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Effect of Between and on Row Distance of First Development, Tillering, Yield and Yield Components in Wheat Cultivars (*Triticum* sp.)

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Abstract: This study was carried out at the University of Ankara, Faculty of Agriculture, Haymana Research and Application Farm, Haymana County, Ankara, Turkey during 1987/1990 with the aim of to determine the effect of between and on row distances (B_{rd} and O_{rd}, respectively) on the first development, tillering, yield and yield components in wheat cultivars (*Triticum* sp.). Five wheat cultivars (Bezostaja-I, Gerek 79, Haymana 79; *Triticum aestivum* L., Çakmak 79 and Kunduru 1149; *Triticum durum* Desf.) were used and experimental design was arranged in a Randomized Completely Block Design (RCBD) in split plots with four replications. The cultivars were allocated to the main plots at three different B_{rd} (5, 10 and 17.5 cm) and six various O_{rd} (4.7, 2.2, 1.2 cm in commons and 3.8, 1.8, 1.0 cm in durums) values. B_{rd} and O_{rd} distances were not affected from emergency date; the number of plant m^{-2} was varied between 173-326; the number of tillering was m^{-2} was determined between 12-86; the number of the first root was changed 3-4; the length of the adventitious root was happened between 89-116 mm; the number of the adventitious root was varied between 2-3 mm; the length of the adventitious root was realized between 42-74 mm; the number of the downy brome (*Bromus inermis* Leyss.) was changed between 7-16; plant height was measured between 45-73 cm; spike length was recorded between 62-81 mm; the number of spikelet was determined between 16-23; the number of grain was found between 19-30; grain weight per plant was calculated between 1-2 g plant^{-1}; 1000-kernel weight was varied between 18-44 g and grain yield per m^2 was fixed between 119-208 g m^{-2}. Increasing in the B_{rd} and O_{rd} were negatively effected the adventitious root development so to ensure a long and fertile spike, narrow B_{rd} and O_{rd} distances should be used. Spikelet and grain number, 1000-kernel weight and grain yield per m^2 were increased by narrowing either between nor on row distances. In addition, all the B_{rd} parameters were not significantly effected to seedling traits in commons but not in durums. B_{rd} = 17.5 cm was found the most beneficial distance in durums. On the other hand, to avoid reducing of the yield components, between row distance should not be increase and in all circimcustances, that value always must be adjusted wide otherwise control of the weeds, diseases and pest could be a great problem during the cultivation.

Key words: *Triticum aestivum*, *Triticum durum*, *Bromus inermis*, yield and yield components, between and on row distance

INTRODUCTION

A successful crop production requires such cultivars that they must be high yielded and resist to biotic and abiotic stress factors. Profitable small grain production requires a thorough knowledge of crop development and growth, and how cultural and environmental factors can influence crop development. The crop and weed responses to inputs such as fertilizers, pesticides, plant growth regulators and supplemental irrigation depend on the stage of development rather than on calendar date. The oldest archaeological evidence for the wheat cultivation comes from Syria, Jordan, Turkey and Iraq showed that wheat is one of the first grains domesticated by human and it is known to have been grown in the Nile Valley by 5000 BC and it is believed that the Fertile Crescent (esp. Asia minor) was the centre of domestication. It belongs to genus of *Triticum* and family of *Poaceae*. This genus has more than 150 species and subspecies. It is the world's most widely grown and important cereal crop in terms of both area cultivated (217 m ha) and amount of grain produced (632.5 m t) and is a food stable for most of the world. It is widely grown throughout the temperate zones (in Northern Europe up

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to 60°N) and in some tropical/sub-tropical areas at higher elevations. It is estimated that by 2020 year, the demand for wheat will be about 40% greater than its current level of more than 600 million tons (Rosegrant *et al*., 1997). The major centres are: Europe (219 m t, 57.1 m ha), Turkey (21 m t, 9.3 m ha), North America (84,5 m t, 30.0 m ha), China (91,9 m t, 21.6 m ha) and India (72,1 m t, 26.6 m ha) (Anonymous, 2004). The yield level of the wheat can be expressed as the product of two basic or main components as grain yield = Grain number (n) x Grain weight (g) (Genç, 1977; Fischer, 1985; Paulsen, 1987). Wheat yield potential could be achieved through changes in grain number and/or grain weight it was discovered that there were strong associations with yield in the wheat genotypes. This period coincides with tiller and florets mortality along with the active growth of the stem and spike. Gains in this process, however, do not translate directly in yield potential gain due to partial compensation by decreased grain weight. Yields are high when favorable filling conditions, mild temperatures and active leaves promote growth of large, plump grains.

The aim of this study is to test and assess some of the common and durum wheat cultivars to agronomic potential (first development and mature states) and values under the Central Anatolian field conditions. Traits investigated included for the first development traits; Emergency Date (ED), Plant Number (PN), Tillering Plant (TP), first root (= the roots originating from the seed) number and length (FN and FL), the number and the length of the adventitious root (= the roots produced by crown nodes on the main shoot and tillers) (AN and AL), downy brome number (DB); for the mature stage traits, Plant Height (PH), Spike Length (SL), Grain Weight (GW), Thousand Kernel Weight (TKW) and grain yield per plant (GY).

MATERIALS AND METHODS

This study was carried out at the University of Ankara, Faculty of Agriculture, Haymana Research and Application Farm (39°-36° N, 32°-40° E, asl 925 m), Haymana County, Ankara, Turkey during 1987/1990 with the aim of to determine the effect of between and on row distances (B_{rd} and O_{rd}, respectively) on the first development, tillering, yield and yield components in the wheat cultivars (*Triticum* sp.) culture on a silty clay loam soil. According to soil anaysis results of the experimental site are clay structure, dark brown, pH = 5.7, lime 23.7%, organic matter 1.33% and changeable potassium level is 0.028% (Anonymous, 1987). Each year plots were sown with five outyielded wheat cultivars (Bezostaja I, Gerek 79 and Haymana 79, *Triticum aestivum* L.; Kunduru 1149 and Çakmak 79, *Triticum durum* Desf.) by hand. This procedure was done on 14 October during the 1987-1988 and 1989-1990 years. Used cultivars were provided from the Field Crops Research Institute (FCR), Ankara, Turkey. Experiment were arranged in a randomized completely block design (RCBD) in a split plots with four replications. Plot size was 1.8 m^2 (for B_{rd} = 5 cm), 2.36 m^2 (B_{rd} = 10 cm) and 3.15 m^2 (B_{rd} = 17.5 cm) with 8 rows and 2 m row length). Crops were fertilized with 60 kg ha^{-1} DAP prior to sowing and 20 kg ha^{-1} urea at spring. Extreme, average and 5 cm upper from the soil surface temperature values, relative humidity and rainfall parameters of the experimental site's during the growing seasons are shown in Fig. 1. Seeding rate was adjusted to 500 viable seeds per m^2. All relevant agronomic applications were followed as recommended. Weeds were periodically removed by hand. And all calculations were done according to Tosun and Yurtman (1973) on the (n = 10) sample plants from each plots.

