg / da. While the highest grain yield per unit area was obtained from 45^0 cross sowing with 166.01 kg / da, the lowest unit area grain yield was obtained from 100.56 kg / da from broadcast planting (Table 2). Panwar et al. (1989) and Johri et al. (1992) that the cross-sowing method gives the highest grain yield, Görmüş (1998) stated that the highest yield is obtained from broadcasting and row sowing, although it varies according to the varieties, Kaydan et al. (2011) reported that the highest grain yield was obtained from 90^0 cross-sowing. Although the results obtained in this study are similar to most of the researchers, there have been studies in which different results were obtained.

The average harvest index in wheat of different sowing density applications varied between 25.08-28.83%. While the highest harvest index was obtained from the sowing density application of with 450 seeds / m^2 28.83%, the lowest harvest index was obtained from the application of 550 seeds / m^2 with 25.08% (Table 2). Akkaya (1994), Kaydan et al. (2011) reported that as the sowing frequency increased, the harvest index decreased. The findings of the researchers and the findings obtained in this study are in parallel. The average harvest index of wheat for different sowing practices varied between 23.77-28.77%. While the highest harvest index was obtained from row sowing with 28.77%, the lowest harvest index was obtained from broadcasting sowing with 23.77%. Yılmaz et al. (1994) reported that the average harvest index of Tir wheat was 28.5% in the adaptation study they conducted under Van conditions. Abd El-Lattif (2011) reported that sowing method x seed quantity interaction is important in terms of harvest index.

Although there was no difference between applications in terms of 1000 seed weight characteristics examined, the average 1000 seed weights obtained in terms of sowing density varied between 37.50-39.16 g, while the average sowing method varied between 38.05-38.80 g. Bulut (2005) stated that the effect of sowing frequencies on 1000 seed weight is insignificant, Khan et al. (2000) stated that 1000 seed weight was not affected by different sowing methods.

There was no difference between applications in terms of protein ratio in the grain. The average protein ratio in the grain obtained in terms of sowing density varied between 10.63-10.87%, while the average sowing method varied between 10.57-10.93%. Abd El-Lattif (2011) investigated the effect of three different sowing methods (ridge sowing, row sowing with seeder and broadcasting sowing) and four different seed amounts (100, 125, 150 and 175 kg / ha) on yield and yield components. reported that the protein content was not affected by applications. Çekiç et al. (2008), in their study examining the effect of sowing times and sowing frequencies on quality criteria, reported that the ratio of protein per grain was not affected by any sowing frequency. The findings of the researchers and the findings obtained in this study are compatible with each other.

There was no difference between the applications in terms of the hectoliter weight properties examined. The average weight of hectoliter obtained in terms of sowing density varied between 79.33-81.33 g, while the average of sowing method varied between 80.00- 81.11 g. Unit volume weight of the grain product is related to the specific gravity of the grain. A high hectoliter weight means that the grains are tight and round. Çekiç et al. (2008) reported that the hectolitre weight varied between 80.6 and 81.1 and was not affected by any sowing density in their study, in which they examined the effect of sowing times and sowing frequencies on quality criteria.

CONCLUSION

Growth characteristics such as plant height, spike length, number of spikelets, number of grains per spike, were affected differently by different sowing densities and sowing method applications. However, characters such as grain yield per unit area, biological yield and harvest index were also affected by the sowing densities and sowing methods. While the highest unit area grain yield values were obtained from 45^0 cross sowing with 183.66 kg / da and 550 seed / m^2 sowing density application and the same value in row sowing and 650 seeds / m^2 sowing frequency application.

As a result, it is recommended to plant 550-650 seeds per square meter to increase wheat yield in this region where rainfall is a factor limiting the yield. In addition, farmers should avoid broadcasting sowing and sowing in rows and it may be suggested that they should turn to cross sowing which takes an active role in weed control.

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CHAPTER 10

THE IMPORTANCE OF SELENIUM FERTILIZATION IN WHEAT

Assoc. Prof. Dr. Ferit SÖNMEZ*

*Bolu Abant İzzet Baysal University, Faculty of Agriculture, Department of Seed Science and Techonology, Bolu, Turkey. sonmezferit@ibu.edu.tr

INTRODUCTION

Among the grains that have a special place in human nutrition, especially the nutritional content of wheat is of great importance. Wheat growing, which has gained strategic importance in recent years, has been of great importance both in reducing hunger and in the continuity of human health. In general, studies on increasing efficiency have now focused on nutrient content. While fertilization studies have been carried out to increase the contents of macro (N, P, K, Ca, Mg) and micro elements (Fe, Mn, Zn, Cu) until today, intensive studies are carried out to increase the content of some elements such as selenium. Currently, there is no single form of selenium that can be applied in any climate and soil conditions. What needs to be done is to prepare selenium fertilization programs for each plant suitable for the conditions of that region with soil and plant analysis.

THE HISTORY OF WHEAT AND THE PRODUCTION CONSUMPTION SITUATION IN THE WORLD AND IN OUR COUNTRY

After the humanity passed from hunter-gatherer to settled life, it switched from nature to the selection of products that it can cultivate and feed. In this sense, cereals were the first example. The first information about the collection of grains in nature dates back to 17.000 BC (Tanno & Willcox, 2006). Turkey is also the first examples are based on the pre-Karacadağ in Diyarbakir and 10 thousand years is estimated to be cultured. After this date, 23 wild and more than 400 varieties of wheat were cultivated in Anatolia (Özberk et al., 2016a). 8

center of the wheat gene at the earth's surface are located both in Turkey thereof (Vavilov, 1987). Covering the southeast of Turkey, in the area known as the Fertile Crescent, barley, peas, lentils, chickpeas, flax, because with bitter vetch have been the main food source for humans domesticated wheat since. Turkey called the Fertile Crescent and the world to spread into the area from Mesopotamia of South east wheat, almost up to the present has been the staple food of the people in all continents (Atar, 2017). Among thousands of plant species in the Fertile Crescent, the first domesticated plants are einkorn and emmer wheats, barley, peas, lentils, chickpeas, vetch and flax (Zohary & Hopf, 2000).

Wheat has not only nutrition but also for the world's increasingly important for Turkey. It is the most produced product after corn and paddy among the grains grown in the world. 28 taxa of wild wheat that hosts hundreds of local varieties of bread 198 and 2016 in Turkey, there are 61 registered varieties of durum (Özberk et al., 2016b). The wild and cultivated forms of wheat used in modern aquaculture (Aegilops and Triticum species) are also Turkey (Table 1). Today, hexaploid bread wheat, *T. aestivum L.* (2n = 42, AABBDD) and tetraploid hard or durum wheat are produced by *T. durum Desf.* (2n = 28, AABB) is widely produced. Here the A genome is from *T. urartu* Thumanjan ex Gandilyan, the B genome *Ae. speltoides* from Tausch, the D genome Ae. It is assumed that it comes from tauschii Coss. Currently, hexaploid bread *T. aestivum L.* (2n = 42, AABBDD) and tetraploid hard pasta *T. durum Desf.* While (2n = 28, AABB) wheat is widely produced, bread wheat (Triticum Aestivum) is cultivated and produced mostly (Atar, 2017).

Table 1. Wheat Species Found in Turkey (Cabi 2010; Özberk et al. 2016b)

Species	*Ploidy level*	*Species*	*Turkish name*
Aegilops species	Diploid (2x = 14)	*Ae. caudata* L.	Karaot
		Ae. comosa Sm., Sibth.& Sm. subsp. *comosa*	Uzunkılçık
		Ae. comosa Sm., Sibth.& Sm. subsp. *heldreichii*	Ergene kılçığı
		Ae. speltoides Tausch. var. *ligustica*	Ak buğdayanası
		Ae. speltoides Tausch. var. *speltoides*	Ak buğdayanası
		Ae. tauschii Coss	Tespih buğdayı
		Ae. umbellulata Zhuk	Hanım buğdayı
		Ae. uniaristata Vis	Tekkılçık
	Tetraploid (4x = 28)	*Ae. biuncialis* Vis.	Ikikılçık
		Ae. columnaris Zhuk.	Kıl buğday
		Ae. cylindrica Host.	Kirpikli ot
		Ae. geniculata Roth	Konbaş
		Ae. kotschyi Boiss	Asi buğday
		Ae. neglecta Reg. ex Bertol	Tüylü buğday
		Ae. peregrina (Hack.) Marie & Weiller	Kum buğdayı
		Ae. triuncialis L. subsp. *triuncialis*	Üçkılçık
		Ae. triuncialis L. subsp. *persica*	Acem kılçığı
	Hekzaploid (6x = 42)	*Ae. crassa* Boiss	Kalın buğday
		Ae. juvenalis (Thell.) Eig.	Kaba buğday
		Ae. neglecta Reg. ex Bertol	Tüylü buğday
		Ae. vavilovii (Zhuk.) Chennav	Zarif buğday
Triticum species	Diploid (2x = 14)	*T. boeoticum* Bois.	Yabani siyez
		T. monococcum L.	Siyez
		T. urartu Thumanjn ex Gandilyan	Urartu buğdayı
	Tetraploid (4x = 28)	*T. carthlicum* Nevski	Acem buğdayı
		T. dicoccoides (Körn. ex Ausch & Graebn.)	Yabani gernik
		T. dicoccon (Shrank) Schübl	Gernik
		T. durum Desf.	Makarnalık buğday
		T. polonicum L.	Polonya buğdayı
		T. timopheevii (Zhuk.) Zhuk. var. *araraticum*	Rus buğdayı
		T. turgidum L.	Şişik buğday
	Hekzaploid (6x = 42)	*T. aestivum* L.	Ekmeklik buğday

In order to increase genetic variation against existing biotic and abiotic stress factors in bread wheat cultivation, synthetic bread varieties obtained with the help of cross-breeding between *T. turgidum or T. durum* and *Aegilops tauschii* and biotechnological methods were taken into culture (Mc Fadden & Sears 1944; Mujeeb-Kazi et al. 1996; Reynolds et al.2007; Van Ginkel & Ogbonnaya 2007; Dreisigacker et al.2008; Trethovan & Mujeeb-Kazi 2008). In addition to being tolerant or resistant to drought, temperature, salinity, water cut, some fungal leaf diseases, new varieties developed today have contributed to the breeding programs in terms of increasing the adaptation of newly developed lines (Özbek et al., 2016b).

According to the data of 2019-20, 216.659.000 hectares of wheat were cultivated all over the world, 764.405.000 tons of wheat production and 744.205.000 tons of consumption (Anonymous, 2020a), and the distribution of wheat production rates by countries, 18.2% of the European Union countries, China 17.6%, India 13.9% Russia 10%, US 6.6%, Turkey 3.1% and other countries constitute 32.6% of health (Anonymous, 2020). According to 2018-19 data, 72.993.000 decares of wheat were cultivated in our country and 20.500.000 tons of production was realized (TÜİK, 2020).

Wheat is one of the rare plants grown from sea level to very high areas. High nutritional value (60-80% starch and 8-14% protein), cultivation within a few months, bread quality and taste better than barley, corn, rice, storage is easy and long, and varieties are self-pollinated. It reveals its advantageous features such as time training (Atar, 2017).

HISTORY OF SELENIUM

Selenium, whose absolute necessity for plants is still unknown, was first discovered by the Swedish scientist Jacob Berzelius in 1817, but was known as a highly toxic element for humans until it was discovered in 1969 that it prevented cancer (Andino & Koo, 2005).

It has been reported by various researchers that the source of selenium in the soil is volcanic, marine or lacustrine origin (Byers et al., 1936; Moxon et al., 1939; Flemin & Walsh, 1957).

As with some absolutely necessary microelements, selenium has a very narrow limit between sufficient value and toxic value in soil (Underwood, 1977; Yang et al., 1983). Therefore, it is necessary to determine the appropriate selenium doses with field trials before selenium fertilization of plants. Soil pH, liming, sulphate, phosphorus and climatic conditions have an effect on selenium uptake of plants. Plants take selenium in the form of selenium ($Se0_4^{-2}$) and selenite ($Se0_3^{-2}$) in a small amount in the environment in which they grow. In alkali-reactive soils, selenium is mostly taken in the form of selanate (Kacar & Katkat, 1998).

Investigating the relationships between organic and inorganic selenium compounds and zinc, cadmium and mercury, Feroci et al. (2005) reported that selenite and Zn, Cd and Hg formed compounds with different solubility and strength in the environment, and that they did not form compounds with selanate.

THE IMPORTANCE OF SELENIUM FOR HUMAN HEALTH

Although selenium is not an absolutely essential nutrient element for plants, it is of great importance in human and animal nutrition. Although there is 0.015 g of selenium in a 70 kg human (Halilova, 2008), it causes the formation of some diseases in its deficiency or excess as well as preventing the development of cancer in humans. While the daily consumption of selenium required to strengthen the human immune system should be 200 µg, it is reported that consumption in the world and in our country is far below this amount. As of today, it is known that more than one billion people on the world surface are inadequate intake of selenium and it is common in developed countries such as western Europe (Combs & Lu, 2001). Therefore, selenium is seen as one of the elements that cause important health problems in human nutrition, such as iron and zinc. Microelement deficiency affects half of the world population and this is due to the fact that there is a nutritional culture based on grain-based foods that are poor in micro elements (Çakmak et al., 2002).

In his 1997 British Medical Journal entitled "Selenium: Time to Act," researcher Rayman states that there has been a 50% reduction in the amount of selenium ingested with food in the last 22 years. According to Rayman, there was a significant increase in cases such as cancer, heart disease and infertility in the same period (Rayman, 1997).

Table 2. Calculated Daily Se Intake of Adults in Different Countries.

Country	Se intake (µg day^{-1})
Germany	35*
Austria	48*
Belgium	45*
China	
Keshan disease zone	7-11*
Middle decel Se zone	40-120*
Selenosis region	750-4990*
Denmark	40*
Finland	67-110*
France	29-43*
Croatia	27*
Netherlands	67*
England	12-43*
Scotland	30-60*
Spain	72.6⁺
Sweden	38*
Swiss	70*
Japan	104-127*
Canada	98-224*
Libya	13-44⁺
Lithuania	100⁺
Hungary	41-92*
Mexican	61-73⁺
Egypt	49*
Norway	80⁺
Uzbekistan	60-93*
Poland	11-94*
Russia	54-80*
Serbia	30*
Slovakia	27-43*
USA	60-220*
Venezuela	200-350*
New Guinea	20⁺
New Zeland	19-80*
Greece	110*

*: Combs and Lu, 2001, +: Taken from Harmankaya 2009

Selenium intake of 50-200 μg day^{-1} for adults is considered safe and sufficient. The recommended daily selenium intake levels in the USA are 55 μg day^{-1} for men and women. It is recommended 60 μg day^{-1} during pregnancy and 70 μg day-1 during lactation. The tolerable selenium intake level is 400 μg day^{-1} (NAS, 2000). The recommended selenium intake levels in the UK are 60 μg day^{-1} for women and 75 μg day^{-1} for men. Hawkesford and Fang-Ji (2007) reported that daily selenium consumption was 30-100 μg in Europe, 60-220 μg in North America and 19-80 μg in New Zealand in a study conducted with adults. Information on daily selenium intake calculated for adults in different countries is given in Table 2.

In a study conducted in Turkey in the serum of children S ratio of ~ 50-70 mg L^{-1} SA and daily intake has been found to vary between 30-40 mg day^{-1}. This value found is borderline for children aged 9-13 and lower for children aged 14-18 in terms of daily intake. It has been reported that the amount of Se required to be taken daily should be 40 μg for children aged 9-13 and 55 μg for children aged 14-18 (Hıncal, 2007). In Turkey, on the day of selenium consumption (Table 3).

Table 3. Plasma Concentration and Estimated Dietary Daily Intake of Selenium in Different Regions of Turkey (Giray and Hıncal, 2004)

Regions	Plasma		Daily intake*		Daily intake**	
	Se, µg l^{-1}	Range	Se, µg day^{-1}	Range	Se, µg day^{-1}	Range
Central Anatolia	71 ± 11	51 – 96	45 ± 10	27 – 67	43 ± 11	25 – 65
Black Sea	66 ± 17	28 – 114	44 ± 14	17 – 84	39 ± 16	4 – 82
West	58 ± 15	28 – 85	33 ± 13	10 – 57	31 ± 13	4 – 55
Middle	58 ± 17	35 – 93	31 ± 12	17 – 60	31 ± 15	11 – 62
East	75 ± 15	42 – 114	49 ± 12	23 – 84	46 ± 17	17 – 82
Marmara	72 ± 10	54 – 96	–	–	–	–
Thrace	69 ± 9	55 – 88	–	–	–	–
Southern	75 ± 10	54 – 96	47 ± 9	26 – 64	46 ± 9	28 – 65
Mediterranean	78 ± 16	51 – 110	48 ± 15	21 – 80	49 ± 14	25 – 78
Overall	71 ± 15	28 – 114	44 ± 13	10 – 84	43 ± 13	4 – 82

Estimated as described by *Longnecker et al., 1996 and **Haldimann et al., 1996a

Various diseases occur in both humans and animals due to selenium deficiency. Selenium binds to proteins to make selenoproteins, which are important antioxidant enzymes. The antioxidant properties of selenoproteins help prevent cellular damage by free radicals. Free radicals are natural byproducts of oxygen metabolism and may contribute to the progression of chronic diseases such as cancer and heart disease. Other selenoproteins help regulate thyroid function and play a role in the immune system (Anonymous, 2009).

As the first symptom of selenium deficiency in humans, Keşan and Keshan-Beck diseases have been seen in China (Tang, 1979; Diplock et al., 1981). Although the diseases seen in humans due to selenium deficiency are due to the low selenium content of wheat, especially wheat, among the foods used in daily consumption, many studies have been conducted and are still being conducted in this area to increase the selenium content of wheat (Sagoo et al., 2004; Sharma et al., 2008).

Table 4. Selenium Content of Country Wheat (Harmankaya, 2009)

Countries	Samples number	Change interval, µg Se kg^{-1}	Cover. Se Con. µg Se kg^{-1}	Referances
Austria	127	11 - 281	56	Edelbauer and Grausgruber, 2003
Austria	210	2-160	-	Edelbauer and Spanischberger, 2000
South Australia	107	47-316	170	Babidge, 1990
South Australia	-	70-280	-	Lyons et al. 2005a
Croatia	-	22-62	-	Popijac and Prpıc-Majıc, 2002
England	452	6-858	32	Adams et al., 2002
England	41	11-236	44	Fan et al., 2008
Spain	-	-	35.5	Diaz-Alarcon et al., 1996
Swiss	138	2-525	23	Haldimann et al., 1996b
Swiss	309	22-39	-	Quinche, 1994
Canada	-	60-3060	760	Boila et al., 1993
Canada	1604	-	400	Gawalko et al., 2002
Latvia	-	-	40	Duma and Karklina, 2006
Hungary	29	5 - 235	34	Alfthan et al., 1992,
Mexican	-	30-200	-	Lyons et al., 2005a
Poland (summer wheat)	-	-	66	Korol et al., 1992
Poland (winter wheat)	-	-	74	Korol et al., 1992
Russia (Transbaikalian)	12	1-36	16	Aro et al., 1994
Serbia	28	-	50.94	Jovanovic et al., 1998
Slovakia	-	8-122	29	Ducsay et al., 2007
Slovenia	2		11	Smrkolj et al., 2005
Saudi Arabia	52	8-293	78.37	Al-Saleh and Al-Doush, 1997
U.S.A.	190	-	457	Hahn et al.,1981
U.S.A.	290	10-5300	370	Wolnik et al., 1983
U.S.A. (Hutchinson, Kansas)	14	280-480	360	Garvin et al., 2006
U.S.A (Manhattan, Kansas)	14	39-55	45	Garvin et al., 2006
Venezuela	-	25-250	-	Bratter et al., 1991
Yugoslavia	58	3.6 – 65.5	20.5	Maksimoviç et al., 1992
Greece (common wheat)	156	19-528	210	Bratakos and Ioannou, 1989
Greece (durum wheat)	37-801	290		Bratakos and Ioannou, 1989

Selenium constitutes the building block of more than 30 selenoproteins or selenoenzymes in mammals (Rayman, 2002).

Diseases seen in humans and animals due to selenium deficiency arise from the consumption of plants grown on soils with selenium deficiency. In addition, the daily diet of people is due to the consumption of products with low selenium content due to insufficient attention to selenium.