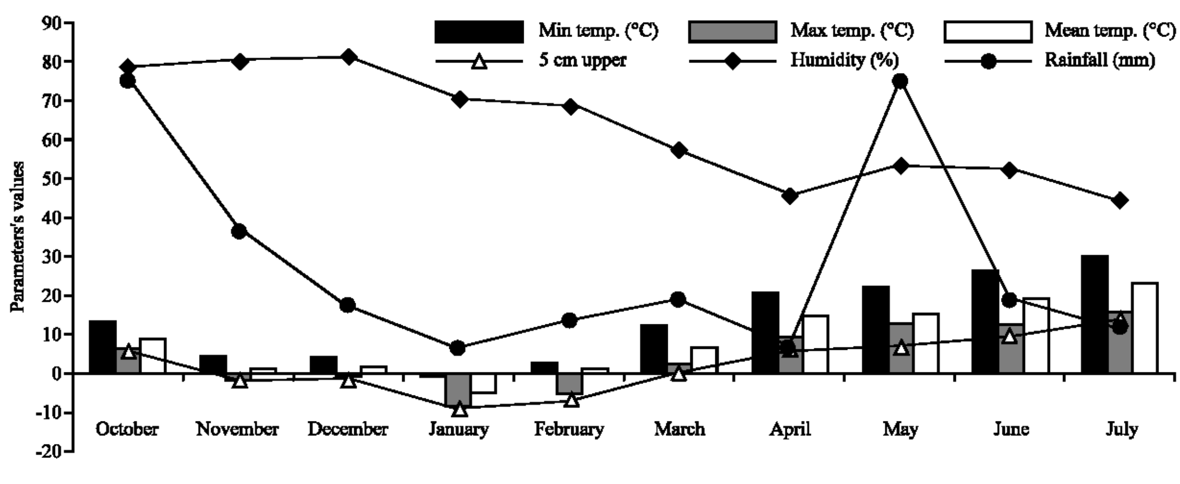

Fig. 1: Meteorological parameters of the experimental site

Observation, counting and measurements

The first development observations

The emergency date: It was recorded min one hundred and thirty five seedlings (or 30%) m^{-2} area at the sowing time on 17 October 1989 at the plots and it was two times by ten days interval. (Data was not shown).

The number of plant m^{-2} (n): PN was done with three times after the sowing process with one week interval.

The number of tillering plant m^{-2} (n): TP was found by carefully counting examined in the each tillered plant in the plots.

The number of the first and adventitious roots (n) and length (mm): FN and FL were calculated after the carefully and gently washing with the tap water of the ten randomly selected seedlings.

The number of the downy brome (*Bromus tectorum* Leyss.) (n): DB was determined by the counting among the outer rows in the each plots.

Mature stage observations

Plant height (cm): PH was determined at the maturity by measuring of the length between soil surface and top of the ear (awns excluded) of the tallest spikes at the 10 sample wheat plants from the each plot as a mean.

Spike length (mm): SL was found out by counting between the lowest internodi and the terminal spikelet as a mean of ten values in sample wheat plants.

The number of the spikelet (n): SN was fixed by counting of the spikelets of the three longest spikes in ten sample wheat plants.

The number of grain (n): GN was found by weighting of the ten rooted sample wheat plants after harvest and treshing.

Grain weight per plant (g plant^{-1}): GW was determined by weighting each of the ten rooted sample wheat plants after the harvest and treshing.

1000-kernel weight (g): TKW was found by the equation from the grain weight x grain number parameters in the ten sample wheat plants.

Grain yield per m^2 (g m^{-2}): GY was calculated by multiplying with the number of the plant per m^{-2} and the grain weight per plant (g).

Statistical analysis: All obtained data were subjected to analysis of variance (ANOVA) with the MSTAT-C (1998) Statistical Software and recorded mean values were groupped as described by (Duncan, 1955).

RESULTS AND DISCUSSION

The analyses of variance identified significant differences among genotypes for all the traits indicate there was a considerable variation within the genotypes (Table 1), B_{rd} and $G \times B_{rd}$ (Fig. 2-6, Table 2 and 3). At the first development stage, except of FR and DB (Table 1) and at the mature stage except of SN, GW and GY (Table 3).

First development stage observations

The number of plant m^{-2} (n): PN was found between 173±9.92 (B_{rd} = 5 cm) in Bezostaja I and 326±26.85 (B_{rd} = 17.5 cm) in Kunduru 1149 (Table 1 and Fig. 2-6). According to three times plant counting results after the ten days from the sowing with one week interval during the study, it was found statistically significance among the (G) (genotype) ($p<0.05$, 4.459) and B_{rd} ($p<0.01$, 29,4395) (Table 3). There is an increasing in the plant of number m^{-2} when SR increased. This result is possible. So, each plant formed from the germinated plant.

Table 1: The means of the seedling traits of five different wheat cultivars under the field conditions

Genotype	RD* (cm)	PN (n)	TP (n)	FN (n)	FL (mm)	AN (n)	AL (mm)	BN (n)	PH (cm)	SL (mm)	SN (n)	GN (n)	GW (g plant^{-1})	TKW (g)	GY (g^{-2})
BezostajaI	S_1	193±12.2f	27±2.46e	3±2.01b	94±8.88e	3±1.98a	53±5.20f	14±6.24a	51±3.20ı	73±5.13f	20±1.55b	27±2.53b	2±0.08c	26±1.92h	196±8.86b
	S_2	186±10.0f	44±3.89c	3±2.75b	91±7.95e	3±1.91a	42±3.26g	8±3.51d	53±3.65h	70±5.01h	19±1.46c	30±3.00a	1±0.50c	23±1.20k	182±7.47e
	S_3	244±17.9d	26±1.95f	3±2.47b	100±8.02d	3±2.02a	65±5.02bc	12±5.70b	45±2.05j	72±5.00g	18±1.03d	27±2.10b	1±0.60b	20±1.33l	187±8.13d
Haymana 79	S_1	173±9.9g	35±2.47d	3±2.89b	85±7.66g	2±1.75b	52±5.10f	11±4.66c	67±5.33c	81±5.29a	19±1.00c	27±1.79b	1±0.05h	33±2.01d	153±7.79k
	S_2	182±11.8g	15±6.05g	3±3.06b	89±8.05f	2±1.43b	53±5.47f	15±6.20a	72±5.76a	79±5.34c	18±0.97d	25±1.50c	1±0.03e	26±1.85h	132±6.25m
	S_3	220±13.4d	12±4.90h	3±2.15b	82±7.00g	2±1.30b	60±5.88e	16±5.85a	71±4.84b	80±5.21b	18±0.94d	24±1.20e	1±0.02g	32±1.96e	167±7.01h
Gerek 79	S_1	211±10.7e	56±5.44b	3±2.10b	89±8.12f	3±1.99a	53±5.70f	12±5.60b	65±4.96d	79±4.68c	19±1.10c	24±1.10e	1±0.40d	30±1.90f	191±7.88c
	S_2	175±11.4g	45±4.01c	3±2.99b	94±8.46e	2±0.67b	54±4.99f	7±4.50d	59±3.81c	75±5.20e	16±1.37e	19±1.02g	1±0.02g	24±1.77g	119±6.21n
	S_3	249±18.2c	15±5.99g	4±3.52a	97±9.09d	3±1.70a	63±5.03d	9±5.05c	59±2.87f	78±4.90d	18±1.28d	22±0.97f	1±0.07i	27±1.94h	170±7.24g
Çakmak 79	S_1	270±22.3b	86±7.71a	4±4.26a	98±10.27d	3±1.65a	74±6.84a	12±4.90b	56±2.38g	63±4.00k	20±1.46b	22±0.70f	1±0.4d	18±0.89m	151±7.32l
	S_2	263±20.1b	46±5.26c	4±4.03a	89±7.45f	3±1.50a	60±4.30c	8±3.45d	51±2.75ı	62±3.75h	23±2.54a	26±1.00c	2±0.6a	29±1.05g	165±6.89ı
	S_3	326±26.8a	24±1.23f	4±3.69a	88±7.03f	2±1.27b	67±5.25bc	8±4.13d	60±3.39e	63±3.97k	18±0.60d	22±0.55f	1±0.5c	34±1.27c	175±8.03f
Kunduru1149	S_1	263±17.4b	83±6.63a	3±2.52b	112±10.68b	3±2.06a	68±5.67b	12±4.60b	73±4.70a	63±3.56k	18±0.66d	25±1.25d	1±0.45b	39±1.28b	208±10.54a
	S_2	212±13.2e	57±4.27b	3±2.66b	116±10.95a	3±2.33a	67±5.40b	10±4.40c	66±4.26d	65±4.05j	20±1.59b	25±0.98d	2±0.49a	44±1.41a	160±8.31j
	S_3	280±26.7b	16±4.38g	3±3.03b	106±9.99c	3±2.26a	65±5.01bc	12±4.30b	67±5.10b	68±5.98ı	18±1.05d	22±0.84f	1±0.60b	44±1.34a	183±8.92d

*: Means with the same letter are not significantly different at p<0.05. **: Means with the same letter(s) are not significantly different at p<0.01. *: RD: Row Distance (cm), S_1, 5 cm, S_2, 10 cm, S_3, 17.5 cm, PN: Plant No. (n), TP: Tillered Plant (n), FN: First Root No. (n), FL: First Root Length (mm), AN: Adventitious Root No. (n), BN: Downy Brome No. (n), PH: Plant Height (cm), SL: Spike Length (mm), SN: Spikelet No. (n), GN: Grain No. (n), GW: Grain Weight (g plant^{-1}), TKW: 1000-grain weight (g), GY: Grain Yield (g m^{-2})

Table 2: Analysis of variance of investigated agronomic traits at the first developmental stage

Vs[a]	df	PN (n m^{-2})	TP (n)	FN (n)	FL (mm)	AN (n)	AL (mm)	BN (n)
Between main plots	19							
Blocks	2							
G	4	4.459*	0.9259	44.238**	5.8015	1.5620	0.094	1.509
E_1	8							
Inside main plots	30							
B_{rd}	2	29.4395**	20.1056**	0.542	0.0993	1.7853	2.897	3.882*
B_{rd}xG	8	1.061	2.4763*	0.702	0.9934	3.1864**	1.225	2.203
E_2								

*: F-values with the same letter are not significantly different at p<0.05. **: F-values with the same letter(s) are not significantly different at p<0.01. [a]: VS: Variation Source; df: Degree of freedom; PN: Plant No. (n m^{-2}); TP: Tillered Plant (n); FN: First Root No. (n $plant^{-1}$); FL: First Root Length (mm); AN: Adventitious Root No. (n $plant^{-1}$); BN: Downy Brome No. (n)

Table 3: Analysis of variance of investigated agronomic traits at the mature stage

Vs[a]	df	PH (cm)	SL (mm)	SN (n)	GN (n)	GW (g)	TKW (g)	GY (g m^{-2})
Between main plots	19							
Blocks	2							
G	4	9.8499**	5.4980*	0.479	8.7831**	0.6747	4.115*	1.0971
E_1	8							
Inside main plots	30							
B_{rd}	2	0.7507	0.7128	1.537	1.3517	0.7280	1.412	3.0660
B_{rd}xG	8	1.5363	0.2434	1.293	1.2670	1.3021	1.134	0.7798
E_2								

*: F-values with the same letter are not significantly different at p<0.05. **: F-values with the same letter(s) are not significantly different at p<0.01. [a]: VS: Variation Source; df: Degree of freedom; PH: Plant Height (cm); SL: Spike Length (mm); SN: Spikelet No. (n); GN: Grain No. (n); GW: Grain Weight (g $plant^{-1}$); TKW: 1000-grain weight (g); GY: Grain Yield (g m^{-2})