Selenium is found in two forms as selenocysteine in animal-based foods and selenomethionine in vegetable-based foods (Kangalgil and Yardımcı, 2017). Selenium deficiency causes the disease seen in cattle and sheep known as white muscle disease in livestock (Combs, 2001). It causes Keshan disease and Kaschin-Beck diseases, which are first seen in humans especially in China (FAO, WHO, 2001).

Rayman (2000) reported that due to selenium deficiency, the resistance of the immune system of people against viral infections, prostate cancer, thyroid function, asthma and febrile diseases decreased, and if selenium was taken enough, their resistance against these diseases increased. Rayman (2002) reported that daily selenium consumption in some European countries decreased significantly in the last 10 years. This situation is attributed to the decrease in the amount of wheat in daily consumption of people.

Jonhson et al. (2000) reported that people are fed with low selenium resulting in increased cardiomipathy, hypertension, infertility, cystic fibrosis, arthritis, muscle failure, and increased sensitivity to viral infections.

Kangalgil & Yardımcı (2017) Selenium is an essential element that plays a role in many mechanisms in the body, including thyroid hormone metabolism, antioxidant defense and regulation of the immune system, and participates in many enzymes as a cofactor. It was stated that selenium deficiency may be associated with aging, cancer, insulin resistance, diabetes, cardiovascular and neurodegenerative diseases, increased mortality risk, and immune system diseases.

Navarro-Alarcon and Cabrera-Vique (2008) stated that selenium content of soils as an indicator of selenium content of people and selenium content of foods are important factors and this may differ both between countries and within the country.

The country where this situation is most evident is China. As reported by Rayman (2000), China has the most and the least soils in terms of selenium. For this reason, Keshan and Keshan-Beck diseases first appeared in China.

Clark et al. (1991) investigated the relationship between the selenium content of animal feed and foods and cancer mortality. They determined that there is a very important relationship between cancer mortality and low selenium content of soils.

4. SELENIUM IN SOIL

Mayland et al. (1989) reported Stated that the selenium content of the parent material has a significant effect on the selenium content of soils. They also reported that soils made of sedimentary rocks have higher selenium content and less in soils composed of igneous rocks. In another study, selenium was found in acid rocks 0.14 mg kg^{-1}, basic and ultrabasic rocks 0.13 mg kg^{-1}, and alkali rocks 0.1 mg kg^{-1}, and in places where the main material consists of sedimentary rocks, 9 selenium was found in the form of disulfide and high Fe in these types of rocks. It is stated that the presence of $(SO_3)_2$ attracts selenium (Savelyev, 1964). The amount of Se found in the upper layer of the soil is listed as chernozem-like soils> brown-mountain forest soils> mountain-brown forest soils, while desert soils are listed as chestnut meadow soils <cierosem meadow soils <solonchack (Halilova, 1974; 1976)

Kacar & Katkat, (1998) reported that selenium uptake is more in alkaline soils and the form of selenium dominant in alkaline soils is selenate (SeO_4^{2-}), and that nitrogenous and sulfur-containing fertilizers and phosphorus have different effects in the environment. They stated that the soil pH, liming and the types and amounts of other elements have an effect on the usefulness of selenium to the plant. Swaine (1955) reported that the total selenium content of soils ranged from 0.1-2.0 mg Se kg^{-1}, with an average of 0.3 mg Se kg^{-1}.

According to the results of the study carried out by Harmankaya (2009), they reported that the suitable selenium contents of the soils of the Central Anatolia region vary between 0.59-9.79 µg Se kg^{-1}. According to the results of the study covering Van and its districts, it was reported that the selenium content of the agricultural areas in this region ranged between 24.3-47.0 µg Se kg^{-1} (Çığ et al., 2020).

Water-soluble selenium content of soils increases with the increase in soil pH and decrease in organic matter content. Therefore, application of organic matter and lime to acid-reactive soils increases the mobility of selenium and its uptake by plants (Kudryevsev & Andreyev, 1969). Seleniferous soils with toxic levels of Se have an alkaline pH, high independent calcium carbonate content, and their selenium content is easily soluble in water, as these soils are located in areas with less than 500 mm of annual precipitation (Halilova, 2004). Selenium content of soils with high clay content, that is, heavy textured soils, is also high (Davis et al., 2006).

5. SELENIUM AND WHEAT

Many studies on Selenium have been carried out since the early 1900's. These studies were carried out in various plants and were carried out to determine the selenium dose that would not cause any loss in yield and quality. The effect of sodium selenite doses on alkaline and silty loam textured soil was measured in mustard, corn, wheat and paddy. As a result, it was observed that doses of 5 mg Se kg^{-1} in mustard and corn, 4 mg Se kg^{-1} in wheat and 10 mg Se kg^{-1} in paddy caused significant decreases in green parts dry matter yields (Rani et al., 2005). In a study investigating the effects of different forms of selenium, it was determined that the most toxic compound was selenious acid, while the least toxic ones were sodium selenate and potassium selenocyanide (Levine, 1924).

In 1937, Hurd-Karrer reported in his study to determine the effects of toxic levels of selenate and selenite in wheat, depending on the sulphate in the environment. He reported that selenite was more toxic in high sulphate conditions, whereas selenate's toxicity decreased. This decrease in selenate was attributed to the decrease in the absorption of increasing sulfate by root and root parts of selenate.

Hurd-Karrer (1938), in his soil culture study to determine the effect of sulphate on selenium uptake of plants, reported that selenium toxicity decreased up to a certain dose of selenium with the increase of sulfate in the environment and also that selenium content in the plant decreased. As a result of the study, it was determined that soil pH, oxide, clay and $CaCO_3$ contents are effective on the spreading of selenium in the soil, and selenium is more useful in silty-clay textured soil than silty-loam textured soil (Mao & Xing, 1999).

Yi-Zong et al. (2008) reported in their study with the corn plant that the sulfur content of the plant decreased with the condition that the selenium content remained constant in the environment, while the increase in the selenium content in the nutrient solution increased the sulfur content of the plant root parts and did not affect the root sulfur content. As a result, they stated that the selenium and sulfur contents of both the soil and the nutrient solution should be balanced in order to increase the selenium content of the plants.

Investigating the relationships between organic and inorganic selenium compounds and zinc, cadmium and mercury, Feroci et al. (2005) reported that selenite and Zn, Cd and Hg in the environment produced compounds with different solubility and strength, and that they did not form compounds with selenate.

Although selenium (Se) plays an antioxidant role, especially in plants under abiotic stress conditions, it is involved in biophorication. Selenium is considered as a beneficial element for plants because it promotes plant growth. It accumulates in the roots and is transformed into L-selenomethionine (SeMet) and similar species in plants. The useful content for plants varies depending on the plant species. Approximately 25 plant species are grouped as selenium accumulators (Yavaş et al., 2020).

Wheat has been shown as the most effective Se accumulator among cereals (Lyons et al., 2003). Due to the protein structure of selenomethionines, there is a higher amount of selenium in grains. As the oxidation level and soil pH increase, Se is taken up more easily by plants (Harmankaya, 2009). In studies conducted in our country, it was found that wheat collected from different geographical regions contains an average of 34 µg kg^{-1} selenium (Çakmak et al., 2009). Irmak and Semercioğlu (2012) emphasized that the selenium content of wheat in the Çukurova region varied between 11.3 - 626.9 µg kg^{-1} and that there was a significant positive relationship between soil Se presence and grain content. Selenium is found in more of the stalks of the wheat plant (Çığ et al., 2020).

Selenium application method is an important factor. For this purpose, the sodium selenate form of Selenium and its application methods were applied to the soil, seed application, foliar application and application amounts of 5, 10, 20 g Se ha^{-1}, as well as two different wheat varieties in autumn and spring in two different locations that are irrigated and not irrigated. At the end of the study, the grain Se concentration in the control plots was 30 µg kg^{-1}, while it reached the highest level at 20 g Se ha^{-1}, and it was determined that foliar application in spring was more effective as the application method (Curtin et al., 2006). Zhang et al., (2017), in the study investigating the effect of selenate and selenite forms in wheat with phosphorus fertilization, determined that selenite form restricts plant growth, selenate form has no effect on plant growth, and the increase in plant selenium content is higher in selenate form. While the increase in selenium content of plants was limited in the applications of phosphorus and selenite form, they obtained more significant increases in selenate form applications (Table 5).

Harmankaya (2009) reported that the selenium contents of the Central Anatolian soils varied between 0.59-9.79 µg kg^{-1} and the selenium contents of their wheat ranged between 10.13-96.01 µg kg^{-1}.

Table 5. Selenium (Se) Concentration (Mg Kg^{-1}) in Wheat (Triticum Aestivum L) Organs as Affected by the Rate of Phosphorus (P) Fertilizer and the Type and Rate of Selenium (Se) Fertilizer (Zhang et al., 2017)

Treatments		Sodium selenate				Sodium selenite			
P, g kg^{-1}	Se, mg kg^{-1}	Roots	Stems	Leaves	Spikes	Roots	Stems	Leaves	Spikes
	0	0.215 g	0.163c	0.257 g	0.195f	0.215f	0.163e	0.257f	0.195f
0	1	3.546f	1.087b	7.599f	3.592e	3.361b	0.942b	2.187b	2.851c
	2	5.502c	1.878a	15.463c	6.265c	4.597a	1.666a	3.042a	4.215a
	0	0.220 g	0.165c	0.309 g	0.212f	0.220f	0.165e	0.309f	0.212f
1	1	3.980e	1.128b	10.344e	4.911d	2.660d	0.737c	1.013d	2.132d
	2	5.718b	1.940a	16.307b	7.429b	3.067c	1.092b	1.472c	2.769b
	0	0.255 g	0.200c	0.366 g	0.252f	0.255f	0.200e	0.366f	0.252f
2	1	4.364d	1.272b	12.512d	5.823 cd	1.261e	0.287e	0.394f	0.986e
	2	6.306a	2.053a	21.523a	9.741a	1.318e	0.464d	0.591e	1.104e

Different letters within a column indicate differences among treatments at the 0.05 level

There are great differences in selenium forms applied in feeding plants with selenium. In general, selenite form of selenium accumulates less on shoots compared to Se (VI), while Se (VI) form is the most transported form of selenium to shoots. The Se (IV) form of selenium is very easily transformed into an organic form in the plant. When the Se (VI) form of selenium is applied to plants, more than half of it is transported to the shoots, while the Se (IV) form remains in the roots (Yavaş et al., 2020). The effect of selenium in plants can be bilateral. This situation arises according to the amount of selenium in the soil and the application dose of selenium. In the presence of high levels of selenium in the environment, it causes negativity in plant metabolism, while the ideally applied selenium can increase the plant chlorophyll content (Shekari et al., 2015; Jiang et al., 2015; Manaf, 2016). El-Ramady et al. (2016) reported that the appropriate dose of selenium promotes growth in plants, increases their antioxidative capacity, and increases the plant's resistance to oxidative stress conditions.

An important problem encountered in selenium fertilization is that it causes a decrease in the intake of certain essential nutrients (Hu &

Yuan, 2015), while it causes an increase in the amount of some heavy metals (Hu et al., 2015). In this case, we need to perform selenium fertilization or fertilizer applications containing selenium in a controlled manner with a system based on analysis.

7. CONCLUSION

Fertilization related to selenium, which has an important place in terms of both human and animal health and increasing the resistance of plants against stress conditions, should be given more importance. Selenium should be given importance in the fertilization of wheat, which has an important place in the nutrition of countries.

Countries have added the application of selenium to their fertilization program to increase the daily consumption of selenium. For this purpose, the present selenium status of the country's soils and cultivated products is revealed by the production of selenium fertilizers according to the plant pattern. Although organic fertilizers are a source of selenium (Park et al., 2011), importance should be given to the chemical forms of selenium in fertilization. In this context, the application of sodium selenate from the soil should be done as foliar application, especially in products that are bent due to moisture and heat stress (Lyons et al., 2005b) and in areas with low selenium content. Due to the high activity of selenium in the plant (Broadley et al., 2010), the issue that needs to be taken into consideration when applying from the leaves should be controlled by considering the toxicity of selenium salts (Garousi, 2017).

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CHAPTER 11

POTENTIAL GENETIC RESOURCES OF SOUTHEASTERN ANATOLIA REGION AND LOCAL KARACADAĞ PADDY

Assoc. Prof. Dr. Aydın ALP*

Assist. Prof. Dr. Sadettin ÇELİK**

Dicle University, Faculty of Agriculture, Department of Field Crops – Diyarbakır-Turkey. aydinalp21@hotmail.com

Bingöl University Genç Vocational School Bingöl - Turkey. sadettincelik@bingol.edu.tr

1. INTRODUCTION

Karacadağ is an important plant site where crop wild relatives of cereal and legume are cultivated as well as endemic and rare plant species. It is estimated that 30-35% of all the crops in Turkey are cultivated in this area. The region is important since it is the genetic resource of certain cereal varieties (wild wheat and barley) and Legume varieties (wild chickpea, lentil, and green pea) (Ertekin, 2002).

Karacadağ is an extinct volcano in the Southeastern Anatolia Region and is in the southeast of Diyarbakır province. Volcanic Karacadağ mass is defined as a large lava shield composed of basaltic lava. It outstretches to three different directions as Diyarbakır, Viranşehir, and Hilvan. The Diyarbakır side of Karacadağ, which spreads to approximately 7.200 km^2 area, is suitable for vegetative production. The highest part of Karacadağ is Mergimir Hill (1981 m) (Ertekin, 2002). It has the steppe climate's climatic characteristics, with an average annual rainfall of 495.4 - 601.4 mm.

Primitive forms and local varieties are significant gene resources to eliminate the future problems of cultivated plants or transfer new characteristics to cultivated plants as they are critical genetic pools. Since the local species have gone through natural selection for many years in a particular region, they adapt well to the environment and succeed in the unfavorable climatic conditions throughout the years. It should be kept in mind that local varieties that are tried to being cultivated in limited quantities due to their characteristics suitable to be used as bulgur, bread, and pasta in narrow regions, reached genetic stability, and proved that their ecological adaptabilities are more easily used in gene transfer in modern species development studies when compared to their wild relatives.

The base of plant breeding studies is the richness of genetic resources. Local and wild varieties are important gene pools for transferring new characteristics to cultivated plants as a genetic basis. The richness of the genetic resources forms the base of the plant breeding studies. Karacadağ and Dicle Basin are important potential agricultural genetic resources of Diyarbakır. Karacadağ Basin is the genetic center of the wheat plant. Wheat species, such as Sorgül, Bağacak, and Ruto used for duro-compactum wheat varieties are the preferred high-quality species in bulgur and bread consumption (Alp & Taşer, 2011).

Most local species become extinct with the introduction of high-tech agriculture and high-yielding species into the production areas recently, and many species continue to disappear. The sustainability of vegetative production is only possible if the wild and local species are protected.

Karacadağ paddy is mainly produced in Karacadağ basin, Çınar, Hazro, Çermik and Kocaköy which are administered from Diyarbakır, and Siverek, and Viranşehir, which are administered from Şanlıurfa, and Derik district and villages, which are administered from Mardin, and it is widely consumed by the people living in these regions.

Two crucial rivers, Euphrates and Tigris, are the surface water resource of the Southeastern Anatolia Region. Karacadağ elevation of

Southeastern Anatolia Region has the highest snowfall in winter. Irrigation water is provided as a result of the melting of snow in March and April, and snow waters flowing into the Tigris River. As a result, the temperature of the irrigation water is low in paddy cultivation areas in Karacadağ.

Different public institutions started several projects to make the Karacadağ region suitable for agriculture by cleaning the rocks. Diyarbakır General Directorate of Rural Services pointed out that an area of 3689 decares was cleaned of rocks and prepared for agriculture in 2003, and the rocks could be used as paving stones. Paving stones will create employment opportunities. Ninety thousand hectares of land in Diyarbakır can be made suitable for agriculture by cleaning the rocks (Anonymous, 2003).

According to Turkish Statistical Institute data, the Southeastern Anatolia Region in 2010, paddy cultivation area is approximately 5.914,9 Ha (4.66%), rice production is 30.675 tons (2.66%), and the yield is 51,9 kg/ha. 98% of the paddy in the region is cultivated in Şanlıurfa and Diyarbakır. In Şanlıurfa, which is the first among the provinces in the region, the total paddy cultivation area is 3.344,5 Ha, production is 17.885 tons, the cultivation area in Diyarbakır, which is the second among the provinces in the region, is 2.437,6 Ha, and the production is approximately 12.346 tons (Anonymous, 2010). The present work aim to identify of cereal genetic resources of southeastern anatolia region and local karacadağ paddy.

2. MATERIAL AND METHOD

The climate conditions of the Southeastern Anatolia Region is continental steppe. Experiencing the lowest temperatures and precipitation rates in winter, while the summers are scorching and dry, are the typical features of the Mediterranean precipitation characteristics. The winters in the region, where the summers are scorching, are freezing, and the annual temperature difference ranges between 25 and 27.5 °C.

The instructors of Dicle University Faculty of Agriculture conducted the identification of cereal genetic resources by collecting the materials on field visits between 2000-2002. The research including the yield and quality studies of Karacadağ paddy and rice in the field of Research and Application of Dicle University Faculty of Agriculture was conducted between the 2015-2020 cultivation periods. The wild forms and Karacadağ paddy populations were used as materials for the research. The Karacadağ paddy cultivated in this region for centuries is a local population that survived until today only through natural selection, without any breeding programs. The Patent Office officially registered the Karacadağ paddy in 2018 for Diyarbakır as a result of joint work of Diyarbakır Governorate, Provincial Directorate of Agriculture, and Diyarbakır University Faculty of Agriculture.

The Karacadağ paddy is cultivated in stony areas using intermittent irrigation. In this research, after broadcast seeding, the first irrigation was done as sprinkling irrigation to enable germination and emergence.

Subsequent irrigations were intermittent in 4-5 days, and weed control and the harvest was done manually.

3. FINDINGS AND DISCUSSION

3.1. Cereal Genetic Sources of Karacadağ Basin

Thirty-two endemic species were identified in Karacadağ. 3 of these endemic species (*Hesperis hedgei, Lathyrus trachycarpus and Paracaryum kurdistanicum)* are indigenous to Karacadağ (Ertekin, 2002).

The following are the important cereals, which are among the priority plants included in the In-Situ Conservation of the Turkey Plant Genetic Diversity National Plan, cultivated in Diyarbakır:

Triticum (wheat) species**:** *T. dicoccoides, T. boeticum* and *T. monococcum* are the primitive wheat species that grow naturally as wild species, especially in Karacadağ and Diyarbakır regions.

Recently, extensive studies on *Triticum monococcum,* known as einkorn wheat colloquially, are being conducted. Einkorn wheat drew researchers' attention by having diploid features and the fact that the data obtained can easily be applied to plant breeding studies on bread wheat and pasta wheat. Heun et al. (1997) conducted comparative DNA studies on approximately 1400 wild einkorn wheat (*T. monococcum* ssp. *boeoticum*) and einkorn wheat (*T. monococcum* ssp. *monococcum*) to find the place where the einkorn wheat was first cultivated. The conducted analysis resulted that the population collected from the

Karacadağ/Diyarbakır region is the closest population to the cultivation form. It is widely accepted that wheat and barley are first cultivated in the region known as the "Fertile Crescent" (Israel, Palestine, western fringes of Syria, the southeastern region of Turkey, Northern Iraq, and western fringes of Iran) (Heun et al., 1997; Diamond, 1997; Nesbit & Samuel, 1998; Lev-Yadun et al, 2000).

Different researchers stated in their morphological research that einkorn wheat is durable in biotic and abiotic stress conditions and can be used in wheat breeding. Einkorn wheat has the A genome, which can be found in the durum wheat and bread wheat. Therefore, it is considered as a gene resource that can increase the genetic diversity in durum wheat and bread wheat breeding studies.

Table 1. Diyarbakır Province local wheat and barley species, and wild wheat species

Local Wheat Species		**Local Barley Examples**	**Local Paddy Species**	**Wild Wheat Species**
Sorgül	Bağacak	2-Row White Barley	Karacadağ Paddy	Aegilops biuncialis
Beyaziye	Aşure	2-Row Black Barley		Aegilops caudata
Menceki	İskenderiye	2-Row Barley		Aegilops cylindirica
Mersiniye	Karakılçık	6-Row White Barley		Aegilops triuncialis
Mısıri	Ruto	6-Row Barley		Hevidi

Hordeum Species:

Hordeum spontaneum, Hordeum bulbosum, Hordeum murinum subsp. leporinum var. leporinum

Aegilops Species:

Aegilops speltoides, Aegilops columnaris, Aegilops neglecta, Aegilops triuncialis

3.2. Legume (Leguminosae) Species:

Cicer (chickpea): C. Echinospermum is a close relative of the cultivated chickpea species.

Lens (lentil): 3 species, Lens culinaris, L. Orientalis and L. Montbretii, grow naturally.

Pisum (green pea): Three variations of P. Sativum's two subspecies grow naturally.

Vicia (Faba bean): 12 species (13 taxons) grow naturally. V. Assyriaca is one of the most important species.

Astragalus: 13 species grow naturally.

Lathyrus: 12 species (14 taxons) grow naturally.

Lotus (bird's-foot trefoil): 3 species grow naturally.

Medicago (clover): 5 species (8 taxons) grow naturally.

Trifolium: 25 species (27 taxons) grow naturally.

3.3. Ornamental Plants:

Anemone coronaria (Mountain Tulip): The red-flowered species grow naturally.

Adonis aleppica: Large and red-flowered, grows on the lower parts of Karacadağ.

Linaria confertiflora: a remarkable plant with large and fragrant flowers.

Lathyrus chrysanthus and L. trachycarpus species are potential ornamental plants due to their dense, large, colorful, and fragrant flowers.

Lotus aegaeus and L. gebelia: Examples of ornamental plants to be used on the slopes or gardens.

3.4. Plants Used as Vegetables and Fruits:

Gundelia tournefortii (Acanth-Kenger): Several naturally grown plant species in Karacadağ are used as vegetables. The commonly sold plants in Diyarbakır and Siverek are "acanth" (*Gundelia tournefortii*) and *Ornithogalum.* Other important plants that are used as vegetables in the region are Lepidium sativum (cress), Mentha longifolia (pennyroyal), Nasturtium officinale, Capsella (shepherd's purse), Sinapis arvensis (mustard).

Crataegus, Celtis (knotgrass) species, and Pyrus syriaca (wild pear) are used as fruits.

Glycyrrhiza glabra (Licorice-Meyan); Belongs to the Leguminosae family. It grows naturally in the Southeastern Anatolia Region in sandy, deep, and humus soils. Using the rhizomes (roots and stems) in sherbet by drying the rhizomes and peeling the skin is very common in the region. It is also used as a dye plant. The cultivation area has narrowed considerably with the introduction of tractors in fields.

3.5. Local Karacadağ Paddy

Karacadağ Paddy: The husked spelt grains of the native cultivated plants of the Oryza sativa L. species of the (Gramineae) family.
Karacadağ Rice: The paddy, which is the fruit of native cultivated plants of the Oryza sativa L. type, is the product obtained after the embryo is peeled according to the technique; fruit shell (pericarp) and aleuron are partially removed by applying various polishing processes.

3.5.1. Plant Features:

The root structure is fibrous, as in all grains. Short and straight leaves allow the sun rays to reach lower leaves. It consists of a stem, gnarl, and internode. The internode length increases upwards. The plant height of the Karacadağ paddy is usually tall. The height ranges between 75 cm and 120 cm based on the cultivation conditions. The plant has many leaves since the number of gnarls on the main stem is high. The number of companion plants for Karacadağ paddy ranges between 5 and 12. The number of panicles of the companions is high as a result of the ecological suitability. The biological yield of the plant is approximately 150 to 400 g/plant. The grain yield per decare ranges between 220 and 600 kg. The number of panicles of Karacadağ paddy ranges between 2 to 10 for each plant, and the number of grains in each panicle ranges between 34 to 83. On average, each panicle yields 1.18 to 2.39 g of product.

The total vegetation duration of Karacadağ paddy from sprouting to harvest is approximately 140 to 150 days. The panicles grow in approximately 120 to 125 days. The response of Karacadağ paddy species to fertile soil and fertilization is not very high. The lodging is more in fertile soils.

3.5.2. Flower Features:

Each rice plant has approximately 3 to 7 panicles that seed, and according to the growing conditions, each panicle yields 50 to 100 grains on average. There is a positive and important correlation between plant height and panicle length. An awn develops as an extension of the middle vein of the inner husk on a spikelet. Karacadağ paddy generally has yellow awns, whereas ecotypes with black awns can be found in other regions.

3.5.3. Grain Features:

The height of the spelt grain of Karacadağ paddy is approximately 5 to 6.33 mm. Its width is approximately 4 to 5 mm. The weight of a thousand grains ranges from 23 to 35 gr. The color of the spelt around the grain can be yellow or tawny; the color of the peeled grains can be matt white or light yellow. The hectoliter weight of the paddy is approximately 64 to 83 kg; and the hectoliter weight of the rice is approximately 85 kg.

In rice manufacturing technology, the longer the grain is, the higher is the broken grain yield. The medium height of the Karacadağ rice is an advantage. The moisture content of the grain is also important in the broken rice ratio. The moisture content of the grain varies based on the drying method, and it is an important factor affecting the broken rice ratio during rice processing. Local farmers usually lay products to dry under the sun; therefore, the grains dry excessively. On the other hand, sometimes the grains are transported to the factory without drying enough. All these factors negatively affect the broken rice yield. Unbroken solid rice yield range of the Karacadağ paddy is detected to be between 51-74%.

3.5.4. Quality Features:

Different processes are not needed to dry the products. 8-14% by weight of the grain consists of protein compounds. This ratio is higher than many other paddy species.

Karacadağ paddy is a high-quality species that adapted to the ecological features of the region. The ecology of the region is exceptional in paddy disease and pests are taken into consideration. Farmers state that they do not fight diseases and pests in paddy fields.

Chemical fertilizer and pesticide use are limited. This species has high durability against the melting snow waters of Karacadağ. The yield potential is stable. This species that is being cultivated for centuries is genetically stable.

The cultivation period of paddy is between May and September. The temperature in the region's lowlands could rise above 40 ^{o}C and may cause infertility in the plants, albeit at a low rate. However, as the summer season in Karadağ, where the summers show similar characteristics as plateaus, is cool, infertility is not common.

The only challenging factor for yield and quality in cultivation is the weed problem. Karacadağ rice sold in the market has lower physical purity than other foreign origin varieties. The high ratio of hayseeds and other impurities can negatively affect the choice of consumers.

Fig1: Local Karacadağ Rice and its Panicle

Table 2. Agricultural and quality features of Karacadağ paddy and rice

Agricultural Features		**Quality Features**	
Plant Height	90-120 cm	Solid Rice Yield	51-74%
Number of Tiller in the plant	4-10	Grain Length	5-6,33 mm
Number of Panicles	3-7	Hectoliter Weight	64.7-83.0 kg
Number of Grains in the Panicle	48-96	Moisture Content in the Grain	13-15%
Panicle Grain Yield	2-3 gr/panicle	Protein Ratio in the Grain	8-14%
Weight of a Thousand Grains	25-37 gr	Starch Ratio in the Grain	63-72%
Biological Yield	160-210 gr	Cellulose Ratio in the Grain	2-4%
Number of Maturating Days	130-140 day	Fat - Lipid Ratio	1.3-2.3%
Grain Yield	421-620 kg/daa	Ash Ratio	1.6-2.5%

This paddy is distinct from other species since it is adapted to the unique soil features and irrigation water of the region. The most important feature of the local Karacadağ paddy that is widely cultivated in Karacadağ soils that is stony, rich in organic matter, and limited in terms of chemical applications, is that it is the most sought after species by the people of the region since its color, aroma, and taste appeals to the palate of the people living in the region. The grains have high water absorption quality during cooking. The grains do not flake or stick. Grain shape and size are other important distinctive features as well. The grains of Karacadağ paddy are medium-sized. The high protein and starch within the grains enable the cooked rice to be a delicious dish. It can also be said that it adapted to the region's ecology and durable to various stress factors, including diseases and pests. These features make it a valuable material to be used for plant breeding. Karacadağ rice along with "Sarı Çeltik" (Yellow Paddy) is the general name of the local populations even though these populations show several differences.

The Karacadağ paddy is cultivated in stony areas using intermittent irrigation. It is planted by broadcast seeding and watered for the first time for germination. Subsequent irrigations are intermittent in 4-5 days and with manual weed control and harvest. Paddy in the Karacadağ basin of Diyarbakır province is cultivated by broadcast seeding in stony fields without any leveling processes. Stony areas do not permit tillage using machines. Seeds are broadcast by 15 - 17 kg per decare within the period between mid-April to the end of May, and the fields are irrigated by using the basin flooding method. Pan evaporation is not conducted. Banks are constructed periodically to enable the water flow.

Chemical fertilizer usage is low. Even though herbicides have not been used against weeds until recently, they are being used now. The product was first harvested by sickle, then dried on the field, and blended; however, now, reapers can be used for harvest on flat fields.

The most suitable harvest period is thought to be 42 - 49 days after flowering when the grains on the bottom of the panicle are within the yellowing period, and when 80% of the grains are straw-yellow; at this period, the paddy leaves are still green. The moisture of the grains should be measured, and the product should be harvested when the grain moisture is between 22-24%.

Paddy processing factories consist of combined machines that separate the husk and stem by maintaining the moisture at a specific range (10-13%), clean and polish, and manufacture rice as a result. Since the moisture level of paddy brought by farmers straight from fields is high, the product is dried by being spread on the concrete floor on sunny days and by maintaining the moisture level at a certain level. The drying process is conducted purely under natural conditions.

Since paddy is cultivated in the same field once every 2 to 7 years, the region is not polluted due to excessive use of synthetic fertilizers and pesticides. The region is thought to be suitable for organic paddy cultivation. Only recently, Karacadağ paddy can be cultivated in the same field once every 3 to 4 years by using chemical fertilizers and nutrients.

Fig2: Local Karacadağ Paddy

Agricultural research shows that local Karacadağ paddy and rice show exceptional values compared to plant breeding varieties in terms of number of panicles, number of grains on each panicle, grain weight of the panicles, and hectoliter weight, and rice yield. The broken grain ratio is low while processing paddy to rice. Unbroken solid rice yield is detected to range between 51-74%. The broken rice ratio is low because the paddy grains are medium-sized. As the grain length increases, the ratio of broken grains increases as well. However, it is observed that local paddy varieties fall behind the plant breeding varieties in terms of weight of a thousand grains, panicle, and grain yield per unit area. local paddy varieties grow longer than 100 cm and produce excessive companions.

The moisture level of Karacadağ paddy is lower than other paddies in different regions of Turkey; the level of moisture is identified as 13-

15%. Various processes are not needed to dry the products. The 8-14% of the grain by weight is protein. This ratio is higher than many other paddy varieties. The starch level (63-72%) in the rice grain is lower than different plant breeding varieties, the ratio of fibrous compounds (2-4%) such as cellulose is higher than other commercial rice. Lipide and ash level is determined as higher than other processed imported rice.

"Karacadağ Rice," registered on 28.03.2018 with the name of origin number 337 to be protected under the Industrial Property Law numbered 6769, is seen as an important plant genetic resource specific to Diyarbakır.

Grain shape and size are other distinctive features. The grains of Karacadağ paddy are medium-sized. The high protein and starch within the grains enable the cooked rice to be a delicious dish. It can also be said that it adapted to the region's ecology and durable to various stress factors, including diseases and pests. These features make it a valuable material to be used for plant breeding.

4. CONCLUSION AND RECOMMENDATIONS

Gene resources can be consumed directly as well as being used indirectly as parents in plant breeding studies. There are enough vegetative materials in the region for organic farming. Five of the local wheat species (Sorgül, Bağacak, Beyaziye, Ruto, Karakılçık), all of the local barley species, Karacadağ paddy, local chickpea, and lentil species are local materials that adapted to the region's climate and soil conditions. Their yield capabilities are satisfactory for organic farming.

The plant length is long, stem and fodder yield is high, and the products can contribute to local animal feeding. The potential to be cultivated under organic conditions without needing fertilizers and other agricultural products is high. The protein ratio of the grains is high.

Acanth, licorice, Ornithogalum, cress, and many other plant species are still widely used in the region, gathered from nature. By taking these plants that grow in their natural environment into the culture, cultural farming can be introduced to the people living in the region. Thus, the gene resources of these plants could be protected. Producing and distributing propagation materials such as seeds or rooted seedlings on the lands that the willing farmers cannot use can commence cultivation.

Knowledge and experience of the farmers can be increased by explaining cultivation methods. The local people are already familiar with the market of the products to be cultivated. Even now, these products can be commercialized in Middle Eastern countries, such as Syria.

It is imperative for the region’s economy to popularize the quality species with high yield that are suitable for intensive farming and with high production potential. Karacadağ paddy, which is the primary paddy species of the Southeastern Anatolia Region, is a species that the consumers sought and prefer due to its taste, smell, aroma, and water absorption capacity. The local community does not consume other rice species other than Karacadağ rice. Karacadağ paddy has its unique morphology before harvest, and it is possible to distinguish this product by looking at its grain features after being processed into the rice.

However, the yield of Karacadağ paddy is lower compared to other plant breeding species. Unfortunately, scientific research along with breeding studies are not conducted adequately (Alp et al., 2010)

Therefore, this paper concludes that local paddy genotypes can contribute to breeding studies to obtain species with high yield; however, local agriculture should continue using modern species as well as local species. Local species have proven their adaptability to the ecological conditions of the region. The overall assessment on not only the grain yield but also the harvest and quality characteristics proves that these species will not be easily discarded.

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CHAPTER 12

DETERMINATION OF SOME TRITICALE VARIETIES ADAPTATION SIIRT PROVINCE

M Sc Adnan ÖZTÜRK*

Assoc. Prof. Dr. Fatih ÇIĞ*

Assoc. Prof. Dr. Necat TOĞAY**

* Siirt University Faculty of Agriculture, Department of Field Crops, Kezer Campus Siirt, Turkey. adnanozturk.gevas@gmail.com, fatihcig@hotmail.com

**Fethiye ASMK Vocational High School, Mugla S. K. University, 48300 Mugla, Turkey. necattogay@mu.edu.tr

[a]The study is part of the master's thesis.

1. INTRODUCTION

The interest in cereal products has increased due to meeting the hunger need arising with the increase in the world population. While wheat and barley are the most consumed sources among the cereal products, and because of the belief that these products will be insufficient in the future, the focus is on triticale as an alternative to these products. The triticale plant is an artificial grain type obtained by crossing the wheat *(Triticum)* and rye *(Secale)* plant.

It has been observed that triticale, which has a rich adaptation feature in the world, adapts better than other grains in arid, hilly, inclined and high places. Triticale has the ability to adapt to difficult conditions and yield potential from durum wheat, which is its parent, the main plant, and which has A and B genes, and rye with R genes that can grow in acidic, cold and salty soils. Since triticale is adapted to poor growing conditions from the father - parent rye plant, better results than wheat and barley have been obtained in salty agricultural areas, areas with excess boron, ie toxicity, fields with micronutrient deficiency such as molybdenum and zinc, and problematic agricultural areas where some diseases are seen.

Better results than wheat and barley have been obtained in salty farming areas, areas with boron excess, ie toxicity, fields with micronutrient deficiency such as molybdenum and zinc, and problematic agricultural areas where some diseases are seen, since triticale is adapted to poor growing conditions from the father and parent rye plant. Triticale has been found to be more tolerant to soil adaptation and changing environmental conditions than other cool climates. In addition, it has become a plant which cultivation area and importance are increasing day by day because it is cheap, high quality and suitable for storage and machine agriculture. It is emphasized that triticale has an important role in human and animal nutrition due to its growth characteristics, yield and alimentary nutrients.

Given priority forage deficit in Turkey, it was also stated by other researchers that there will be increases in both cultivation area and production with the development of new varieties of triticale. (Muntzing, 1989; Mergoum et al. 1992; Kün, 1996). It is predicted that it is an inevitable fact that triticale will gain value day by day both as a basic human food source and as an animal nutrition. In our country, it meets the roughage need of our animals in addition to human food resources, it is thought to be a plant that can prevent these due to the demolition that our animals cause to natural pastures and they have concentrated on experiments in various regions related to this. Although the purchase guarantee for the triticale product has been given in recent years, due to the variety development, seed problems and because of lacking in recognition among farmers it is not known enough. As a result of intensive breeding studies, today varieties with short length, strong stem, resistant to lying, no grain wrinkles, high hectoliter weight, sufficiently tillering, resistant to diseases, insensitive to photoperiod, adaptation and high yield have been developed. It is emphasized that the sterility problem still persists in triticale, and that triticale has a higher rate of foreign fertilization than wheat

(Yağbasanlar, 1990). In some triticale lines and varieties, it has been observed that the upper and lower flowers of the spikes do not hold seeds. In addition to these, according to the data obtained from international research organizations such as CIMMYT and ICARDA, which are among the breeding programs in our country in recent years, the varieties that have the highest yield in the Mediterranean and Aegean regions have been selected, and their fertilization, planting time, planting frequency breeding techniques have been aslo put forward. (Demir et al, 1980; Genç et al., 1987; Yağbasanlar & Ülger, 1989a) It was observed that the seeds have low wrinkle and hectoliter weights.

It is emphasized that triticale has many usage areas. It has been observed that the nutritional value of bread is further increased by adding Triticale flour, which has 15-16% high protein usage area, to 30% wheat flour (Bishnoi & Hughes, 1979). It is emphasized that the grain feed quality of Triticale product is equal to corn, wheat and barley. (Azman, 1997). It has been determined that, in recent years, triticale has been mixed with high quality wheat flour and also used in baking cakes, biscuits, bread, muffin and pasta. (Elgun et al., 1996; Bagjı, 2001). In Turkey, where the regions are with high altitudes,lower yields, with acidic soils and in places where diseases are intense, it is produced commercially, since the yield potential of triticale is close to wheat.

In Turkey, triticale production is carried out in 78 provinces. Total production in 641.010 da cultivated area in Turkey is 215.090 tons and its yield per decare is 336 kg / da (TÜİK, 2019). The most produced provinces are Çorum, Tokat, Kütahya, Bayburt, Denizli, Samsun, Muğla, Kırklareli, Karabük. Provinces which produces it in the Eastern and Southeastern Anatolia region are Adıyaman, Malatya, Ağrı, Elazığ, Erzurum and Ardahan. Production is made in a total of 6.814 decares of cultivated area in the Eastern and Southeastern regions, with a total production of 1.926 tons and an decare yield is average 285 kg / da. (TÜİK, 2015).

The negative changes in climate conditions along with global warming mostly caused some adverse effects in the Eastern and Southeastern Anatolia Regions. Due to these negativities in these regions, problems were also experienced in the cultivation of grains. The biggest problem is the lack of water due to drought. One of the other problems is that the deterioration of the rainfall regime causes the grain to lie down, together with the decrease in the yield. Due to this and similar negativities, it is directed to different plants that will adapt to the problems living in such regions. It is thought that the triticale plant, which adapts to these problems in such regions, will be more productive than other cereals. In order to get high yield in triticale agriculture, good soil preparation, timely planting, fertilization based on soil analysis, a correct weed control and timely harvest should be done.

In this study, it is aimed to determine the adaptation of some triticale varieties suitable for Siirt province conditions.

3. MATERIAL VE METHOD

3.1. Material

3.1.1. Test Area location

The research was conducted in Siirt University Faculty of Agriculture Field Crops Experiment Area in the growing season of 2014-2015.

3.1.2. Climate Characteristics of the Research Area

Table 3.1. The average temperature, raining and humidity data of 2014-2015 and average of long years of Siirt province where the test was conducted. (Siirt Meteorology General Directorate data 2015-2016).

	Temperature (^{0}C)		Rainfall (mm)		Relative humidity (%)	
Months	2014-15	LTA	2014-15	LTA	2014-15	LTA
September	25.4	25.1	32.1	5.3	31.0	34.0
October	18.1	18.1	51.7	48.7	52.8	50.3
November	8.9	10.4	94.8	80.2	62.5	64.0
December	7.0	4.8	92.8	93.8	80.3	72.4
January	2.5	3.2	61.0	80.0	72.8	72.0
Febuary	5.9	4.5	90.8	99.1	70.8	66.6
March	8.7	8.7	122.3	107.3	63.3	61.3
April	13.0	14.3	53.8	99.7	56.2	58.2
May	19.7	19.7	29.6	57.8	41.2	49.9
June	27.1	26.4	3.6	9.0	27.7	35.0
Total/Aver.	**13.6**	**13.5**	**63.2**	**68.1**	**55.9**	**56.4**

LTA: Long Term Average

As seen in Table 3.1, while the average temperature for many years was 13.5^0 C, it is seen that the average temperature was 13.6^0 C in the 2014-15 growing season when the experiment was established. As can be seen from the data, the temperature data in the year of the experiment show similar values with the averages of long years. The monthly total rainfall average is 63.2 mm. In terms of rainfall, the total raining between October and June was 600.4 mm, while the average for long years was 675.6 mm. As can be understood from here, it is seen that the production years of 2014-2015 received more rainfall than the average of long years. As seen in Table 3.1, it is seen that the average relative humidity of the experiment is 55.9 in the 2014-15 growing season. Although the value of 56.4, which is the relative humidity value of the averages for many years, is higher than the relative humidity value seen in the year when the experiment was established, this difference is not significant..