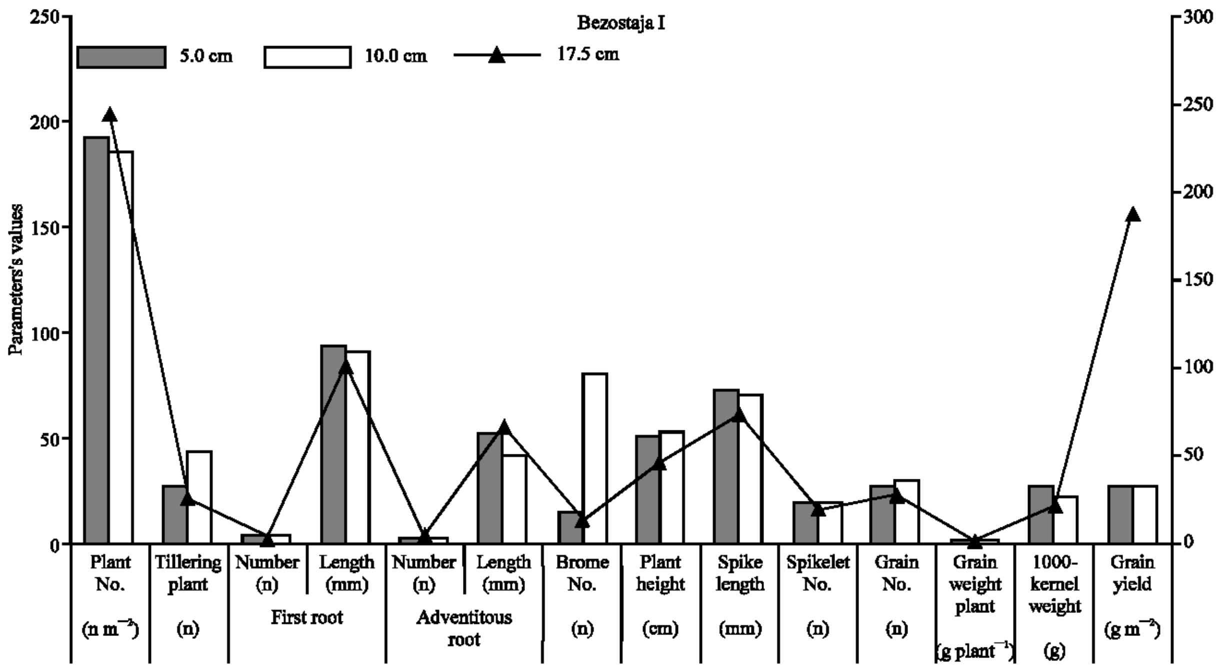

Fig. 2: Investigated agronomic traits in Bezostaja I

The number of tillering plant (n): In view of TP, this was varied between 12±4.90 (B_{rd} = 17,5 cm) in Haymana 79 and 86±7.71 (B_{rd} = 5 cm) in Çakmak 79 (Table 1). After one month from the sowing, in the possibility of the snow cover approaching, tillering was carefully examined during the plant counting. As shown in the Table 3, among the B_{rd} (p<0.01, 20,1056) and B_{rd}×G (p<0.05, 20,1056) were found statistically significant. Statistically importance of the three B_{rd} (esp. at the 10 cm) values for this trait, it can be explain that row distances are effective on the tillering plant number m^{-2} and this effect is the most clear at the narrowest and largest row distances than the 5 cm. In present research, reason of the investigation of the tillering phenomena at the first development stage is very