3.1.3. Soil Characteristics of the Research Area

Çizelge 3.2. Soil analysis results of test fields.

pH	**Ec s/cm**	**Lime $CaCO_3$ %**	**Organic matter %**	**Phosphorusr P2O5 Kg/da**	**Potash K2O Kg/da**	**Fe Ppm**	**Cu Ppm**	**Zn ppm**	**Mn ppm**	**Sand %**	**Clay %**	**Silt %**	**Structure category**
6.87	602	0.64	0.90	1.67	114	13.01	1.78	0.60	21.89	41.64	51.32	7.04	L

The necessary physical and chemical analyzes (amount of lime, pH, potassium, phosphorus, organic matter, iron, copper, zinc and manganese) of the soil samples taken from the 0-30 cm part of the soil where the test will be applied, were made in the laboratories of the Black Sea Agricultural Research Institute. Soil properties of samples taken from 0-30 cm depth of the soil of the tested area are given in

Table 3.2 According to the results of the analysis, it is seen that the soil structure of the test area is clayey, neutral, has pH, lime content is very low, organic matter is poor, there is no salt problem, K, Fe, Cu and Mn content is sufficient, phosphorus and Zn are poor (Kaya et al. 1995).

3.1.4 Types Used in the Test

7 triticale varieties obtained from different Agricultural Research Institutions and applied in the experiment were used as material.

Melez 2001

This variety, which is recommended for wet areas, has a white awned spike, plant height between 110-120 cm, grain yield This variety, which grows in the Central Anatolian transition regions, has a protein ratio of 11-13%, a thousand grain weight of 35-39 g, a hectoliter weight of 69-75 kg and is used in feed, blend, flour making and silage. It is a variety that is resistant to rascals, resistant to all rust types, resistant to sprout and root throat rot.350-900 kg / da resistant to moderate drought, cold and slanting.

Ümran Hanım

It is an alternative to other cool climate cereals that can be used as concentrate feed. It is an annual plant. The recommended planting density under arid conditions takes values between 400-450 kg / da per m^2, 73-77 kg per hectoliter and 34-45 g per thousand grain weight. According to the results of the tests, it is recommended for cold and frost resistant, suitable for agriculture in dry and heat resistant arid conditions the high parts of Central Anatolia and the arid and irrigable areas of eastern Anatolia due to its high yield and quality characteristics. It is resistant to powdery mildew, smut and rust diseases.

Tatlıcak-97

It grows in dry and watery areas in all regions of our country. It is not selective in terms of soil and climate. It has a high drought tolerance. Its tolerance to salt, boron excess, micro element deficiency, winter damage, drought, diseases and other problems is higher than wheat and barley. It has a height of 110-120 cm, a hectolitre weight of 73-79 kg, a thousand grain weight 35-41 g, its spike color is light brown with awn. It is cultivated in September in Eastern Anatolia and in October in Central Anatolia and Transition Regions. Good tolerance to slanting. It is medium early and comes with wheat at harvest. Does not pour grain, has good blending ability.

Karma 2000

This variety, which has wide adaptation in winter western passage regions, is resistant to slanting, spike color is white, with awns, early, grain and stem yield is high. It is a variety with the characteristics of plant height 110-120 cm, thousand grain weight 35-40 g, hectolitre weight 75-80 kg.

Mikham 2002

The spike is light brown, long, with awn, resistant to slanting, resistant to drought and cold, and used for feed, blended flour making and silage. It is a winter variety with the characteristics of plant height 110-130 cm, grain yield 200-550 kg / da, thousand grain weight 33-41 g, hectoliter weight 73-79 kg. It is a disease resistant and evergreen variety grown in Central Anatolia and transition regions.

Alperbey

Recommended for dry areas, this variety is white, awny, plant height 100-120 cm, grain yield 250-400 kg / da, resistant to drought, cold and slanting. This variety, which grows in the Central Anatolian transition regions, has a protein ratio of 12-14%, a thousand grain weight, a hectoliter weight of 71-72 kg, it is used in feed, blended flour and silage. It is a variety that is resistant to rascals, resistant to all rust types, resistant to sprout and root throat rot.

Egeyıldızı

Spike is white and awny, grain color is red and coarse grained, and the plant height is 120-140 cm. It is resistant to slanting. Egeyıldızı, which has a summer grow nature, is quite early and tolerant of cold. Sowing frequency should be adjusted as 400-450 seeds per m^2. Egeyıldızı thousand grain weight is 42.5-43.5 g, hectolitre weight is 74.2-77.8 kg, 2.5-2.8 mm.

3.2. Method

The experiment was carried out in a randomized block design with 3 replications. During the growing season, a total of 10 kg of pure phosphorus (P_2O_5) and 16 kg of nitrogen (N) fertilizer were given. All of the phosphorus and half of the nitrogen were given by seeder during planting, and the remaining half as sprinkling during tillering. The planting was done with a 6-row parcel drill on 5 square meters of plots with 500 seeds per square meter. The experiment was conducted in dry conditions. Weed control was done manually during the tillering period. Planting was 20 cm between rows and 5 rows. Planting was held on October 30th. Deep ploughing with plow in the autumn before planting and duplication in shadow annealing before planting was done. Before planting, an experiment was established in the wheat growing area. Harvesting was carried out with the parcel harvester and 50 cm from the beginning and end of each plot, after separating one row from the edges of the parcel as edge effect. The harvest took place on June 25.

In the research, it was subjected to correlation analysis to determine the relationship between plant height, spike height, number of tillerings, number of spikes per square meter, number of spikelets per spike, grain number per spike, grain weight per spike, thousand grain weight, grain yield, biological yield, hectolitre weight, grain protein content, grain phosphorus content and properties. Statistical calculations were analyzed according to the SPSS package program in accordance with the experiment plan. Grouping of average was done according to Duncan test.

RESULTS AND DISCUSSION

4.1. Plant height

As can be seen when Table 4.1 is examined, the difference in plant height of the varieties has emerged significantly at 1% level in terms of statistics.

Table 4. 1. Plant height average values and formed duncan groups

Varieties	Plant height (cm)
Melez-2001	*112.0 a*
Ümran Hanım	108.7 ab
Egeyıldızı	111.7 a
Tatlıcak-97	104.3 b
Alperbey	111.0 a
Mikham-2002	112.7 a
Karma 2000	78.7 c
Average	**105.6**

* Differences between averages indicated by the same letter are insignificant.

When the Table 4.2 of the plant height values of the varieties is examined, the Melez-2001, Egeyıldızı, Alperbey and Mikham-2002 varieties gave the highest values, while the difference between them was statistically insignificant. However, the highest value was obtained in Mikham-2002 with 112.7 cm. The lowest value was observed in the Karma 2000 variety with 78.7 cm. Average plant height values discussed in the research are shown in Figure 4.1. When previous studies were examined, Gill et al. (1990), in a study they conducted with 485 summer triticale lines, found that the plant height in triticale lines varied between 44.8 and 172.4 cm. Yağmur (1993), in a study conducted in Çukurova's ecological conditions, reported that the plant height was between 98.2–133.7 cm. Yanbeyi & Sezer stated that the triticale genotypes they used in an experiment conducted to determine the yield and yield of triticale genotypes in Samsun's ecological conditions between 1994-1996 were 94.7 cm in the shortest and 117.4 cm in the longest. These values obtained by the researchers were similar to our findings.

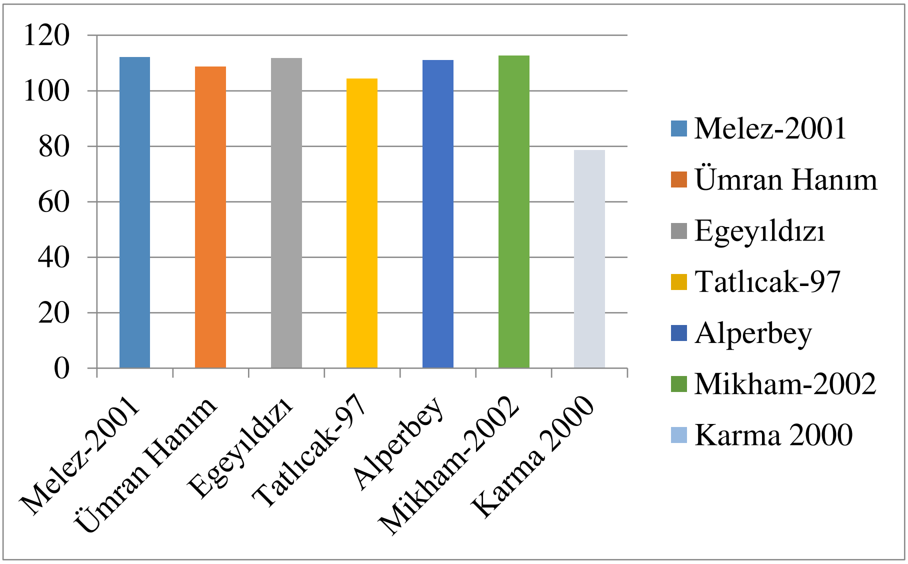


Figure 4.1. Plant height averages

Ünver (1999), one of the other researchers, in an experiment conducted with 17 triticale breeding lines and 1 variety candidate in Ankara's ecological conditions in 1996-1997, stated that the average values of the triticale lines varied between the shortest 103 and 123.7 cm in terms of plant height, while the plant height of Tatlıcak-97 variety was 115 cm. Demir et al.(1981), in a study conducted in Bornova's ecological conditions, emphasized that the plant height varied between 108-144.2 cm in triticale lines. Yağbasanlar et al. (1990), As a result of the comparison of yield and yield elements in some triticale lines in Çukurova and Şanlıurfa's ecological conditions, determined that the average plant height was 135.3 cm under Çukurova conditions and 125.9 cm under Şanlıurfa conditions. Lehman et al. (1983), in a study they conducted in California, reported that triticale was higher in plant height than wheat. Botezan et al. (1988), as a result of an experiment with Vladeasa, a triticale variety grown in Romania, emphasized that the plant height varied between 100 and 108 cm. It has been observed that previous research values and our study contain different findings. As is known, plant height is a parameter closely related to plant nutrients and rainfall. For this reason, these differences are thought to be caused by different soil characteristics and conditions, as well as not being similar to climatic conditions such as rainfall, temperature and humidity of the area where triticale varieties are grown.

4.2. Spike height

The average spike height values obtained from the Triticale varieties used in the experiment and the resulting duncan groupings are also given in Table 4.2.

As can be seen when examining Table 4.2, the spike size of the varieties has statistically significant differences at the level of 1%.

Table 4.2. Spike height average values and duncan groups

Varieties	Spike height (cm)
Melez-2001	*9.6 b*

Ümranhanım	13.6 a
Egeyıldızı	13.6 a
Tatlıcak-97	11.6 ab
Alperbey	12.6 a
Mikham-2002	12.3 ab
Karma 2000	9.6 b
Average	**11.9**

* Differences between averages indicated with the same letter are negligible.

When the table 4.2 of the spike height values of the varieties is examined, Ümran Hanım, Egeyıldızı and Alperbey varieties gave the highest values, while the difference between them was statistically insignificant. However, the highest value was obtained with 13.6 cm in Ümran Hanım and Egeyıldızı. The lowest value was observed in Karma 2000 and Melez-2001 varieties with 9.6 cm.

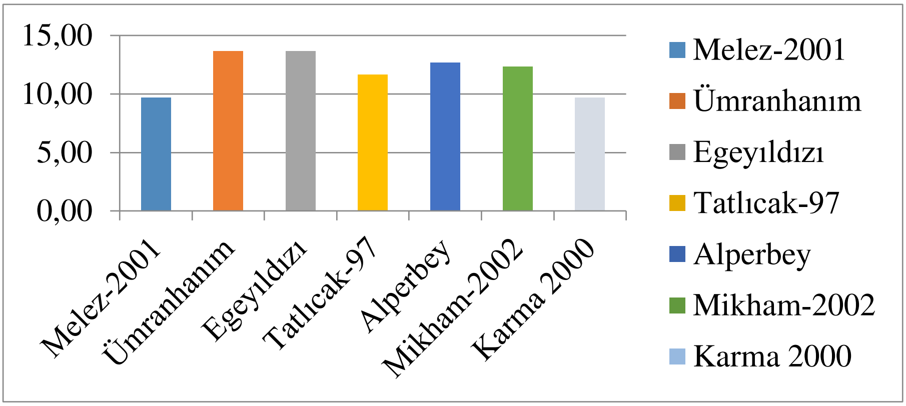


Figure 4.2. Spike height averages

The graphic of the spike length average values discussed in the research is given in Figure 4.2. When the spike size values obtained in this study are compared with previous studies, Yanbeyi & Sezer (2006), as a result of a research they conducted to determine the yield and yield elements of triticale genotypes in Samsun's conditions between 1994-1996, reported that the shortest spike length values of the triticale genotypes used in the experiment were 10.7 cm and the longest was 13.6 cm. Yağbasanlar et al. (1988) reported that the spike length in triticale is higher than the other grains-wheat and barley. While these studies show similarities with the values we obtained, in another one, Akgün et al. (2007) reported that the spike length of the triticale genotypes ranged from the shortest to 6.1 cm, the longest to 8.5 cm in their study to determine the yield and yield components of some triticale line / varieties in Isparta ecological conditions. With the findings of this research, it was determined that the values we obtained were realized differently. It is thought that the spike height values of some varieties are longer or shorter compared to previous studies, depending on the genotype, the number of spikes per square meter, climate and environmental factors.

4.3. Number of tillering

The average tillering number values and the resulting duncan groupings obtained from the Triticale varieties used in the experiment are given in Table 4.3.

Table 4. 3. Average values of tillering number and duncan groups

Varieties	Tillering number (pcs.)
Melez-2001	*2.3 b*
Ümran Hanım	2.3 b
Egeyıldızı	2.6 b
Tatlıcak-97	3.3 ab
Alperbey	2.3 b
Mikham-2002	4.0 ab
Karma 2000	5.0 a
Average	**3.11**

* Differences between averages indicated with the same letter are negligible.

When the table 4.3 regarding the spike height values of the varieties is examined, the Karma 2000 variety showed the highest value with 5.0 units. The lowest value was observed in Melez-2001, Ümran Hanım and Alperbey varieties with 2.3 and the difference between them was statistically insignificant.

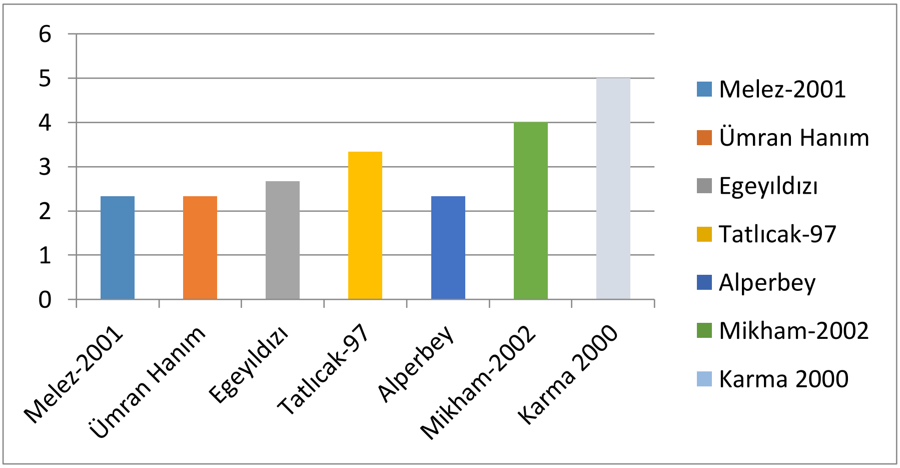


Figure 4.3. Average number of tillerings

Average values graph of the number of tillering considered in the study is given in figure 4.3. In a detailed literature search, Ünver (1999) determined the average number of triticale lines in the plant as 3.1 in the first year and 3.3 in the second year in his study for 2 periods. İn the study conducted by Atak & Çiftçi (2005) on 2 varieties for 2 years, the first variety, Tatlıcak-97, gave an average of 4.1 in the first planting year and 3.4 tillering number in the second planting year. Karma-2000, another variety used, showed 3.6 tillering numbers in the first planting year and 3.7 in the second planting year. The values obtained in this study were similar to the reviewed literature. The reason for the different results compared to previous studies may be due to the climate, soil, types of use, environmental conditions, applied cultural processes, different planting times and different planting densities.

4.4. Spike per Square Meter

The average number of spikes per square meter obtained from the Triticale varieties used in the experiment and the resulting duncan groupings are also given in Table 4.4.

As can be seen from Table 4.4 examination, the difference in terms of the number of spikes per square meter of varieties was statistically significant at 1% level.

Table 4. 4. Average values of spike number and duncan groups

Varieties	Skipa per sq. m. (pcs)
Melez-2001	*494.0 c*
Ümran Hanım	518.7 a
Egeyıldızı	497.3 bc
Tatlıcak-97	531.0 a
Alperbey	515.7 ab
Mikham-2002	411.7 d
Karma 2000	527.3 a
Average	**499.4**

* Differences between averages indicated with the same letter are negligible.

When the values of the number of spikes per square meter of the varieties are examined in Table 4.4, Ümranhanım, Alperbey and Karma2000 varieties gave the highest values, while the difference between them was statistically insignificant. However, the highest value was obtained from Tatlıcak-97 with 531.0 pieces. The lowest value was observed in Mikham-2002 variety with 411.7. The graphic of the average values of the spike number per square meter discussed in the research is given in figure 4.4. In the examinations made on the number of spikes per square meter obtained in previous studies, Yağmur (1993) emphasizes that the number of spikes determined by different researchers in triticale genotypes in terms of the number of spikes per square meter is very similar. In an experiment conducted in Çukurova's ecological conditions, it is reported that the number of spikes of triticale per square meter took values between 438 and 510. Akgün et al. (2007), in their study in Isparta's ecological conditions, found that the number of spikes in the square meters was between 297-475 and the plant density of triticale genotypes was low.

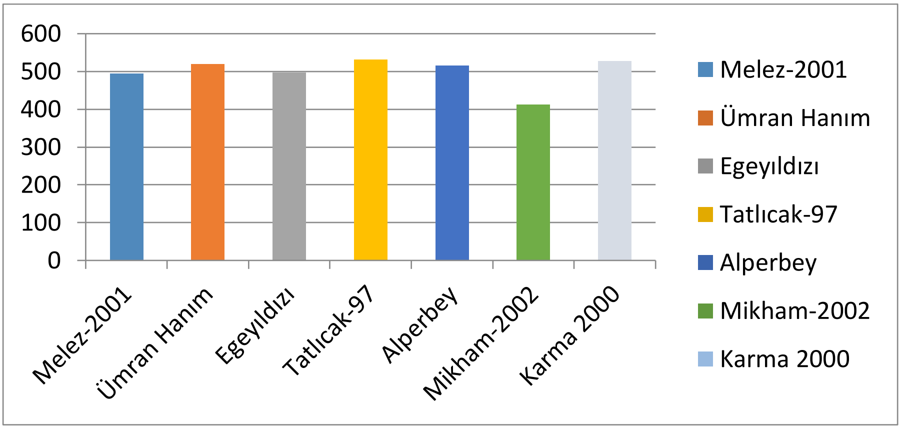


Figure 4. 4. Average number of spikes per square meter

Akgün et al. (1997) reported that in a study conducted under Erzurum conditions, the number of spikes per square meter took an average of 233 to 348 pieces. It was determined that the values obtained by the researchers were realized differently from our findings. Other studies on this subject have shown almost similar results to our research results. The reason for this is thought to be due to the low germination rate depending on the genotypes used in the experiments, environmental conditions, planting time, planting frequency, tillering capacity, cultural processes applied, soil properties and physical condition of triticale seeds in most research results.