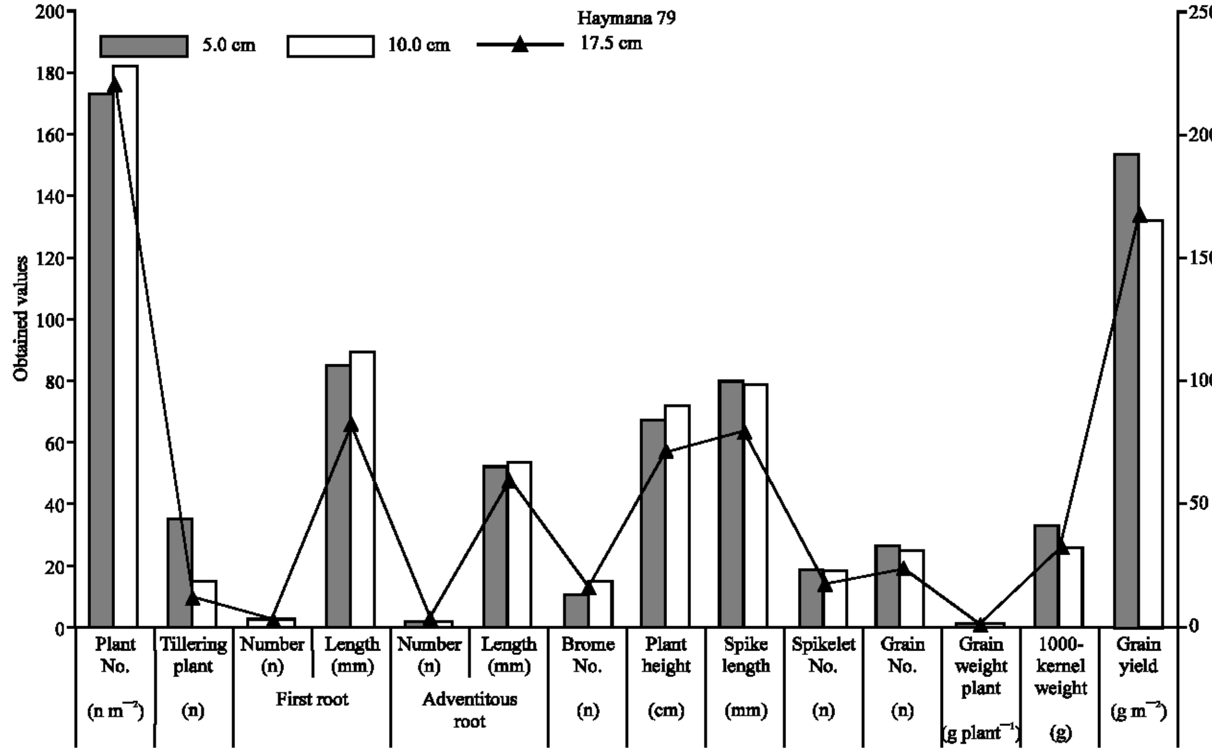

Fig. 3: Investigated agronomic traits in Haymana 79

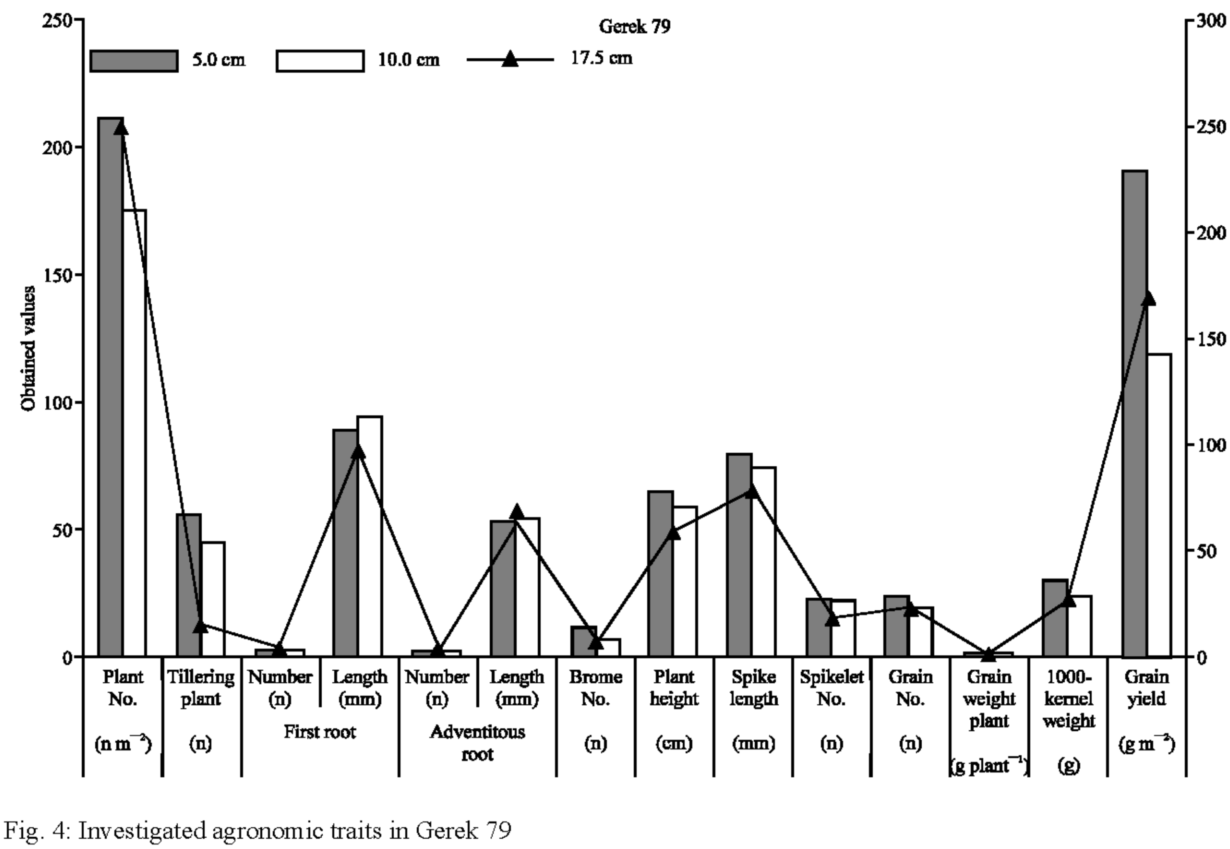

Fig. 4: Investigated agronomic traits in Gerek 79

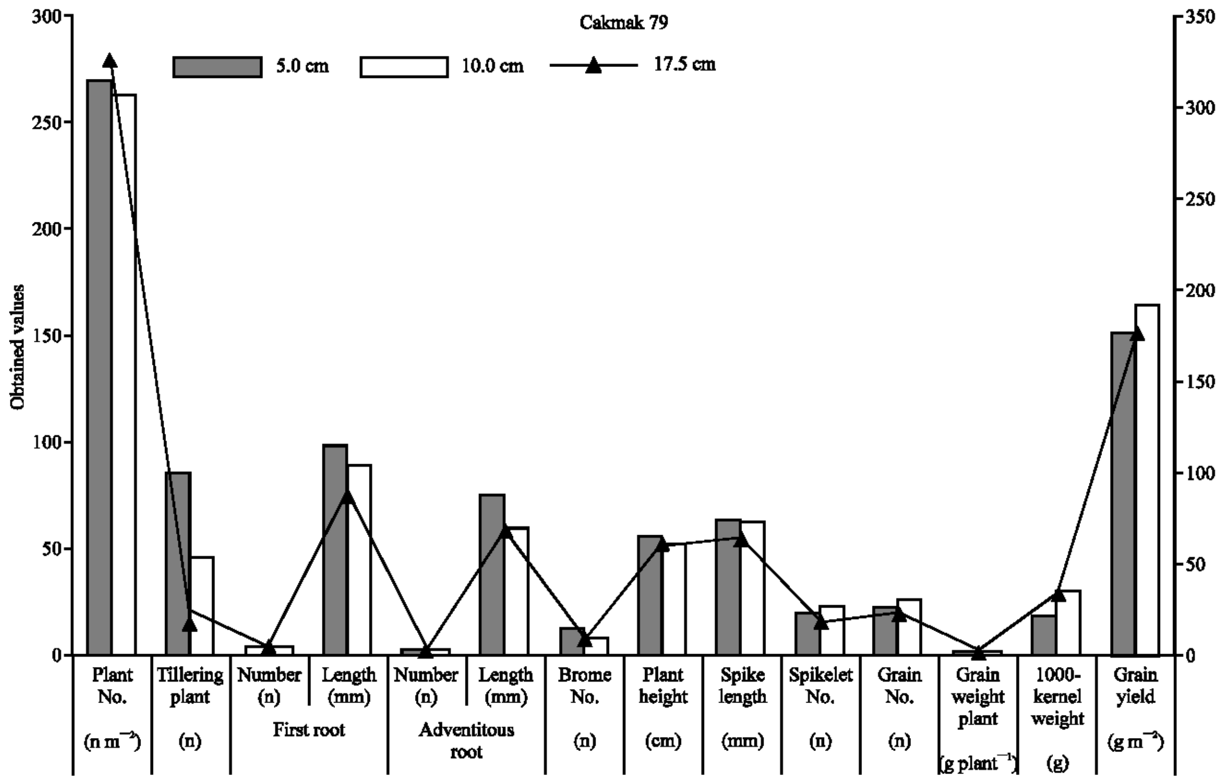

Fig. 5: Investigated agronomic traits in Çakmak 79

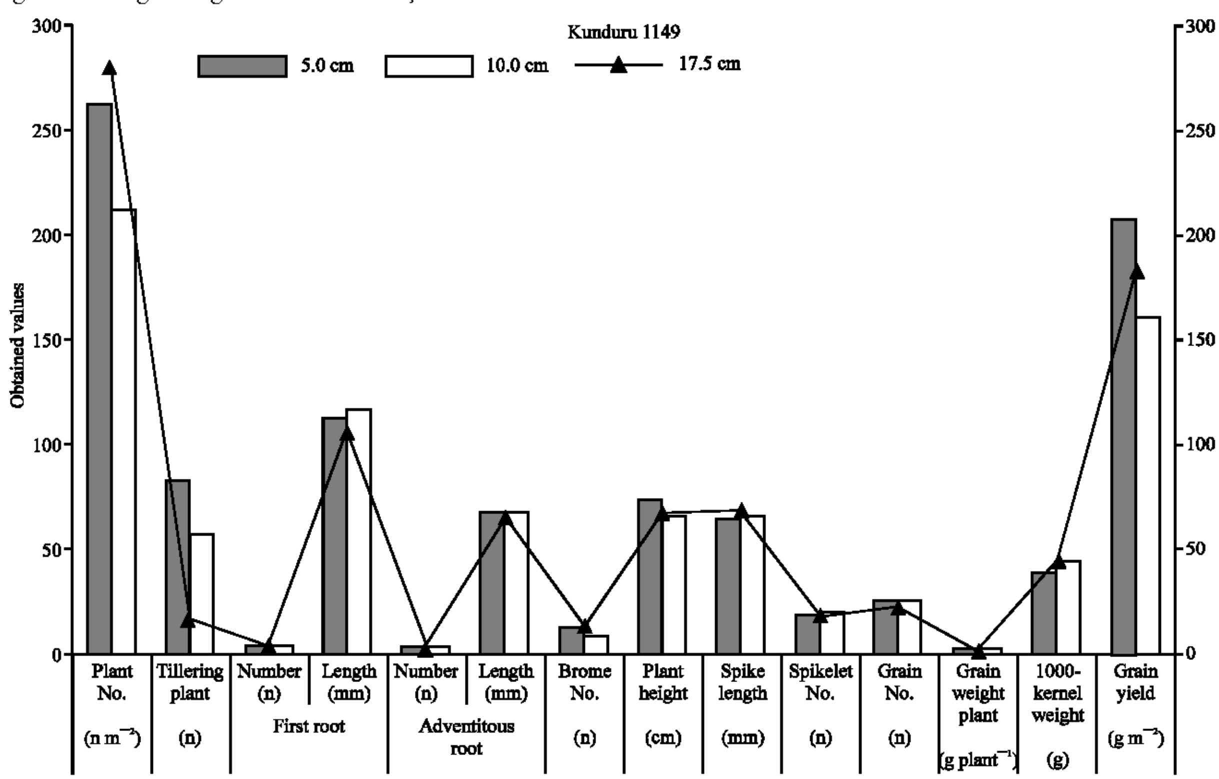

Fig. 6: Investigated agronomic traits in Kunduru 1149

tide relation between or largeness the tillering and adventitious root formation. As known, each tiller has one or two advetitious roots at the tiller base (Kün, 1983) and starting of the tillering process is identic with the root development in the cereals. On the other hand, durum wheats have been started more earlier than the commons according to our experiment. This formation's possible explanation is their seeds (durum) are bigger and reachness of the stored plant nutrients in it. Similarly, Pinthus (1969) was reported that common wheat much more tillered than the durums in spite of tiller number differences. But, Cheema *et al*. (1984), were informed that there was a critic reducing in the number of tillers at the B_{rd} = 10 cm and B_{rd} = 20 cm in their research. These findings are being supported and verified the our results. In addition, it was observed that suit meteorological conditions were caused earlier start of tillering in the durums than the commons and increasing the grain number and reducing the undeveloped tiller numbers are only possible with the increased seeding rate.