4.5. Number of Spikelets

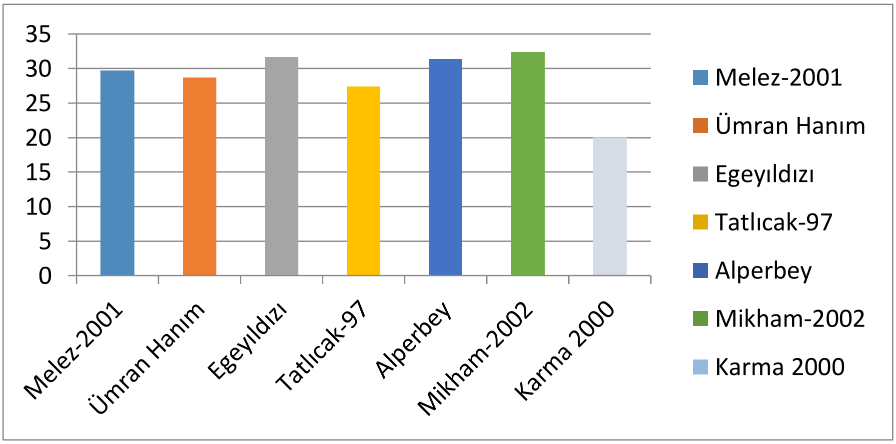
The average number of spikelets obtained from the triticale varieties used in the experiment and the resulting duncan groupings are also given in Table 4.5.

When Table 4.5 of the spikelet number values of the varieties is examined, the Mikham-2002 variety gives the highest value, while the difference between the other varieties except the Karma 2000 variety was statistically insignificant. However, the highest value was obtained from Mikham-2002 with 32.3 pieces. The lowest value was observed in the Karma 2000 variety with 20.0.

Table 4.5. Average values of the number of spikelets and duncan groups

Varieties	Number of spikelets (pcs)
Melez-2001	*29.6 a*
Ümranhanım	28.6 a
Egeyıldızı	31.6 a
Tatlıcak-97	27.3a
Alperbey	31.3 a
Mikham-2002	32.3 a
Karma 2000	20.0 b
Average	**28.7**

* Differences between averages indicated by the same letter are insignificant.



Şekil 4. 1. Başakçık sayısı ortalamaları

The graph of average values of the number of spikelets discussed in the research is given in figure 4.5. As a result of a study conducted by Yağmur (1993), who examined the number of spikelets in triticale in previous studies, in Çukurova's ecological conditions, it is reported that the number of spikelets was at least 22.2 and maximum 30.2. Atak & Çiftçi (2006) reported that, as a result of their 2-year study between 1999 and 2001, they obtained an average of 19.4-27.1 spikelets of the triticale varieties and lines they examined. The values obtained by the aforementioned researchers showed similarities with our findings. Bostan (1995), one of the other researchers, in his research conducted in Van ecological conditions, found that the average number of spikelets was at least 20.2 and at most 22.5 in his research consisting of 15 different summer triticale lines. Gill et al. (1990) reported that the number of spikelets in triticale lines varied between 14-27.2 in a study conducted with 485 summer triticale lines obtained from different countries. Our study showed different values with the given research findings. It is thought that the number of spikelets varies depending on the climate, environmental factors, soil nutrient values.

4.6. Number of Grains in Spike

The average number of grains per spike obtained from the Triticale varieties used in the experiment and the resulting duncan groupings are given in the table 4.6.

Table 4.6. Average number of grains per spike and duncan groups

Varieties	**Number of grains in spike (pcs)**
Melez-2001	*53.3 c*
Ümranhanım	75.6 a
Egeyıldızı	68.0 ab
Tatlıcak-97	59.3 bc
Alperbey	65.0 bc
Mikham-2002	64.6 bc
Karma 2000	71.0 ab
Average	**65.3**

* Differences between averages indicated by the same letter are insignificant.

When the table 4.16 of the grain number values per spike is examined, the highest value was obtained from Ümran Hanım variety with 75.6 pieces. The lowest value was observed in Melez-2001 with 53.3 pieces.

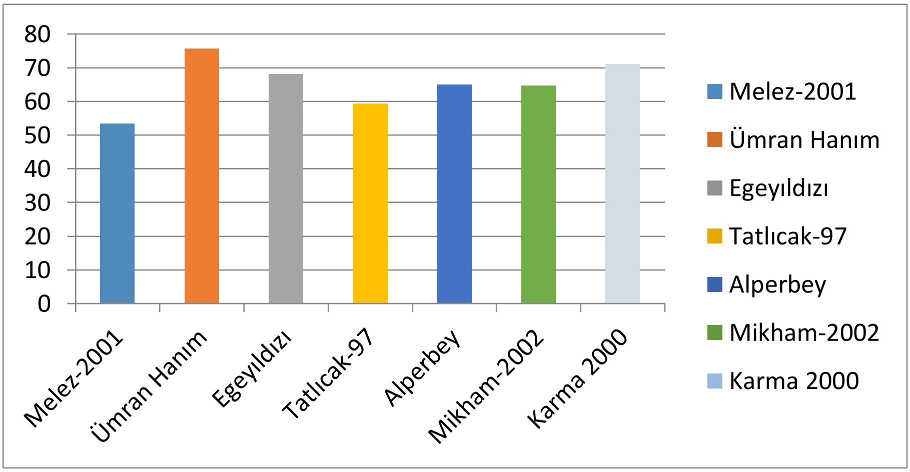


Figure 4.6. Average number of grains per spike

The graphic visual of the number of grains per spike discussed in the research is given in figure 4.6. In previous studies on grain number values in spike, Ünver (1999) conducted a study in Ankara ecological conditions for 2 years, between 1996-1997, the average of 17 triticale breeding lines and 1 variety candidate's grain number per spike was determined 49.3 in the first year, 47.0 in the second year. While the values obtained were similar to this study, Genç et al. (1987) in the Çukurova's ecological conditions, obtained a minimum of 37.9 and a maximum of 50.7 grains per spike in the first test. In the II test, they reported that they obtained a minimum number of 32.3 and a maximum of 51.3 grain in spike. In another study, Ülger et al. (1989) reported that the average number of grains per spike of 46 triticale line in Çukurova ecological conditions was 47.5 pieces / spike. Karan et al. (2011) reported that the number of grains per spike was 37.2 as a result of a study conducted in Diyarbakır's ecological conditions. When the research findings are compared with similar studies, it is thought that the reason why the data is different is due to the genotype, spike height and the number of spikes per square meter, and the effects of climate and environmental factors.

4.7. Thousand Grain Weight

The average thousand grain weight values obtained from the Triticale varieties used in the experiment and the resulting duncan groupings are given in Table 4.7.

Table 4.7. Thousand grain weight average values and duncan groups

Varieties	Thousand grain weight (gr)
Melez-2001	32.3 b
Ümran Hanım	37.3 a
Egeyıldızı	28.8 c
Tatlıcak-97	28.6 c
Alperbey	26.5 d
Mikham-2002	29.3 c
Karma 2000	26.8 d
Average	**29.1**

* Differences between averages indicated by the same letter are insignificant.

When the table of thousand grain weight values of the varieties is examined, the highest value was obtained from Ümran Hanım with 37.3 gr. The smallest value was observed in Alperbey variety with 26.5 gr.

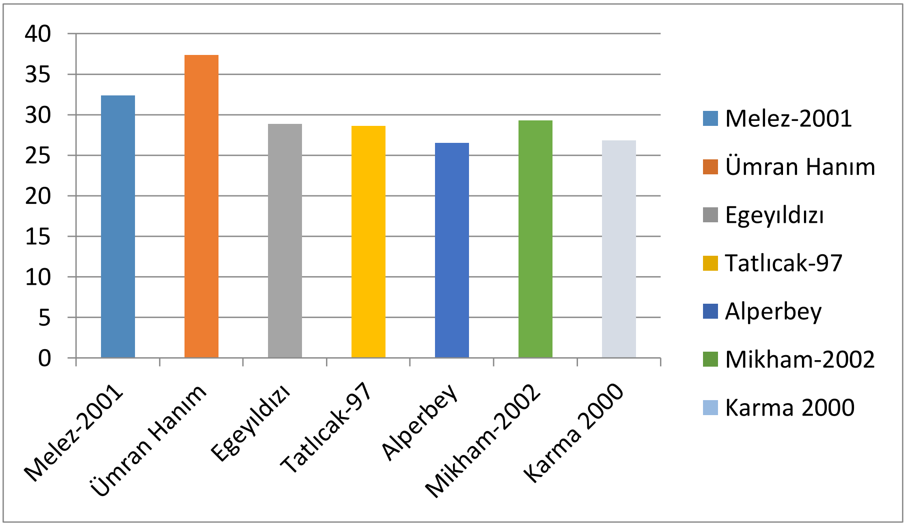


Figure 4. 7. Averages of thousand grain weight

The graphic representation of the average values of thousand grain weight discussed in the research is given in Figure 4.7. When the thousand grain weight values were examined in previous studies, Akgün et al. (1997), in a study conducted in Erzurum conditions, was found that it varied between 35.3 g and 37.5 g, Arısoy et al. (2005) in their study in Konya ecological conditions reported it to be between 33 g and 42 g. The findings we obtained are similar to these values, while one of the other researchers Genç et al. (1987), in an experiment conducted in Çukurova's ecological conditions with an interval of 2 years obtained the average lightest 35.9 g, the heaviest 49.4 g thousand grain weight in the first test, and the average lightest 36.6 g heaviest 48.5 g thousand grain weight in the second experiment, Kutlu (2008), as a result of a research conducted in Eskişehir between 2006-2007, reported that they obtained thousand grain weight values between 36.5 gr lightest and 47.3 gr heaviest. As a result of a study conducted by in the tests of Sapra et al. (1973), which included superior triticale lines in Bornova, it was reported that a thousand grain weight was between 43.9-50.2 g. Yanbeyi & Sezer (2006) found in their study that the weight of one thousand grains varied between 38.3-53.1 g on average, Albayrak et al. (2006), in terms of the average thousand grain weight values between 33.0-47.2 g, Çiftçi et al. (2010), in a study they conducted, stated that they determined the average lightest 43.4 g and the heaviest 52.2 gr of thousand grain weight. It has been determined that the findings of this research and the results of previous studies are different from each other. Thousand grain weight is a factor that varies depending on the genotype, but it is also affected by environmental factors. It is thought that the difference in results due to these effects.

4.8. Biological yield

The average biological yield values obtained from the triticale varieties used in the experiment and the resulting duncan groupings are given in the Table 4.8.

When the table of biological yield values is examined 4.8, the highest value was obtained from Tatlıcak-97 variety with 1223.0 kg / da. The lowest value was observed in Mikham-2002 variety with 758.2 kg / da. Biological yield average values are shown in the graphic figure 4.8. Biological yield values obtained in this study we conducted, from earlier studies Lithourgidis et al. (2006), in their study to determine the grass yield and quality of triticale in Greece, determined the dry matter yield as 975.9 kg / da.

Table 4.8. Biological yield average values and duncan groups

Varieties	Biyological yield ((kg/da))
Melez-2001	958.4 d
Ümranhanım	1067.8 bc
Egeyıldızı	886.8 e
Tatlıcak-97	1223.0 a
Alperbey	1016.0 c
Mikham-2002	758.2 f
Karma 2000	1098.6 b
Average	1001.3

* Differences between averages indicated by the same letter are insignificant.

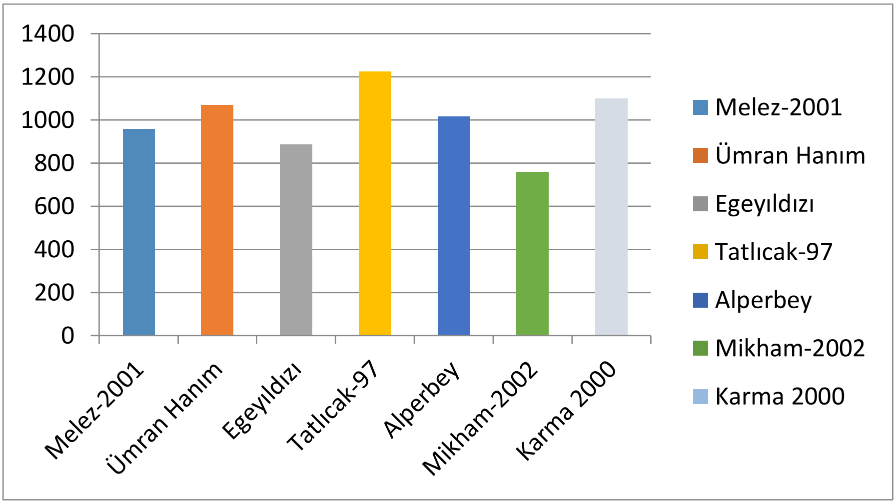


Figure 4.8. Biological yield averages

While the values obtained are similar to our study, Rao et al. (2000), as a result of a study they conducted in Nebraska emphasized that, consequently comparing the yield characteristics of wheat and triticale, it was found that the biomass increase of triticale genotypes during the physiological maturity period was 22% higher than wheat, grain yield 3.5% less, hay yield 28% higher and triticale biological yield was obtained as 737.8 kg / da. The values obtained as a result of the research differ with the findings of this study. It is known that the most important element in the development of the vegetative component of the plant is nutrients in the soil and among the nutrients the most important element is known to be the nitrogen. In addition to the nitrogen content of the soil where plants grow, climatic parameters also play an important role. Especially rainfall positively affects vegetative development. It can be said that the difference that occurred in previous studies may be due to climate and soil.

4.9. Grain Yield

The average grain yield values obtained from the Triticale varieties used in the experiment and the resulting duncan groupings are given in the Table 4.9.

When the table of grain yield values is examined in Table 4.9, the highest value was obtained from Tatlıcak-97 with 460.6 kg / da. The lowest value was observed in Mikham-2002 variety with 171.6 kg / da.

Table 4.9. Grain yield average values and duncan groups

Varieties	Grain yield (kg/da)
Melez-2001	287.1 e
Ümranhanım	387.3 c
Egeyıldızı	256.9 f
Tatlıcak-97	460.6 a
Alperbey	348.5 d
Mikham-2002	171.6 g
Karma 2000	450.1 b
Average	337.5

* Differences between averages indicated by the same letter are insignificant.

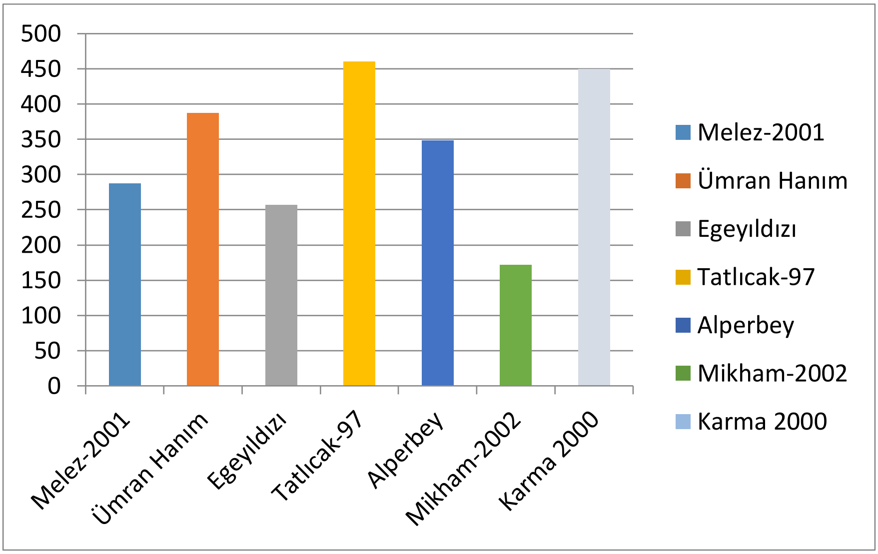


Figure 4. 9. Grain yield averages

The grain yield average values graph handled in the research is given in figure 4.9. In his previous studies, Ünver (1999) stated that the grain yield per decare in triticale lines varied between 206.3-340.0 kg / da on average, Yağbasanlar et al. (1989a) in their research under Çukurova conditions reported that the grain yield in Nc.Ic.Bulk 181 triticale line of the ICARDA origin was 434 kg / da and ranked first in terms of yield. Yağbasanlar et al. (1989b) observed in a study they conducted on triticale in Çukurova ecological conditions that the grain yield per decare varied between 253.1 and 514.7 kg / da. While the results of this study were similar with the values obtained by the researchers, Yanbeyi & Sezer (2006) reported that the grain yield of triticale per decare took values between 225.5 and 415.3 kg / da in a study they conducted in Samsun's ecological conditions. Mut et al. (2006) reported that the grain yield per decare in triticale varied between 358.8-564.4 kg / da.

Akgün et al. (2007), as a result of a study conducted in Isparta, reported that grain yields per decare in triticale took values between 254.2-357.1 kg / da on average, and Kaydan & Yağmur (2008) reported that triticale grain yields varied between 303.0-328.3 kg / da in their study. Yağmur (1993) reported that the grain yield of triticale varied between 617.2 and 796 kg / da in a study conducted in the Çukurova region's ground and barren conditions that are not suitable for agriculture. It was determined that the results of this study, which was conducted with the findings of the researchers, were realized differently. The grain yield is directly positively affected by the number of spikes per square meter, the number of grains per spike, and the weight of one thousand. Grain yield is thought to be highly affected by ecology and genotype. The difference is thought to be due to these reasons.

4.10. Hectoliter Weight

The average hectoliter weight values obtained from the triticale varieties used in the experiment and the resulting duncan groupings are also given in Table 4.10.

Table 4. 10. Hectoliter weight average values and duncan groups

Varieties	Hectoliter weight (kg/100L)
Melez-2001	*70.6 d*
Ümran Hanım	74.5 b
Egeyıldızı	71.4 d
Tatlıcak-97	72.6 c
Alperbey	68.9 e
Mikham-2002	71.7 cd
Karma 2000	78.4 a
Average	72.6

* Differences between averages indicated by the same letter are insignificant.

When the table 4.10 of the hectoliter weight values of the varieties is examined, the highest value was obtained from the Karma 2000 variety with 78.4 kg / 100L. The lowest value was observed in 68.9 kg / 100L Alperbey variety.

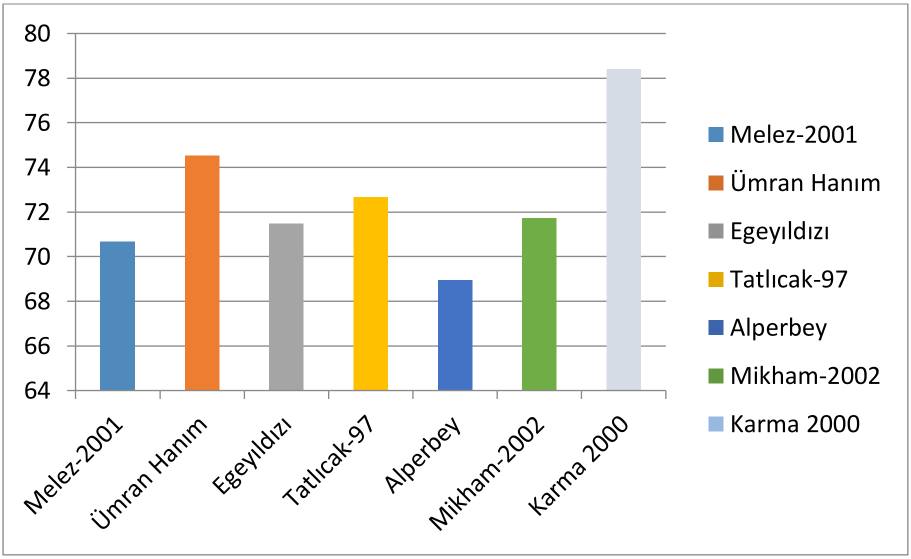


Figure 4. 10. Hectoliter weights averages

Figure 4.10 shows the graph of the hectoliter weight values. Comparing the hectolitre weight values obtained in this study, the studies of some researchers Sade et al. (1999) reported that the high hectolitre weight is related to the tight structure of the grains and the thinness of the shell surface, also the high protein ratio and flour yield. Yağbasanlar et al. (1994), in their study, to examine the effect of seed size on yield and quality under Çukurova's ecological conditions, reported that the hectolitre weight took values between 71.0 and 76.3 kg / 100L. Akgün et al. (2007) reported that they obtained average hectoliter weight values between 67.3-73.8 kg / 100L in the yield experiment they conducted under Isparta conditions. Taşyürek et al. (1999) reported that the hectolitre weights took values between 76.2-76.8 kg / 100L. The findings of these researchers and the findings we obtained in our study differ. It can be stated that hectoliter weights vary depending on venotype, environment and cultural practices, biotic and abiotic stress factors, and the difference occurred with previous studies may be due to these reasons.