The number of the first and adventitious root and their length

The number of the first root (n) and length (mm): FN value was changed between (3±0.1, B_{rd} = 5 cm) in Bezostaja I and 4±4.26 (B_{rd} = 5 cm) in Çakmak 79 (Table 1 and Fig. 2-6). For the first root number, it was found statistical significance among the G (p<0.01, 44.238) (Table 3). Salim *et al*. (1965), Kirjan (1971) and Vel'sovskaja (1971) were reported that first root number was changed between 3 to 6. Similarly, the first root length (cm) was varied between 82±7.00 (B_{rd} = 17,5 cm) in Çaknak 79 and 116±10.95 (B_{rd} = 10 cm) in Kunduru 1149. It was not found significant. Kmoch (1960, 1961) were found that 160 cm of the root system depth of the wheat plant; Pinthus and Eshel (1962) were fixed the significant differences for the first root length; Salim *et al*. (1965) were informed that the longest first root is close to each others within the cultivars; Schleuber and Tucker (1967) were measured the length of it at least 185 cm; Kirjan (1971) was reported first root length (cm) between 23 and 114; Pinthus and Eshel (1962) and Kün and Şehirali (1977) were indicated that there was a difference the among the wheat cultivars for the rooting and development, first root length (cm) between 16 and 19; Cygankov (1971) was informed that most drought resistant cultivar had the highest first root number; Kandaurov and Movchan (1973) were notified that there was a positive but weak relationship between the first root number and yield level; Vedrov (1973) was indicated that there was a relationship with the drought resistance and the first root number. Present research findings are in the same direction of these research findings.

The number of the adventitious root (n) and length (mm): AN value was varied between 2±0.67 (B_{rd}= 10 cm) in Gerek 79 and 3±2.02 (B_{rd}= 17.5 cm) in Kunduru 1149 (Table 1 and Fig. 2-6). For this trait, it was only found at the statistical significance of B_{rd}×G (p<0.01, 3,1864) (Table 3). Pinthus and Eshel (1962), Salim *et al*. (1965), Vel'sovskaja (1971), Danıl'chuk (1973) and Kandaurov and Movchan (1973) were indicated that there were some significant differences among the cultivars, the number of the adventitious root was 3 and it was affected from the moisture and other environmental conditions but there were a weak and positive relationship between the number of the adventious and first root. Our findings were verified the previous research findings. The adventitious root length value was varied between 42±3.26 (B_{rd} = 10 cm) in Bezostaja I and 74±6.84 (B_{rd} = 5 cm) in Çakmak 79 (Table 1). This trait were found neither for the cultivars nor the B_{rd} and B_{rd} x G statistically significant (Table 3). Heen (1983) reported linking with the SR increasing, adventitious root development (Wilhelm *et al*. 1982) and water consumption were increased; Uprety *et al*. (1988), were fixed development at the adventitious roots mainly depended on the photosynthetic products which was carried; Gorny and Larsson (1989) discovered that there was a tight relationship between the adventitious root formation and tillering. In our experiment, it was found out that the adventitious root length highest at the B_{rd} = 5 cm. In that case and at the same SR class the tiller number should be restrained similar. However, this idea was supported by the Table 1 and mentioned research findings.

The number of downy brome (*Bromus tectorum* Leyss.) in plots: As known, *Bromus tectorum* Leyss. is an important weed for the wheat production areas in Central Anatolian. In our research, it was investigated that whether relationship with the wheat production. With this idea, during the experimental stage, one plot had been allocated without sowing as a control in each replication. DB was varied between 7±4.50 (B_{rd} = 10 cm) in Bezostaja I and 16±5.85 (B_{rd} = 17,5 cm) in Gerek 79 (Table 1 and Fig. 2-6). For the number of downy brome in plots, B_{rd} was found statistically significant (p<0.05, 3.882) (Table 3). In the sown plots, the number of downy brome plants recorded evidently high but it was decreased both in sown and unsown plots at the after end of the march. According to present research data showed that along with different in the cultivars for the number of downy brome in plots, B_{rd} increasing caused the number of this weed but this point was not considered that all obtained data were taken only from the two-years growing seasons. Present data was verified that, it would be more safety for the experiment that investigating of the downy brome number effect to the first development in wheat should be started in spring (April and May). However, this kind experiment should be settled on the brome-free fields and with foresighted amount of weed and sown to the certain depth. In addition, these points should be considered that weed development might be affected from the spring rains and should be more chancefull than the wheats for the competition of the limited water uptake in drought years.

Mature stage observations

Plant height (cm): PH was varied between 45±2.05 cm (B_{rd} = 17,5 cm) in Bezostaja I and 73±4.70 cm (B_{rd} = 5 cm) in Kunduru 1149 (Table 1 and Fig. 2-6). According to variance analysis results, G ($p<0.01$, 9,8499) <0.05, 20,1056) was found statistically significant (Table 3). Puckridge and Donald (1967); Geçit (1982); Güney and Kün (1985) were discovered that the plant height was increased when the SR increased, but according to Tugay (1978) it was reduced when the SR increased. In terms of this trait, our research data were in contradiction with the formers but harmony with the later. On the other hand, all recorded data for this agronomic trait had been taken from the severity drought growing season so they were not able to showed their plant height potential. Especially, negative plant height reducing effects were realized especially in the Kunduru 1149, this cultivar had the long height. In addition, drought year's plant reducing effect had been observed much more evidently during the experiment and it should be expected that yield and yield components were affected the negatively from the meteorological conditions.

Spike length (mm): Since photosynthetic surface and bringing the flower and floral counterpars, SL component is very important. SL was varied between 62±3.75 mm (B_{rd} = 10 cm) in Haymana 79 and 81±5.29 mm (B_{rd} = 5 cm) in Çakmak 79 (Table 1 and Fig. 2-6). In addition, G was calculated statistically significant ($p<0.05$, 5.498) (Table 3). There were no significant differences for the SL in all used B_{rd}, but this variation had been more notebly recorded in durum wheats. Our findings (Table 1) were in the same direction and harmony with the results of the Albustan and Kün (1987) who were discovered the SR increased when SL reduced. In addition, it was found out to avoid from the SL reducing large B_{rd} and densely sowing (may be at the limit of 400 seed per m^2 and at multi-locations (Peltonen-Sainio *et al*., 2007) should not be used.