4.11. Grain Protein Content

The average protein values obtained from the triticale varieties used in the experiment and the resulting duncan groupings are given in the table 4.11.

Table 4. 22. Grain Protein average values and duncan groups

Varieties	Protein (%)
Melez-2001	*11.8 a*
Ümranhanım	11.4 b
Egeyıldızı	11.5 b
Tatlıcak-97	11.5 b
Alperbey	10.2 c
Mikham-2002	12.0 a
Karma 2000	12.1 a
Average	11.5

* Differences between averages indicated by the same letter are insignificant.

The data of the protein values of the varieties are shown in the table 4.11.

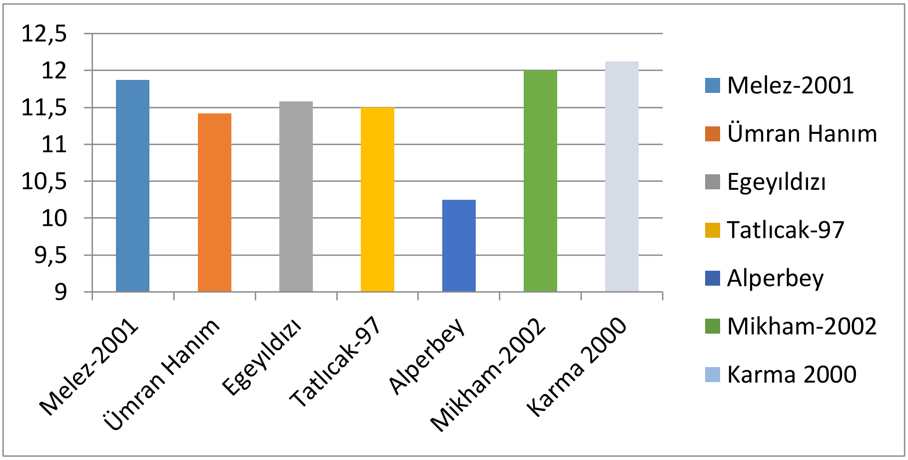


Figure 4. 11. Averages of grain protein content

When Table 4.11 is examined, Karma 2000, Mikham-2002 and Hybrid-2001 varieties gave the highest values, while the difference between them was statistically insignificant. However, the highest value of protein was obtained from the Karma 2000 variety with 12.1. The lowest protein value was observed in Alperbey variety with 10.2.

The graphic of the average values of grain protein content is given in figure 4.11. When the findings provided in this study were compared with the grain protein content values obtained by the researchers in their previous studies, Arısoy et al. (2005), in a study they carried out with Tatlıcak-97 variety in two years, emphasized that protein values the first year was 9.33% and the second year it was12.46% in Tatlıcak-97 triticale variety. While the values obtained by the researcher and our study results were similar, another researcher Anonymous (1999), as a result of the research conducted with Tatlıcak-97, emphasizes that the grains of Tatlıcak-97 contain 12-14% protein under normal growing conditions. It has been determined that the findings of the researchers and our data are far from each other. It is stated that the protein ratio, which is an important quality parameter, varies depending on the nutrient, variety, environment and cultivation technique applications.

4.12. Grain Phosphorus Content

The average grain phosphorus content values obtained from the triticale varieties used in the experiment and the resulting duncan groupings are also given in the table 4.12.

Table 4.12. Average values of grain phosphorus content and duncan groups

Varieties	Grain Phosphorus cont. (%)
Melez-2001	*0.26 ab*
Ümranhanım	0.24 bc
Egeyıldızı	0.26 ab
Tatlıcak-97	0.25 bc
Alperbey	0.22 c
Mikham-2002	0.10 d
Karma 2000	0.28 a
Average	0.23

* Differences between averages indicated by the same letter are insignificant.

When the table 4.12 of grain phosphorus content is examined, the highest value was obtained from the Karma 2000 variety with 0.28. The lowest value was observed in Mikham-2002 variety with 0.10.

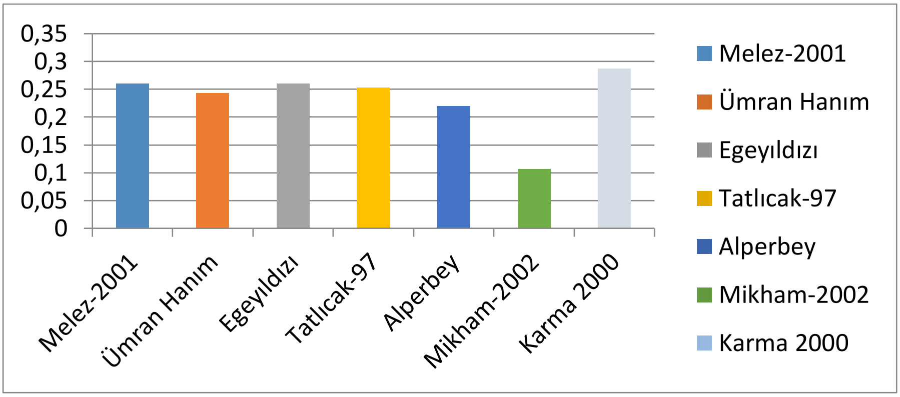


Figure 4.12. Grain phosphorus content averages

The graphical visual of the grain phosphorus content average values is given in Figure 4.11. When the previous study was examined, Güneş et al. (2013), as a result of a study they conducted in Şanlıurfa, reported that the values varying between 0.17-0.30% in the first year, varyied between 0.25-0.36% in the second year, according to the average data on the phosphorus ratio to triticale for two years.

While our study was in parallel with the first year test results of the previous research, it was observed that it took different values with the findings of the second year. The reason for this is thought to be due to different climate, soil structure, rainfall and different regions.

4.13. Relationships Between Agricultural Products and Quality Characteristics

Determining the relationship between the grain yield of triticale varieties and the factors affecting the grain yield and quality criteria is of great importance for selection studies. The relationships between the parameters examined in this study were tried to be revealed with the help of correlation and path analysis with the help of the SPSS 13 program (Table 4.13).

In the evaluation results, the correlation coefficients related to the examined features were calculated and the results are shown in the table 4.13. When we look at the correlation matrix, there was a statistically significiant correlation in the positive way between grain yield and biological yield (r = 0.952 **), spike weight (r = 0.942 **), plant weight (r = 0.840 **), spike number per m^2 (r = 0.873 **), hectolitre weight (r = 0.532 *) and phosphorus (r = 0.675 **), and statistically significant correlation between (r = -0.619 **) and spike number (r = -0.646 **) in the negative way. The relationship between grain yield and other yield and quality characteristics was not statistically significant.

By applying path analysis to the data obtained in the study with the help of SPSS 13 program, the direct and indirect effects of the grain yield and some quality characteristics and some yield characteristics of these data were determined. The established Path diagram is shown in table 4.14 for direct and indirect effects. As a result of the path analysis, the total effect of plant height on grain yield was found to be positive (p = 0.156). Hectoliter weight and spikelet number (p = -0.054) had the highest indirect effect (p = 0.057) on grain yield over plant height.

5. CONCLUSION AND RECOMMENDATIONS

Using high-yielding varieties adapted to the region in order to obtain high yield and quality products in triticale production, good soil tillage and seed bed preparation, timely and proper sowing, adequate fertilization, effective weed control, irrigation when needed and timely harvesting are important issues.

In this study, 7 different varieties were used under Siirt conditions, and observations of this type of yield and yield components were taken. According to the obtained results, it was tried to determine suitable triticale types for the region. As a result of the research, the plant height is 78.7-112.7 cm, the spike height is 9.67-13.67 cm, the number of tillering is 2.3-5.0, the number of spikes per square meter is 411.7-527.3, the number of spikelets is 20.0-32.3, the number of grains per spike is 53.3-75.7, the weight of a thousand grains is 26.5. -37.3 g, biological yield is 758.3-1223.0 kg da^{-1}, grain yield is 171.6-460.7 kg da^{-1}, hectolitre weight is 68.9-78.4 kg $100L^{-1}$, grain protein content is 10.3-12.1%, grain phosphorus content is 0.107-0.287 g kg^{-1}. In terms of grain yield, Tatlıcak-97 variety has the highest grain yield value with 461 kg da^{-1}.

As a result of our study, it is seen that Tatlıcak-97 variety stands out in terms of grain yield, which is the most important feature, and can be recommended for triticale cultivation in the region.

ACKNOWLEDGEMENT

This thesis study was supported by Siirt University Scientific Research Projects Directorate with the project numbered 2015-SİÜFEB-24.

In published BOOK OF ABSTRACTS OF THE II. INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SCIENCE AND TECHNOLOGY- BELGRADE 2016 (ICOEST-BELGRADE 2016) as "DETERMINATION OF SOME TRITICALE VARIETIES FOR PHOSPHORUS AND PROTEIN CONTENTS IN SIIRT PROVINCE"

Table 4.13. Correlation coefficients (r) between grain yield and some quality traits and some yield traits

	Grain yield	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Grain yield	1											
1. Plant height	-0.619**	1										
2. Spike height	-0.212	0.498*	1									
3. Number of tillering	0.140	-0.582**	-0.435*	1								
4. m^2 spike amount	0.873**	-0.431	-0.153	-0.119	1							
5. Spikelet amount	-0.646**	0.780**	0.480*	-0.554**	-0.463*	1						
6. Number of grains per spike	0.154	-0.287	0.226	0.210	0.070	-0.161	1					
7. Biological yield	0.952**	-0.446*	-0.146	0.033	0.840*	-0.543*	0.034	1				
8. Plant weight	0.840**	-0.549*	0.120	0.154	0.778**	-0.522*	0.387	0.767**	1			
9. Spike weight	0.942**	-0.538*	-0.184	0.044	0.875**	-.639**	0.223	0.895**	0.774**	1		
10. Thousand grain weight	-0.044	0.326	0.203	-0.392	0.022	0.155	0,109	0.005	-0.176	0.235	1	
11. Hectoliter weight	0.532*	-0.825**	-0.297	0.601**	0.310	-0.770**	0.388	0.361	0.517*	0.582**	0.086	1

is important at the *: ($p<0.05$); **: ($p<0.01$) level .

Table 4.14. Path coefficients related to direct and indirect effects of different characters on grain yield

Specifications	Direct Effects Grain yield	Dolaylı Etkiler														Toplam etki
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1. Plant height	-0.069	-	-0.034	0.040	0.030	-0.054	0.020	0.031	0.038	0.037	-0.022	0.057	0.026	0.026	0.031	0.156
2. Spike height	0.052	0.026	-	-0.023	-0.008	0.025	0.012	-0.008	0.006	-0.010	0.011	-0.015	-0.019	-0.020	-0.012	0.017
3. Number of tillering	0.018	-0.010	-0.008	-	-0.002	-0.010	0.004	0.001	0.003	0.001	-0.007	0.011	0.009	0.009	-0.001	0.016
4. m^2 spike amount	0.348	-0.150	-0.053	-0.041	-	-0.161	0.024	0.292	0.271	0.305	0.008	0.108	-0.102	-0.102	0.299	1.045
5. Apikelet amount	0.157	0.122	0.075	-0.087	-0.073	-	-0.025	-0.085	-0.082	-0.100	0.024	-0.121	-0.056	-0.055	-0.070	-0.375
6. Number of grains per spike	-0.063	0.018	-0.014	-0.013	-0.004	0.010	-	-0.002	-0.024	-0.014	-0.007	-0.024	0.004	0.004	0.002	-0.129
7. Biological yield	0.235	-0.105	-0.034	0.008	0.197	-0.128	0.008	-	0.180	0.210	0.001	0.085	-0.045	-0.045	0.152	0.720
8. Plant weight	-0.102	0.056	-0.012	-0.016	-0.079	0.053	-0.039	-0.078	-	-0.079	0.018	-0.053	0.022	0.021	-0.060	-0.349
9. Spike weight	0.834	-0.449	-0.153	0.037	0.730	-0.533	0.186	0.746	0.646	-	0.196	0.485	-0.049	-0.051	0.625	3.249
10. Thousand grain weight	-0.272	-0.089	-0.055	0.107	-0.006	-0.042	-0.030	-0.001	0.048	-0.064	-	-2.992	-0.044	-0.042	-0.011	-3.493
11. Hectoliter weight	0.118	-0.097	-0.035	0.071	0.037	-0.091	0.046	0.043	0.061	0.069	1.298	-	0.069	0.069	0.045	1.701

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CHAPTER 13

WEED SPECIES OF WINTER CEREALS AND THEIR MANAGEMENT IN TURKEY

M Sc Mesut SIRRI*

Assist. Prof. Dr. Shahid FAROOQ**

Assoc. Prof. Dr. Cumali ÖZASLAN***

*Siirt University, Kurtalan Vocational School, Plant and Animal Production Department, Siirt, Turkey (Orcid No: 0000-0001-9793-9599)
**Department of Plant Protection, Faculty of Agriculture, Harran University, Şanlıurfa, Turkey (Orcid No: 0000-0002-6349-1404)
***Dicle University, Faculty of Agriculture, Department of Plant Protection, Diyarbakir, Turkey (Orcid No: 0000-0002-8660-5451)
*Corresponding author: m.sirri@siirt.edu.tr

1. INTRODUCTION

It is believed that agriculture in the world started for the first time in southern Asia, which includes a wide geography including South and Southeast Anatolia, Palestine, Lebanon and Northern Iraq and called the "Fertile Crescent". It is thought that cereal production also started with the start of agriculture in the above-mentioned geographic regions. Nonetheless, there are evidences that wheat and barley cultivation was initiated in the region around 7000 BC (Haard et al., 1999). Therefore, it would not be wrong to say that agriculture history started with winter cereals, especially wheat and barley. For this reason, winter cereals are among the most important cultivated plants on global level from past to present.

Cereals -the chief architects of the agricultural revolution- are among the cultural plants that dominate present day's agricultural production. Winter cereals are cultivated on 293.600.424 hectares in 124 different countries around the world, which produce 1.044.777.482 tons of grain (FOA, 2018). Wheat has 81% share in the total production areas, while barley ranks second with 14% share in the production areas. The share of oats and rye in the production of winter cereals is 3% and 1%, respectively (Table 1).

India ranks first in terms of cultivation area of wheat (29.580.000 ha), whereas Russia has the highest cultivation area of barley (7.873.944 ha), oats (2.729.162 ha) and rye (956.095 ha) (FAO, 2018). Historically, Turkey occupies an important position in the production of winter cereals. Turkey ranks third in the world in terms of cultivation area of barley (2.601.207 ha) and 10th in terms of wheat production area (7.288.622 ha) of wheat crop according to 2018 data provided by FAO (Table 1).

Cereal production in Turkey is 40% of the total agricultural production of the country and they provide 52% of the calories and 63% of protein in human nutrition. In addition, human obtain 75% of their daily nutritional needs from cereals. Although contents of cereal grains vary according to the species, approximately grains contain 65-75% starch, 8-15% protein, 1-5% oil and 0.5-3% sugar (Kün, 1988; Kordali & Zengin, 2009). Furthermore, cereals constitute an important source of feed for animals (İnan & Rehber, 1987). On the other hand, winter cereals provide raw material for agricultural-based industries of Turkey; thus, playing a vital role country's economy. Unfortunately winter cereals' production of the country cannot meet domestic demand; therefore, domestic needs are fulfilled by imports, which are increasing with each passing day.

Table 1. Cultivation area and production of winter cereals in leading three countries in the world according to FAO 2018

Wheat			Barley		
Country and global rank	Cultivated area (ha)	Production (ton)	Country and global rank	Cultivated area (ha)	Production (ton)
1. India	29 580 000	131 447 224	1. Russia	7 873 944	16 991 907
2. Russia	26 472 051	99 7000 000	2. Australia	4 124 158	9 253 852
3. China	24 068 794	72 136 149	3. Turkey	2 601 207	7 000 000
10. Turkey	7 288 622	20 000 000			
Total	**238 560 684**	**865 492 398**	**Total**	**40 527 629**	**142 910 932**
Oats			**Rye**		
Country and global rank	Cultivated area (ha)	Production (ton)	Country and global rank	Cultivated area (ha)	Production (ton)
1. Russia	2 729 162	4 719 324	1. Russia	956 095	1 916 056
2. Canada	1 004 900	3 436 000	2. Poland	893 962	2 166 884
3. Australia	874 136	1 227 837	3. Germany	523 000	2 201 400
21. Turkey	105 802	260 000	9. Turkey	110902	320000
Total	**10 127 070**	**24 055 797**	**Total**	**4 385 041**	**12 318 355**

World population is constantly increasing (it will reach 10 billion people in 2050), whereas available land for cultivation is constantly decreasing. On the other hand human needs are increasing due to economic development and consumption habits are being diversified. Therefore, it is estimated that food production should be increased by 50% globally till 2050 to meet the demands of rapidly increasing global population. Agricultural production will become extremely important in the future when the problems caused by global climate changes are taken into account (Önen, 2010a; Önen & Özcan, 2010; Önen, 2015a). Naturally, it is expected that priority should be given to crop plants (such as cereals), which fulfill the basic food needs of people. Therefore, it can be concluded cereals will become strategic product in the future compared to today. Problems are expected in fulfilling the domestic needs and countries may be forced to meet their domestic needs at their own.

Considering that Turkey has limited water resources and agricultural areas have reached their marginal limits, it is of great importance to prevent losses in production areas, storage and product processing etc. Increasing per unit area production is priority of research programs in Turkey like rest of the world. Although ecological and economic conditions are ideal for cereal production in Turkey, the production and quality are still too low in the country. The main problems of yield decline in cereal production of the country are seed supply, wrong cultivation practices and plant protection factors (Özer et al., 2001; Gökalp & Üremiş, 2015).

Plant protection problems are among the chief reasons responsible for low agricultural production and quality (Ozer et al., 2001; Önen 2020). Weeds are the major plant protection factors, which compete with crop plants for light, water and nutrients. Nonetheless, weeds result in serious yield and quality losses in crop plants and serve as host for many plant diseases and pests (Yeğen, 1984; Çınar & Uygun, 1987; Özer et al., 1996; Özer et al., 1999; Özer et al., 2001; Tepe, 2014; Güncan & Karaca, 2018). Furthermore, weeds retard growth of cultivated plants with their allelopathic effects and negatively impact crop production (Özer et al., 2001; Önen & Özer, 2002; Önen, 2006; Önen, 2007; Önen, 2013; Akyol et al., 2014). During storage, weeds cause the heating the produce (because they can increase humidity), trigger fungal growth and decrease quality (Özer et al., 2001: Tursun et al., 2006).

Weeds may cause serious yield losses due to their high competitiveness (depending on the type and density of weeds) during the tillering period of winter cereals, particularly wheat. It is impossible to obtain any yield from the fields that are heavily infested with weeds (Kaçan & Tursun, 2019). In addition to damage caused during vegetation period, weeds reduce the value of produce due to weed seed mixing. The odor and taste of the flour obtained from the cereals t contaminated with weed seeds deteriorate quality of the final product and even cause poisoning (Güncan, 1980; Özer et al., 2001).

Weeds can adapt diverse climatic and soil conditions; thus, are cpable of causing significant yield losses numerous agricultural systems (Özaslan et al., 2016a; Özaslan et al., 2016b; Farooq et al., 2017; Önen et al., 2017; Özaslan et al., 2017). Yield losses caused by weeds can reach 15-25% in Germany (Hurle, 1988) and 66% in England (Whitehead & Wright, 1989). The yield losses due to weeds in Turkey are reported to vary from region to region. Nonetheless, it has been reported that weed cause 30% yield losses in the Aegean region (Bilgir, 1965; Tepe, 1998), while these losses reaches 24% in the Eastern Anatolia region (Güncan, 1975) and 20% in the Çukurova region (Uygur et al., 1999; Güngör, 2005). Nevertheless, average yield losses due to weeds in Turkey are reported between 20-35% (Ozer, 1993;

Uygur et al., 1986; Hill, 1998). Hence, weed management is among the indispensable agricultural operations in winter cereals.

Considering the importance of weed control for successful and sustainable production of winter cereals, this chapter provides detailed information on the problematic weed species in winter cereals of Turkey and provides knowledge of integrated weed management.

2. PROBLEMATIC WEED SPECIES IN WINTER CEREALS IN TURKEY

The development of weeds and their seed production vary according to crop plants, cultural practices and ecological factors (Önen & Özer, 2001; Özaslan et al., 2011; Önen et al., 2012). For example, a study conducted to determine the amount of seed produced by field bindweed (*Convolvulus arvensis* L.) in different areas reported that 32 seeds were produced by the species in barren wheat field, while this number reached to 70 in irrigated field, and 140 in non-cultivated field (Güncan, 1979). Önen et al. (2018) stated that there can be great differences in weed species and their density depending on climate, soil characteristics and management practices. Therefore, based on cultural practices applied in agricultural production and environmental conditions, problematic weeds vary time and place. Nonetheless, some harmless species turn to harmful ones at different time and place (Taştan & Erciş, 1991; Önen & Özer, 2001; Özer et al., 2001; Önen et al., 2012; Önen et al., 2018).

Literature have revealed that cosmopolitan weed species are almost homogeneously distributed in cereal production regions of Turkey, while some of the species seemed to be localized in various regions (Kuntay, 1944; Güncan, 1980; Ozer et al., 2001; Featured et al., 2012; Sırrı, 2019). According to the results obtained from studies conducted in different regions of Turkey, problematic weed species in winter cereal production areas of the country are listed in Table 2 (Güncan, 1971, 2001, 2002, 2018; Uygur et al., 1986; Taştan & Erciş, 1991; Uluğ et al., 1993; Boz et al., 1993; Mennan & Uygur, 1994; Zengin, 1996a, 1996b; Civelek et al., 1997; Özer et al., 2001; Bükün, 2004; Tursun et al, 2006; Kordali & Zengin, 2009, 2011; Tepe, 2014).

Table 2. Prevalent and problematic weed species in winter cereal production areas of Turkey

Family	Latin name	Turkish name
Narrow leaved annuals		
	Aegilops cylindrica L.	Sakal otu
	Alopecurus myosuroides Huds.	Tilkikuyruğu
	Avena barbata L.	Yabani yulaf
	Avena fatua L.	Yabani yulaf
	Avena sterilis L.	Kısır yabani yulaf
	Briza humulis L.	Kuş yüreği
	Bromus sterilis L.	Kısır brom
	Bromus tectorum L.	Püsküllü çayır
	Echinaria capitata L.	Diken baş çimi
	Eragrostiscilianensis L.	Çayırgüzeli
	Hordeum murinum L.	Duvar arpası
	Lolium multiflorum L.	İtalyan çimi
Poaceae	*Lolium rigidum* L.	İnce delice

	Lolium perene L.	Delice
	Lolium temulentum L.	Delice
	Phalaris brachystachys Link.	Kısa başlıklı kuşyemi
	Phalaris canariensis L.	Uzun başlıklı kuşyemi
	Phalaris minor Retz.	Küçükbaşlıklı kuşyemi
	Phalaris paradoxa L.	Yumuşak başlıklı kuşyemi
	Poa annua L.	Tavşanbıyığı
	Poa pratensis L.	Tavşanbıyığı
	Secale cereale L.	Yabani çavdar
	Setaria viridis L.	Yeşil kirpi darı
	Setaria verticillata (L.) P.B.	Kirpi darı
Narrow leaved perennials		
	Poa bulbosa L.	Yumrulu salkım otu
	Phragmites australis (Cav.) Steude	Kamış
	Elymus repens (L.) Gould.	Ayrık
	Echinochloa crus-galli (L.) Beauv	Darıcan
	Cynodon dactylon (L.) Pers.	Köpekdişi ayrığı
Poaceae	*Sorghum halepense* L.	Kanyaş
Broadleaved annuals		
	Amaranthus albus L.	Horozibiği
	Amaranthus blitoides L.	Horozibiği
Amaranthaceae	*Amaranthus retroflexus* L.	Kırmızı köklü horozibiği
	Bifora radians Bieb.	Kokar ot
	Bupleurum rotundifolium L.	Tavşankulağı
	Caucalis daucoides L.	Küçük pıtrak
	Caucalis latifolia L.	Pıtrak
	Falcaria vulgaris Bernh.	Orak otu
	Scandix pecten-veneris L.	Zühre tarağı
	Tordylium spp.	Geyik otları
Apiceae	*Turgenia latifolia* Hoffm.	Pıtrak
	Anthemis arvensis L.	Tarla köpek papatyası
Asteraceae	*Carduus pycnocephalus* L.	Saka dikeni

	Carduu snutans L.	Eşek dikeni
	Centaurea iberica Trevir. & Spreng.	Kısa dikenli gelin düğmesi
	Centaurea solstitalis L.	Güneş dikeni
	Centaurea depressa Bieb.	Yatık gökbaş
	Chondrilla juncee L.	Karakavuk
	Eryngium campestre L.	Boğa dikeni
	Lactuca serriola L.	Dikenli yabani marul
	Matricaria chamomilla L.	Hakiki papatya
	Scariola viminea (L.) F.W. Schmidt.	Yabani marul
	Senecio vulgaris L.	Adi kanarya otu
	Silybum marianum (L.) Gaertner	Meryemana dikeni
	Sonchus oleraceus L.	Eşek marulu
	Tribulus terrestris L.	Demir dikeni
	Tragopogon spp.	Yemlikler
	Xantium spinosum L.	Zincir Pıtrağı
	Xanthium strumarium L.	Domuz pıtrağı
Boraginaceae	*Buglossoides arvensis* (L.) Johnst.	Taşkesen otu
	Heliotropium europaeum L.	Boz ot
	Lappula squarrosa (Retz.) Dumort.	Sülün gürke
Brassicaceae	*Alyssum campestre* L.	Kuduz otu
	Boreava orientalis Jauband Spach.	Sarı ot
	Capsella bursa-pastoris (L.) Medik	Çobançantası
	Cardaria draba (L.) Desv.	Yabani tere
	Isatis tinctoria L.	Yabani çivit otu
	Myagrum perfoliatum L.	Gönül hardalı
	Neslia apiculata Fisch.	Toplu iğne hardalı
	Raphanus raphanistrum L.	Yabani turp
	Rapistrum rugosum (L.) All.	Yabani turp
	Sinapis arvensis L.	Yabani hardal
	Sisymbrium officinale Scop.	Bülbülotu
Caryophyllaceae	*Agrostemma githago* L.	Karamuk
	Cerastium arvense L.	Boynuzotu

	Silene colorata L.	Renkli nakıl
	Silene conoidea L.	Yapışkan nakıl
	Stellariamedia (L) Vill.	Serçedili
	Vaccaria pyramidata Medik.	Arap baklası
Chenepodiaceae	*Atriplex davisii* Aellen.	Unluca
	Chenopodium album L.	Sirken
Dipsacaceae	*Cephalaria syriaca* (L) Schreb.	Pelemir (zıvan)
Euphorbiaceae	*Euphorbia* spp.	Sütleğenler
Fabaceae	*Lathyrus* spp.	Yabani mürdümükler
	Melilotus officinalis L.	Kokulu sarıyonca
	Trigonella spp.	Kokulu yoncalar
	Vicia sativa L.	Adi fiğ
Geraniaceae	*Erodium cicutarium* (L.) L'Herit.	Dönbaba
	Geranium dissectum L.	Turnagagası
	Geranium tuberosum L.	Yumrulu turnagagası
Lamiaceae	*Lamium amplexicaule* L.	Ballıbaba
	Ziziphora capitata L.	Anuk
	Wiedemannia orientalis L.	Doğu ballıbabası
Malvaceae	*Hibiscus trionum* L.	Yabani bamya
Orobanchaceae	*Melampyrum arvense* L.	Pembe ot
Papaveraceae	*Fumaria officinalis* L.	Hakiki şahtere
	Fumaria asepala Boiss	Şahtere
	Papaver dubium L.	Gelincik
	Papaver rhoeas L.	Gelincik
	Roemeria hybrida (L.) DC.	Mor gelincik
Polygonaceae	*Polygonum aviculare* L.	Çobandeğneği
	Polygonum bellardii All.	Çoban değneği
Primulaceae	*Anagallis arvensis* L.	Farekulağı
Ranunculaceae	*Adonis flammea* L.	Kan damlası
	Adonis aestivalis L.	Yaz kanavcı otu
	Consolida orientalis (Gay) Schröd.	Doğu tarla hezeranı
	Consolida regalis Gray	Tarla hezeranı
	Ranunculus arvensis L.	Tarla düğün çiçeği

Resedaceae	*Reseda lutea* L.	Muhabbet çiçeği
Rubiaceae	*Galium aparine* L.	Dil kanatan
	Galium tricornutum Dandy.	Boynuzlu yoğur otu
Scrophulariaceae	*Veronica hederifolia* L.	Adi yavşan otu
	Verbascum spp.	Sığırkuyruğu
Solanaceae	*Hyoscyamus reticulatus* L.	Banotu
Broadleaved perennials		
Asteraceae	*Acroptilon repens* (L.) DC.	Kekre
	Alhagi pseudalhagi Medik.	Deve dikeni
	Anthemis tinctoria L.	Boyacı papatyası
	Centaurea cyanus L.	Gökbaş
	Centaurea triumfetti L.	Dağ gelin düğmesi
	Cichorium intybus L.	Yabani hindiba
	Cirsium arvense (L.) Scop.	Köygöçüren
	Gundelia tournefortii L.	Kenger
Boraginaceae	*Anchusa azurea* Miller.	Sığırdili
	Anchusa officinalis Miller.	Sığırdili
Convolvulaceae	*Convolvulus arvensis* L.	Tarla sarmaşığı
	Convolvulus galaticus Roston. ExChoisy	Boz sarmaşık
Fabaceae	*Glycyrrhiza echinata* L.	Meyan otu
	Glycyrrhiza glabra L.	Meyan otu
	Medicago falcata L.	Yabani yonca
	Medicago sativa L.	Yabani yonca
	Trifolium repens L.	Ak üçgül
Geraniaceae	*Geranium tuberosum* L.	Yumrulu jeranyum
Malvaceae	*Malva sylvestris* L.	Yabani ebegümeci
	Malva neglecta L.	Ebegümeci
Plantaginaceae	*Plantago lanceolata* L.	Dar yapraklı sinir otu
	Plantago media L.	Şimşek yaprağı
Polygonaceae	*Rumex crispus* L.	Labada
	Polygonum convolvulus L.	Sarmaşık çobandeğneği

Table 2 reveals that 138 weed species belonging to 24 families have been reported in winter cereals and most of these species infest wheat crop. Furthermore, 30 of these weed species are narrow-leaved (monocotyledon) and 108 are broad-leaved (dicotyledonous), 108 species are annual, 3 species are biannual, and 30 weed species are perennial. Thus, species with very different characteristics infest winter cereals. Therefore, region-specific weed management strategies are needed to manage weed infestation in winter cereals (Önen & Özer, 2001; Önen et al., 2012).

3. Weed Management Strategies Opted in Winter Cereals in Turkey

Sustainability in agricultural production can be achieved through appropriate variety selection, proper fertilization, irrigation and appropriate soil cultivation, as well as successful management of plant protection (disease, pests and weeds) factors causing significant yield losses in crop plants (Özer et al., 2001; Önen & Kara, 2008a; Önen, 2020). Therefore, density of problematic weed species as well as diseases and pests must be kept below economic loss level for successful cereals' production (Özer et al., 2001). Unfortunately, weed management in cereal production areas of Turkey solely relies on chemicals (herbicides).

Increasing production costs, environmental problems and resistance of weeds to herbicides throughout the country require different weed management strategies in cereal production. However, cultural (crop rotation, sowing time, seed cleaning, etc.) and mechanical weed management measures are not at the desired level; therefore, desired results in weed management are not achieved. Failure to comply with herbicide application rules (appropriate dose, equipment, application time, solution preparation, etc.) is rendering chemical control ineffective in several regions (Önen & Özer, 1995; Akça et al., 2006; Sayılı et al., 2006; Salman et al., 2011; Akdeniz et al., 2015). In addition, although problematic weed species in cereal cultivation areas of the country differ partially, seasonal weed management strategies are implemented in cereals without considering the weed species present in the field (Kordali & Zengin, 2009; Gökalp & Üremiş, 2015; Gürbüz et al., 2018; Kaçan & Tursun, 2019; Sırrı, 2019; Ateş & Üremiş, 2020; Göktaş & Yavuz, 2020; Lökçü et al., 2020). However, there are many scientific studies in the literature that deal with different weed management strategies and these studies direct towards integrated weed management strategies. Different weed management strategies opted in winter cereals in Turkey are discussed under different headings below.

3.1. Cultural Measures

Use of Clean Seeds: The determination of seed dispersal pathways of weeds and their elimination is the first step of weed management (Önen, 2015b; Kaçan & Tursun, 2020). Since seed cleaning is easy and effective among weed management methods, it is necessary to use clean crop seeds for the successful management of weeds. The most important technique for successful management in cereals is the use of clean seeds (Özer et al., 1998). If seeds of cereals are not cleaned, they contain 20-25% of weed seeds (Koch & Hurle 1978). Therefore, using seeds contaminated with weed seeds means that we are planting weed seeds in the field by our own hands. Several studies in Turkey have determined the weed seed mixing in wheat grains when the wheat is planted by the seeds which are not passed through selector (Kuntay 1944; Göksel, 1956; Güncan, 1982; Özer, 1984; Uludağ & Demir, 1997; Güncan & Boyraz, 2001; Güncan, 2002; Mennan & Işık, 2003). As a result of Turkey's efforts made in different regions; Various studies conducted in different regions of Turkey have determined that ~10-47 g weed seeds are mixed 1 kg of wheat grains and this corresponds to 0.502-13% weed seed mixing (Zengin, 1996; Sırma et al., 1997; Tepe, 1998; Tursun et al., 2004; Tursun et al., 2006; Karaca & Güncan, 2009; Baş, 2011; Gökalp & Üremiş, 2015; Bozkurt, 2018). On the other hand, it has been reported that mixing of weed seeds such as darnel (*Lolium temulentum*), corn-cockle (*Agrostemma githago*), celandine (*Cephalaria syriaca*) and pink grass (*Melampyrum arvense*), in wheat grains can cause serious problems in humans (Gökalp & Üremiş, 2015).

Removing weed seeds from crop seeds has been one of the most important weed management strategies opted by the people since the early stages of agriculture. Separating weed seeds from crop seeds increases the success of other weed management methods (Özer et al., 2001). For this reason, certified seeds should be used or the seed should be obtained from weed-free fields and should be used after passing through selector.

Crop rotation: The importance of crop rotation has been noticed long years ago as an alternative to monoculture for soil sustainability. Global studies have reported that crop rotation improves soil physical and chemical properties, reduces the accumulation of chemicals in the soil inhibiting the growth and development of crop plants, and increases crop yield by controlling crop pests (Karlen et al., 1994; Costantini, 2019; Nair, 2019; Önen, 2020). In addition, considering the principle that "every crop plant has its own weeds" in agricultural production (Özer et al., 2001), it is worth mentioning that crop rotation can play an important role in keeping the weed populations below the economic threshold level (Önen, 2020). Furthermore, it has been observed that density of certain weed species that adapt to particular cultivation system gradually increases in cereal areas where the same culture plant (monoculture) is grown every year (Önen & Kara, 2008b). For the reason, crop rotation is of great importance in order to effectively combat the problematic weeds by disrupting weed-crop competition/relationship (Özer et al., 2001; Önen & Kara, 2008b). Inclusion of legumes, cotton, beets etc. crops after cereals in rotation will be of great benefit in this regard (Güncan & Karaca, 2018).

Proper Seedbed Preparation, Sowing Time, Sowing Frequency and Depth: In order for crop plants compete with weed species, early or late planting of crop seeds is recommended based on germination and development periods of weeds. It is reported that planting density is also effective in controlling weeds. Further, it has been concluded that by increasing the number of crop plants per unit area, the competitiveness of winter cereals against weeds can be increased. On the other hand, proper seedbed preparation increases the germination rate of seeds and accelerates emergence time of crop seeds, which provides advantage to crop plants against weeds (Özer et al., 2001; Önen & Kara, 2008b; Kaydan et al., 2011; Önen, 2020). In addition, planting seeds of crop plants at the appropriate depth ensure their vigorous growth and crop plants have competition advantage over weeds (Özer et al., 2001; Önen & Kara, 2008b).

The soils of central regions in Turkey are relatively saline with high boron contents and *Eremopyrum orientale* (L.) Jaub. Et Spach is frequently observed in these regions. Önen et al. (2020) have reported that the species can be successfully controlled by irrigation, tillage and adjustment of planting time. Naturally, delayed tillage, seed bed preparation and planting after irrigation, significantly reduced the density and coverage area of *E. orientale*. Summer planting instead of winter planting completely controlled the species (Önen et al., 2020).

Variety Selection: Selecting highly adaptable and competitive varieties is an important step in weed management. Rapid growth, resistance to diseases and pests, and early maturity of crop plants is important for successful weed control. It has been reported that cultivation of early maturing wheat varieties has been effective against herbicide resistant wild oats (*Avena* spp.), which cause significant yield losses in wheat (Uygur et al., 1984). Furthermore, winter varieties have better competitive ability with weeds than varieties planted in summer (Tepe, 2014). Therefore, considering the climate and soil conditions and the cultivation system applied, the appropriate varieties should be selected for the region.

Disease and Pest Control with Fertilization and Irrigation: Studies have revealed thatr ensuring the healthy development of cereals positively affects their competitive power (Uygur et al., 1984; Özer et al., 2001; Önen & Kara, 2008a, b; Tepe, 2014). Therefore, control of diseases and pests with appropriate fertilization and irrigation, besides cultural practices, such as planting time, variety selection, seedbed preparation and crop rotation will make crop plants more resistant to weeds ensure healthy crop growth. Application of chemical fertilizers in seedbed during seed sowing and irrigating the crop through drip irrigation will help crop plants to benefit more from fertilizer and water than weeds (Özer et al., 2001; Önen & Kara, 2008a, b; Önen, 2020). On the other hand, farm manure must be given to the field as burnt and fermented (Özer, 1982). In this way, weed seeds will be prevented from being transported to the field.

3.2. Mechanical Control (Tillage)

Light tillage just before sowing is very beneficial in terms of decreasing weeds' germination. Tillage in summer, mostly in fallow fields, prevents weeds from setting seeds and partially controls perennial weeds (Özer et al., 2001; Tepe, 2014; Güncan & Karaca, 2018). Harrowing between rows in autumn, especially for winter cereals, delays the germination and emergence of weeds (Güncan & Karaca, 2018).

Several studies from Turkey have reported that tillage method significantly alters weed species and their density in the field. Nonetheless, stubble planting resulted in the highest coverage rate of weeds followed by reduced and traditional tillage (Tücer & Önal, 1997; Önen et al., 2012). Therefore, tillage like other agricultural activities, affects the type and density of weeds. This has a direct positive or negative effect on yield (Önen et al., 2012). In addition, the results of the study revealed that regardless of the tillage method opted, weed populations should be kept under control for proceeding crops (Önen et al., 2012). Considering the results of research conducted in Turkey, tillage method should be opted and weed populations should be kept under control during growing season of crops.

3.3. Biological Control

Biological control method uses natural enemies such as insects, pathogens, nematodes, sheep, geese, fish and snails that feed on weeds and reduce their population growth (Atay et al., 2015; Uygur & Uygur, 2010). Since biological control does not disturb the nature and ecological balance, it is gaining importance the global level, especially in developed countries, including but not limited to the USA, Canada, Australia and New Zealand (Hoffmann, 1995).

The studies conducted so far have tried to control >100 weed species with >200 natural enemies (Haffman, 1995; Tozlu et al., 2011; Atay et al., 2015). However, studies on biological control of weeds in cereal fields are quite limited. *Puccinia chondrillina* can be successfully used to control *Chondrilla juncea* L., which causes yield reduction of wheat fields in Australia (Nemli, 1991; Nemli, 1993; Burdon et al., 1998; Tepe, 2014).

Although many studies have determined beneficial pathogens and harmful organisms from different problem weeds in cereal fields of Turkey (Özaslan, 2011; Özaslan et al.2013; Özaslan, 2016; Özaslan et al.2017); however, promising results have not been obtained in the bioefficacy studies. Therefore, no practical example of biological control of weed species in cereals exist in the country.