Spikelet number (n): Due to carry of yield component, the SN is a very important unit. This trait was varied between 16±1.37 (B_{rd} = 10 cm) in Gerek 79 and 22.75±2.54 (B_{rd} = 10 cm) in Çakmak 79 (Table 1 and Fig. 2-6). With the analysis of variance test none of the investigated variables, G, B_{rd} and B_{rd} x G, were found statistically significant (Table 3). Puckridge and Donald (1967), Tugay (1978), Geçit (1982) and Albustan and Kün (1987) were reported that the SR and PN were increased when the SN decreased. Our findings were supported these reports. Variation in the SN due to the SL. When decreasing in the SL, similarly SN decreased too. Verifying of this postulate, maximum yield level was taken from the largest (B_{rd} = 17.5 cm) and lowest (O_{rd} = 5 cm) row distances (Table 1). However, it was taken higher from the commons (Table 1). Possible reason of this case can be explained individually and interactionally of the genotype, environment and relevant factors. If appears unsuitable conditions (severity droughtness, genotypic segregation etc.) when spikelet formation, flower formation, fertilization and grain filling it can be easily affected negative and that time this new promotion directly reflects to the SN and reduces the GY. By another speech, if lower and upper part of the spikelets converts to sterile, SP increases and important yield decreasing can be occur since unsuitable meteorological conditions during the spikelet formation.

Grain number (n): GN was varied between 19±1.02 (B_{rd} = 10 cm) in Bezostaja I and 30±3.00 mm (B_{rd} = 10 cm) in Gerek 79 (Table 1 and Fig. 2-6). Only G was found statistically significant ($p<0.01$, 8.7831) (Table 3). Puckridge and Donald (1967), Day *et al* (1976), Tugay (1978), Geçit (1982), Mazurek (1984), Güney and Kün (1985) and Albustan and Kün (1997) were discovered that the SR increased when GN increased; Joseph *et al.* (1985) found that B_{rd} and SR increasing caused the superficial increases in the grain number. Present results were in the harmony with the former researchers' findings but not with the Joseph *et al.* (1985). Main reason of these differences might be stem from the applied growing conditions, followed agronomic practices, used genotypes, row distances, ecological and meteorological parameters.

Grain weight per plant (g plant^{-1}): One of the main yield components in any experiment is the GW per plant was changed between 1±0.02 (g plant^{-1}) in Gerek 79 and Haymana 79 and 2±0.60 (g plant^{-1}) in Çakmak 79 (Table 1 and Fig. 2-6); G, B_{rd} and B_{rd}×G were not found statistically significant (Table 3). Schuster and Imhof (1970) were reported B_{rd} was not important for the GW; Joseph *et al.* (1985) were recorded that lightly increasing; Johnson *et al.* (1988) were not found the statistical significance among the G×SR and G×B_{rd}; but, Cıha (1983) was found the statistical significance between the SR and G and used row distances. Our obtained mean values for this trait are higher than the Albustan and Kün (1987)'s who used the same cultivars but generally in accordance with them and with the Puckridge and Donald (1967); Geçit (1982) and Mazurek (1984).

1000-kernel weight plant (g)(TKW): This important yield component was varied between 18±0.89 g (B_{rd} = 5 cm) in Çakmak 79 and 44±1.34 g (B_{rd} = 17.5 cm) in Kunduru 1149 (Table 1 and Fig. 2-6). According to variance analysis results, G was found statistically significant (p<0.05, 4.115) (Table 3). Puckridge and Donald (1967) were indicated the limit of (35-184) PN for the TKW and mentioned would be reducing outside of that limit; Larter *et al.* (1971) and Tugay (1978) were reported that when the SR increased, TKW decreased; Day *et al.* (1976), Albustan and Kün (1978) and Geçit (1982) were there was not significant difference within the used wheat cultivars in terms of the TKW when the SR increased. Present results basically are being supported to these findings.

Grain yield (g m^{-2}): As known, GY is a very important yield component. Due to this importance, should be avoid from the all kind reducing implications. For this trait, it was changed between 119±6.21 (g m^2) (B_{rd} = 10 cm) in Gerek 79 and 208±10.54 (B_{rd} = 5 cm) (g m^2) in Kunduru 1149 (Table 1 and Fig. 2-6). Variance analysis results were showed that G, B_{rd} and B_{rd} x G were not found statistically significant (Table 3). Puckridge and Donald (1967) were showed (35-184) PN for the GY and would be decrease when the outside of this limit; Schuster and Imhof (1970) were reported that B_{rd} = 15 cm had not effected to yield level; Geçit (1982) was indicated that the yield level decreased when PN increased; Mazurek (1984) was claimed that increasing of the PN caused to reduce in the GY; Güney and Kün (1985) were indicated that B_{rd} = 17 cm increased the GY by SR. Albustan and Kün (1987) were discovered that depending on the B_{rd}, the PN and GW can be increased; Marshall and Ohm (1987) were reported that maximum GY can be achieved at the narrowest B_{rd} and maximum SRs. Present findings are completely supported with Puckridge and Donald (1967), Geçit (1982), Mazurek (1984) and Marshall and Ohm (1987) but in contradiction with Tugay (1978), Güney and Kün (1985) and Albustan and Kün (1987).

CONCLUSION

Evaluated findings in this research can be summarized as follow: i) common wheat cultivars were carried out their growth and developments mostly on the mature period (Fig. 2-4), ii) durum wheat cultivars were performed thin growth and developments not only the first development stage but also the mature period (Fig. 5 and 6), iii) due to highness of the PN and TP values and largeness of their seeds of the durum wheats, they were given the highest values majority of the investigated agronomic traits (Fig. 5 and 6), iv) compared to other traits, first development traits are much more powerful and indicative determinants for the GY under the normal meteorological and ecological conditions, v) (B_{rd}) parameter was not clearly or evidently effected to the seedling traits in the common wheats, but B_{rd} = 17.5 cm was found the most appropriate distance for the commons in the majority of the seedling traits and vi) to be able to get high GY level in the wheat production process, wide B_{rd} can be recommended but, in this case, should be extremely attention against to the moisture loosing, weed, pest and diseases control during the cultivation.

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REFERENCES

Albustan, S. and E. Kün, 1987. Buğdayda ekim zaman ve sıcaklığının verim ve verim ögelerine etkisi. Yüksek Lisans Tezi. Ankara Üniv. Ziraat Fak. Tarla Bit. ABD, 82 sf (In Turkish, with English abstract).

Anonymous, 1987. Soil analysis report. Department of Soil Science Laboratories, University of Ankara, Faculty of Agriculture, Ankara,

Anonymous, 2004. http://faostat.fao.org/site/408/DesktopDefault.aspx?PageID=408

Cheema, Z.A., S. Sıddıque and S. Ahmad, 1984. Influence of varying planting densities on the growth and yield of different wheat varieties. Field Crop Abst., 37: 5103.

Cıha, A.J., 1983. Seeding rate and seed date effects on spring seeded small grain cultivars. Agron. J., 75: 735-799.

Cygankov, I.G., 1971. Characteristic of development of the root system in spring wheat. Plant Breed. Abst., 40: 868.

Danıl'chuk, P.V., 1973. The development of the roots and above ground parts of cereals in relation to their productiveness and drought resistance. Plant Breed. Abst., 43: 8529.

Day, A.D., A. Aschalew and E.B. Jackson, 1976. Effect of cultural practices on grain yield and yield components in irrigated wheat. Agron. J., 68: 132-134.

Duncan, B.D., 1955. Duncan's Multiple Range and Multiple F-test. Biometrics, 11: 1-42.

Fischer, R.A., 1985. Number of grains in wheat crops and the influence of solar radiation and temperature. J. Agric. Sci. Camb., 100: 447-471.

Geçit, H.H., 1982. Ekmeklik buğday (*Triticum aestivum* L. Em Thell.) çeşitlerinde ekim sıklıklarına göre birim alan değerleri ile ana sap komponentleri üzerine araştırmalar. Ankara Üniv. Ziraat Fak. Tarla Bit. ABD, Ankara. (In Turkish, with English abstract).

Genç, I., 1977. Tahıllarda dane veriminin fizyolojik ve morfolojik esasları, Çukurova Üniv. Ziraat Fak. Yıllığı 8, 1, 8 (In Turkish, with English abstract).

Gorny, G.A. and S. Larsson, 1989. New aspects in root breeding. Vortr. Planzenzüchtüng, 16: 339-356.

Güney, F. and E. Kün, 1985. Ankara koşullarında buğdayda ekim sıklığının bazı morfolojik karakterlere, verim ve verim ögelerine etkisi. Yüksek lisans tezi, Ankara Üniv. Ziraat Fak. ABD 43sf (In Turkish, with English abstract).

Johnson, J.W., W.L. Hargrove and R.B. Moss, 1988. Optimizing row spacing and seeding rate for soft red winter wheat. Agron. J., 80: 164-166.

Joseph, K.D.S.M., M.M. Alley, D.E. Brann and W.D. Gravelle, 1985. Row spacing and seeding rate effects on yield and yield components of soft red winter wheat. Agron. J., 77: 211-219.

Kandaurov, V.I. and V.K. Movchan, 1973. Drought resistance, biological and morphological characters of spring wheat. Plant Breed. Abst., 43: 9490.

Kırjan, M.V., 1971. Development of the primary root system in winter wheat. Plant Breed. Abst., 41: 823.

Kmoch, H.G., 1960. Die herstellung von wurzelprofile mit hilfe des UTAH-Erdbohrers und ihre ausdeutung. Zeitschrift für Acker und Pflanzenbau, 110: 425-437.

Kmoch, H.G., 1961. Die Herstellung von wurzelprofilen mit hilfe des UTAH-Erdbohrers und ihre ausdeutung. Zeitschrift für Acker und Pflanzenbau, 113: 342-360.

Kün, E. and S. Şehiral, 1977. Buğdayın kök gelişmesi üzerinde araştırmalar. TÜBITAK yayın no 360 V. Bilim Kongresi, Ankara. (In Turkish, with English abstract).

Kün, E., 1983. Serin iklim tahılları, Ders kitabı, Ankara Üniv. Ziraat Fak. Yayını 1032/299, Ankara, pp: 114-147 (In Turkish).

Larter, E.N., R.C. Kaltsıker and R.C. McGınnıs, 1971. Effect of date and rate of seeding on the performance of triticale in comparison to wheat. Crop Sci., 11, 593-595.

Marshall, G. and C. Ohm, 1987. Yield responses of 16 winter wheat cultivars to row spacing and seeding rate, 79: 2027-2030.

Mazurek, J., 1984. Dates of sowing and the rate of nitrogen fertilization for spring wheat, I. The effects on grain yield. Field Crop Abst., 37: 3562.

MSTAT, C., 1998. Michigan State University Statistical Software Manuel Handbook. East Lansing, Mı, 48824, Mishigan, USA.

Paulsen, G.M., 1987. Wheat Stand Establishment. In: Wheat and Wheat Improvement, Heyne, E.G. (Ed.). 2nd Edn. Madison, WI: ASA, CSSA and SSSA, Agron. Monogr. 13: 384-389.

Peltonen-Sainio, P., A. Kangas, Y. Salo and L. Jauhiainen, 2007. Grain number dominates grain weight in temperate cereal yield determination: Evidence based on 30 years of multi-location trials. Field Crops Res., 100: 179-188.

Pinthus, J.M. and Y. Eshel, 1962. Observations on the development of the root systems of some wheat varieties. Plant Breed. Abst., 32: 2962.

Pinthus, J.M., 1969. Tillering and coronal root formation in some common and durum wheat varieties. Crop Sci., 9: 267-272.

Power, J.F. and J. Alessi, 1978. Tiller development and yield of standard and semidwarf durum wheat population. Crop Sci., 26: 96-103.

Puckridge, D.W. and C.M. Donald, 1967. Competition among wheat plants sown at a wide range of densities. Aust. J. Agric. Res., 18: 193-211.

Rosegrant, M.W., M.A. Sombilla, R.V. Gerpacia and C. Ringler, 1997. Global food markets and US exports in the twenty-first century. Paper Presented at the Illinois World Food and Sustainable Agriculture Program Conference. Meeting the demand for food in the 21st Century: Challenges and Opportunities, 28 May, Univ. Illinois, Urbana-Chamopaign, USA.

Salim, M.H., G.W. Todd and A.M. Schleuber, 1965. Root development of wheat, oats and barley under conditions of soil moisture stress. Agron. J., 57: 603-607.

Schlehuber, A.M. and B.B. Tücker, 1967. Culture of Wheat, Wheat and Wheat Improvement. Am. Soc. Agron., Madison-Wisconsin, pp: 138.

Schillinger, W.F., E. Donaldson, R.E. Allan and S.S. Jones, 1998. Winter wheat seedling emergence from deep sowing depths. Agron. J., 90: 582-586.

Schuster, W. and E. Imhof, 1970. Höhere bestandesdichte bei winterweizen mitteilungen der DLG., 43: 1356-1358.

Tosun, O. and N. Yurtman, 1973. Ekmeklik buğdaylarda verime etkili başlıca morfolojik ve fizyolojik karakterler arasındaki ilişkiler. Ankara Üniv. Ziraat Fak. Yıllığı, 23: 434-441 (In Turkish, with English abstract).

Tugay, E., 1978. Dört ekmeklik buğday çeşidinde ekim sıklığının ve azotun verim, verim komponentleri ve diğer bazı özellikler üzerine etkileri. Ege Üniv. Ziraat Fak. Agronomi-Genetik Kürsüsü, Izmir. (In Turkish, with English abtract).

Uprety, D.C., M.C. Ghildiyal, G.S. Sirohli, 1988. Photosynthesis among cultivated and wild genotypes wlthin ploidy levels in wheat. Field Crop Abst., 41: 427.

Vedrov, N.G., 1973. Questions concerning the breeding of wheat for resistance to spring and summer drought. Plant Breed. Abst., 43: 8619.

Vel'sovskaja, L.A., 1971. Some data from investigations on the root system of wheat. Plant Breed. Abst., 41: 824.

Wilhelm, W.W., L.N. Mielke and C.R. Fenster, 1982. Root development of winter wheat as related to tillage practice in Western Nebraska. Agron. J., 74: 85-91.