3.4. Chemical Control

In parallel with industrial development, use of chemical inputs (fertilizers and pesticides) has gradually increased in agricultural production, and pesticides are among the indispensable inputs for agricultural production for controlling diseases, pests and weeds in conventional production systems (Önen, 2010a). Nonetheless, FAO (2018) data indicated that total amount of pesticides used in agricultural production worldwide (167 countries) has reached 5.896.023 tons. Herbicides (1.216.330 tons) are at the first place among the pesticides used in the world, followed by insecticides (386.479 tons) and fungicides (406.013 tons) (FAO, 2018). The total pesticide uses in Turkey as of end 2012 was 36% herbicides, 24% fungicides and 20% insecticides (Anonymous, 2020).

Herbicides are extensively used to control weeds in cereal production systems of Turkey and rest of the world. The main reasons of their extensive use are ability, high efficiency and successful control in a short period of time compared to alternative control. The majority of available agricultural lands in Turkey are under cereal production; therefore, herbicide use is increasing every year in the country. However, broad-leaved weeds can be easily controlled compared to narrow-leaf weeds, which cause severe problems in cereal production systems (Güncan & Karaca, 2018). Herbicides can be applied in different periods (pre-sowing, pre-emergence or post-emergence) in cereal cultivation areas. However, it is generally seen that use of pre-emergence herbicides is more advantageous than other applications. Pre-emergence herbicides can be easily applied in areas where spraying is not applied due to heavy rains after sowing. Pre-emergence herbicides can effectively kill the seedlings of broad-leaved and narrow-leaved weeds (almost immediately after germination). Since pre-emergence herbicides prevent competition at initial growth period of crop, yield is significantly increased. Nonetheless, time between pre-emergence herbicide use and harvesting is long, there is no residue problem.

The active ingredients of herbicides used in winter cereal production systems of Turkey, time of use and recommended doses are compiled from Anonymous (2020b) and given in Table 3.

Table 3. The active ingredients, application timings and doses of herbicides used in chemical control of winter cereals, weed species which are controlled by these herbicides and crops for they are recommended (Anonymous, 2020b)

Active ingredient	**Application time and dose**	**Target weed species**	**Crops**
%20 Metsulfuron-methyl	Post-emergence -1 g/da	Broad-leaved	Wheat
%50 Dicamba + %25 Tritosulfuron	Post-emergence -15 g/da	Broad-leaved	Wheat
100 g/l Clopyralid	Post-emergence -100 ml/da	Broad-leaved	Wheat
%75 Sulfosulfuron	Post-emergence - 2 gr/da	Broad-leaved	Wheat
340 g/l MCPA + 80 g/l Dicamba	Post-emergence - 125 ml/da	Broad-leaved	Wheat
100 g/l Fluroxypyr + 2,5 g/l Florasulam	Post-emergence - 120 ml/da	Broad-leaved	Wheat

6 g/l Iodosulfuron-methyl-sodium + 30 g/l Mesosulfuron methyl + 90 g/l Mefenpyr diethyl (safener)	Post-emergence - 25 ml/da	Broad-leaved	Wheat
600 g/l 2,4-D asite eşdeğer 2-Ethylhexyl ester	Post-emergence - 90 ml/da	Broad-leaved	Wheat
300 g/l Bromoxynil + 300 g/l MCPA	Post-emergence - 35 ml/da	Broad-leaved	Wheat
500 g/l MCPA + 40 g/l Carfentrazone	Post-emergence - 50 ml/da	Broad-leaved	Wheat
%38 Thifensulfuron-methyl + %19 Tribenuron-methyl + %15 Metsulfuron-methyl	Post-emergence - 3 gr/da	Broad-leaved	Wheat
557 g/l MCPA - Ethylhexyl Ester + Florasulam	Post-emergence - 70 ml/da	Broad-leaved	Wheat
%37,5 Tribenuron-methyl + %37,5 Thifensulfuron-methyl	Post-emergence - 2.5 gr/da	Broad-leaved	Wheat
360 g/l 2,4-D Asit (543 g/l 2,4-D EHE eşdeğer) + 90 g/l Fluroxypyr	Post-emergence - 200 ml/da	Broad-leaved	Wheat
200 g/l Bromoxynil + 200 g/l MCPA	Post-emergence - 125 ml/da	Broad-leaved	Wheat
600 g/l 2,4-D	Post-emergence - 90 ml/da	Broad-leaved	Wheat
%30 Aminopyralid + %15 Florasulam	Post-emergence - 3 gr/da	Broad-leaved	Wheat, Barley
600 g/l Chlorotoluron + 40 g/l Diflufenican	Pre and post-emergence - 350 ml/da	Broad-leaved	Wheat, Barley
%65,9 Dicamba + %4,1 Triasulfuron	Post-emergence - 15 g/da	Broad-leaved	Wheat, Barley
100 g/l Amidosulfuron + 25 g/l Iodosulfuron-methyl sodium + 250 g/l Mefenpyr-diethyl (safener)	Post-emergence - 100 ml/da	Broad-leaved	Wheat, Barley
%65,9 Dicamba + %4,1 Triasulfuron	Post-emergence - 125 ml/da	Broad-leaved	Wheat, Barley
344 g/l 2,4-D asite eşdeğer dimethyl amonyum tuzu + 120 g/l Dicamba	Post-emergence -100 ml/da	Broad-leaved	Wheat, Barley
452,42 g/l 2,4-D 2-Ethylhexyl ester + 6,25 g/l Florasulam	Post-emergence - 50 ml/da	Broad-leaved	Wheat, Barley
333 g/l Bentazone + 233 g/l Dichlorprop-P	Post-emergence -200 ml/da	Broad-leaved	Wheat, Barley
%10 Chlorsulfuron	Pre and post-emergence - 7.5 g/da	Broad-leaved	Wheat, Barley, Rye, Oats, Triticale
284 g/l Diclofop-methyl	Post-emergence - 200 ml/da	Narrow-leaved	Wheat

240 g/l Clodinafop-propargyl + 60 g/l Cloquintocet-mexyl (safener)	Post-emergence - 20 ml/da	Narrow-leaved	Wheat
80 g/l Clodinafop-propargyl + 20 g/l Cloquintocet-mexyl (Safener)	Post-emergence - 30 ml/da	Narrow-leaved	Wheat
75 g/l Fenoxaprop-p-ethyl + 30 g/l Fenchlorazole-ethyl (safener)	Post-emergence - 60 ml/da	Narrow-leaved	Wheat
%6,75 Propoxycarbazone Sodium + %4,5 Mesosulfuron-methyl + %9 Mefenpyr-diethyl (safener)	Post-emergence -20 g/da+100 ml/da surfactant	Narrow-leaved	Wheat
%4,5 Mesosulfuron-methyl + %2,25 Thiencarbazone-methyl + %0,9 Iodosulfuron-methyl-sodium + %13,5 Mefenpyr-diethyl (safener)	Surfactabt -25 g/da+100 ml/da surfactant	Narrow-leaved	Wheat
80 g/l Clodinafop-propargyl	Post-emergence - 30 ml/da	Narrow-leaved	Wheat
75 g/l Fenoxaprop-p-ethyl + 19 g/l Mefenpyr-diethyl (safener)	Post-emergence - 30 ml/da	Narrow-leaved	Wheat
30 g/l Mesosulfuron-methyl + 90 g/l Mefenpyr-diethyl (safener)	Post-emergence - 40 ml/da	Narrow-leaved	Wheat
100 g/l Fenoxaprop-P-ethyl + 25 g/l Fenchlorazole-ethyl (Safener)	Post-emergence -75 ml/da	Narrow-leaved	Wheat
240 g/l Clodinafop-propargyl	Post-emergence -20 ml/da	Narrow-leaved	Wheat
284 g/l Diclofop-methyl	Post-emergence -200 ml/da	Narrow-leaved	Wheat
22,5 g/l Pinoxaden + 22,5 g/l Clodinafop-propargyl + 5,63 g/l Cloquintocet-mexyl (safener)	Post-emergence -100 ml/da	Narrow-leaved	Wheat
45 g/l Pinoxaden + 5 g/l Florasulam + 11,25 g/l Cloquintocet-mexyl (safener)	Post-emergence -100 ml/da	Narrow-leaved	Wheat
100 g/l Fluroxypyr + 2,5 g/l Florasulam	Post-emergence -120 ml/da	Narrow-leaved	Wheat
66 g/l Clodinafop-propargyl + 66 g/l Flucarbazone-Na + 20 g/l Cloquintocet-mexyl (safener)	Post-emergence -75 ml/da	Narrow-leaved	Wheat
500 g/l Clopyralid+50 g/l Tribenuron-methyl+22,5 g/l Florasulam	Post-emergence -20 ml/da	Narrow-leaved	Wheat
%42 Metribuzin + %12 Clodinafop-Propargyl +	Post-emergence -50 gr/da + 125 ml/da	Narrow-leaved	Wheat

%3 Cloquintocet-mexyl (Safener)			
%10 Chlorsulfuron	Post-emergence -7.5 g/da	Narrow-leaved	Wheat
%75 Chlorsulfuron	Post-emergence -7.5 ml/da	Narrow-leaved	Wheat
360 g/l 2,4-D Asit (543 g/l 2,4-D EHE eşdeğer) + 90 g/l Fluroxypyr (129 g/l Fluroxypyr)	Post-emergence -125 ml/da	Narrow-leaved	Wheat
25 g/l Clodinafop-propargyl + 25 g/l Pinoxaden + 6,25 g/l Cloquintocet-mexyl (safener)	Post-emergence -90 ml/da	Narrow-leaved	Wheat
419 gr Flucarbazone-sodium + 83 gr Cloquintocet-mexyl (safener)	Post-emergence - 21 ml/da + 20 ml/da WETMAX (surfactant)	Narrow-leaved	Wheat
600 g/l Chlorotoluron + 40 g/l Diflufenican	Pre-emergence - 350 ml/da	Narrow-leaved	Wheat
69 g/l Fenoxaprop-p-ethyl + 33 g/l Cloquintocet-mexyl (safener)	Post-emergence - 80 ml/da	Narrow-leaved	Wheat
69 g/l Fenoxaprop-p-ethyl + 34,5 g/l Cloquintocet-mexyl (safener)	Post-emergence - 80 ml/da	Narrow-leaved	Wheat, Barley
250 g/l Tralkoxydim	Post-emergence -120 ml/da Saber 25 SC + 100 ml surfactant	Narrow-leaved	Buğday, Arpa
50 g/l Pinoxaden	Post-emergence - 90 ml/da	Narrow-leaved	Wheat, Barley
75 g/l Fenoxaprop-p-ethyl + 69 g/l Mefenpyr-diethyl (safener)	Post-emergence - 80 ml/da	Narrow-leaved	Wheat, Barley
45 g/l Pinoxaden + 20 g/l Cloquintocet-mexyl (safener)	Post-emergence -100 ml/da	Narrow-leaved	Wheat, Barley
69 g/l Fenoxaprop-p-ethyl + 75 g/l Mefenpyr-diethyl (safener)	Post-emergence - 60 ml/da	Narrow-leaved	Wheat, Barley
50 g/l Pinoxaden + 12,5 g/l Cloquintocet-mexyl (Safener)	Post-emergence -90 ml/da	Narrow-leaved	Wheat, Barley
69 g/l Fenoxaprop-p-ethyl + 75 g/l Mefenpyr-diethyl (safener)	Post-emergence - 60 ml/da	Narrow-leaved	Wheat, Barley
45 g/l Pinoxaden + 20 g/l Cloquintocet-mexyl (safener)	Pre-emergence - 90 ml/da	Narrow-leaved	Wheat, Barley
%75 Sulfosulfuron + %5 Metsulfuron-methyl	Post-emergence - 4 gr/da	Narrow and broad-leaved	Wheat
% 6,95 (% 6,67 ae) Halauxifen-methyl + % 25 Pyroxsulam + % 35,4 Cloquintocet-acid (Safener)	Post-emergence - 9 g/da + 100 ml/da Surfer EH-9	Narrow and broad-leaved	Wheat
6 g/l Iodosulfuron-methyl-sodium + 30 g/l Mesosulfuron methyl + 90 g/l Mefenpyr diethyl (safener)	Post-emergence - 30 g/da + 100 ml Voce	Narrow and broad-leaved	Wheat

%3 Mesosulfuron-methyl + %0,6 Iodosulfuron-methyl sodium + %9 Mefenpeyr-diethyl (safener)	Post-emergence - 25 g/da + 100 ml Biopower surfactant	Narrow and broad-leaved	Wheat
%75 Sulfosulfuron	Post-emergence - 2.6 g/da	Narrow and broad-leaved	Wheat
30 g/l Clodinafop-propargyl + 7,5 g/l Florasulam + 30 g/l Pinoxaden + 7,5 Cloquintocet-mexyl (Safener)	Post-emergence -100 ml/da	Narrow and broad-leaved	Wheat
66 g/l Clodinafop-propargyl + 66 g/l Flucarbazone-Na + 20 g/l Cloquintocet-mexyl (safener)	Post-emergence -75 ml/da	Narrow and broad-leaved	Wheat
500 g/l Chlorotoluron + 18,75 g/l Isoxaben	Pre-emergence - 360 ml/da	Narrow and broad-leaved	Wheat
500 g/l Chlorotoluron	350 ml/da	Narrow and broad-leaved	Wheat
%7,08 Pyroxulam + %1,42 Florasulam + %7,08 Cloquintocet-mexyl (safener)	Post-emergence - 26.5 g/da+50 ml/da dassoil26-2N	Narrow and broad-leaved	Wheat
%7,5 Pyroxsulam + %7,5 Cloquintocet-mexyl (safener)	Post-emergence -20 g/da+50 ml/da Dassoil 26-2N	Narrow and broad-leaved	Wheat
45 g/l Pyroxsulam + 90 g/l Cloquintocet-mexyl (safener)	Post-emergence - 40 ml/da	Narrow and broad-leaved	Wheat
%75 Chlorsulfuron	Pre and post-emergence - 1 g/da	Narrow and broad-leaved	Wheat, Barley, Oats, Triticale, Rye

3.5. Integrated Management

This method utilizes the principle of using different management practices together in order to keep plant protection factors responsible for significant yield losses under control. It is an integrated pest management system and known by different names such as "Integrated Pest Management" or "Integrated Pest Control". The main purpose of this management system is to keep the population densities of pests below their economic threshold level through utilization of all available control methods and techniques, considering the population dynamics of harmful organisms and their relations with the environment

(Anonymous, 2017). In this context, appropriate management methods are selected based on regional and climatic factors and used sequentially or together for effective weed management in cereals. However, as mentioned above, mostly herbicides are applied alone rather than using them with other control methods due to easy applicability and rapid results of herbicides (Mengüç, 2018). Integrated management will gain importance considering the need for alternative weed management practices to protect human and environmental health (Önen, 2010b; Önen & Kara, 2008b). It is concluded that broad-spectrum studies are needed for with the adoption of integrated weed control strategies in winter cereal production systems of Turkey.

4. BASIC PROBLEMS FACED IN WEED MANAGEMENT

Cereals are cultivated in almost every region of Turkey. However, different regions significantly differ for yield and quality. One of the most important reasons for this variability is conventional weed management strategies which does not consider the nature and density of weed species responsible for yield losses in agricultural production (Sırrı, 2019). Failure to control weeds at the desired level may result in excessive use of herbicides. Even yield losses can be seen and besides environmental problems and herbicide resistance due to excessive herbicide use (Mengüç, 2018). For this reason, determining the problematic weed species and their density is a priority for the successful control of weeds areas; (Önen & Özer, 2001).

Although weeds are suppressed with herbicide application without taking considering the species and densities and provide economic benefits to the farmer (Jennings, 1981; Sayılı et al., 2006), some unavoidable problems such as phytotoxicity, residue and environmental problems or low efficacy may occur (Obst, 1981; Akdeniz et al., 2015). Weed species and densities vary from region to region, field to field, depending on the management strategies opted, irrigation and fertilization practices, soil characteristics and regional climatic conditions (Özer et al., 1999; Önen et al., 2012). In this context, every region and even every field has its own weeds, and therefore its own weed problems (Önen et al., 2012). Therefore, region of even field-specific solutions should be developed for successful weed control (Akdeniz et al., 2015).

Choosing the right herbicide alone is not enough for successful weed control. The use of recommended dose, application at proper time and use of appropriate equipment etc. are among the indispensable elements for success of weed management program (Özer et al., 2001; Tepe, 2014). Besides significant yield losses due to wrong herbicide application (due to phytotoxicity and / or low effectiveness), evolution of herbicide resistance is one of the most important challenge being faced globally. It is reported that 57 weed biotypes have developed resistance against herbicides applied in wheat and barley around the world (Tursun, 2012) and this number is increasing day by day (Anonim, 2020c; Kaya Altop et al., 2017). In Turkey, herbicide resistance problem is limited to a few weed species. However, resistance caused by excessive and unconscious herbicide use is seen as one of the most important threats in the future (Demirci & Nemli, 1996; Uludağ, 2003; Aksoy et al., 2004; Kaya Altop et al., 2017).

Farmers in Turkey have weak knowledge of weeds and their management. The results of different studies aiming to determine the knowledge/awareness levels of producers in terms of weed control are listed below (Akca et al., 2006; Sayılı et al., 2006; Salman et al., 2011; Sırrı & Özaslan, 2020).

- The knowledge level of producers is very low in terms of identification and control of weeds.
- Farmers do not show enough sensitivity to human and environmental health issues.
- Due to high fuel prices, other economic reasons and excessive labor force, they do not apply cultural and mechanical methods of weed control.
- The herbicide dealer chooses herbicides in line with the recommendations of their friends or neighbors, the instructions are not followed and farmers generally use higher than recommended dose of herbicides.
- Small-scale producers, especially in arid regions, are not be able to manage weeds due to low grain prices.
- Generally, they choose low-cost herbicides instead of suitable ones.
- Since every active ingredient is not available at herbicide shops, the dealers force farmers to use available herbicides at the shop.

Due to the problems listed above, it is concluded that focus must be shifted towards farmer trainings producing winter cereals for successful weed management and improved productivity.

5. CONCLUSIONS AND RECOMMENDATIONS

Several survey studies conducted in winter cereals have concluded that significant differences exist among regions and even fields for weed species and their densities. These differences are the result of production system (irrigated or dry), crop rotation, fertilizer and irrigation practices, tillage systems and climatic and geographic conditions of the regions (Önen & Özer, 2001; Özer et al., 2001; Önen et al., 2012; Önen et al., 2018; Sırrı, 2019). However, weed management practices in Turkey are based on crops rather than the weed species prevailing in the field and their densities. Therefore, similar weed control practices are opted in different regions without considering weed species. This situation decreases success rate of weed management programs, increases production costs due to excessive herbicide use and give rise to environmental and human health risks. Moreover, recommended herbicide doses are not used for weed control, which is resulting in evolution of herbicide resistance in different weed species (Güncan, 2001; Önen & Özer, 2001; Sırrı, 2014). Therefore, for successful management of weeds in wheat cultivation areas (depending on land use, crop rotation and ecological factors), determining prevalence and density of problematic weed species is of great importance to, and region/field-specific management practices are needed (Önen & Özer, 2001; Önen & Kara, 2007; Sırrı, 2019; Mengüç, 2018).

The deficiencies in education and awareness levels of producers in terms of weed control in general and chemical control in particular necessitate training activities. It is concluded that trainings are needed for weeds' identification, active ingredient selection and rotation, application time, dose and form, effects of herbicides on human and environmental health, herbicide resistance, alternative weed control strategies and integrated control for successful and sustainable weed control (Akça et al., 2006 Sayılı et al., 2006; Önen & Kara, 2007; Salman et al., 2011; Akdeniz et al., 2015; Sırrı 2019). Considering sustainability in agricultural production, human and environmental health, increasing environmental awareness in the world and the suitable ecological conditions of Turkey, dissemination of good agricultural and / or organic farming practices can contribute to the solution of problems faced in winter cereal production areas (Önen, 2010b; Önen & Kara, 2008a).

Research studies conducted in Turkey have concluded that region-specific soil cultivation systems should be opted based on climate and soil conditions. However, detailed studies are required regarding the effects of tillage methods on species and density of weeds and crop yields (Önen et al., 2012). Integrated with tillage systems and timing, it has been observed that some important weeds in cool winter cereals can be successfully controlled by using cultural practices, including crop rotation, irrigation, fertilization and adjustment of sowing time etc. (Özer et al., 2001; Önen et al., 2012; Önen et al. al., 2020). The research studies focusing on mechanical and cultural control of weeds must be given priority, especially for the areas under organic farming or good agricultural practices (Önen, 2010b). In addition, directing towards combined studies including herbicide applications in traditional production areas will contribute to producers both ecologically and economically.

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Publishing House
ISBN: 978-625-7687-40-9