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Variations in Seedling Characters of Some Wheat and Barley Genotypes During Germination

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Abstract: This laboratory study was conducted in Van, Turkey to determine an evaluation of seedling characters of six wheat and eight barley genotypes during germination. The experimental design was a Randomized Complete Block with four replications. Both barley and wheat varieties of the seed were germinated 98-100% at 4th day during germination. Similar findings were obtained at 8th days. Barley cultivars having high seed test weight gave strong shoot and root in this experiment. First marked things in results of study, homebred mixed population line Tir gave the longest coleoptile length with 5.21 cm at 8th day during germination. This variety is favourable cultivar for deep planting as this study results.

Key words: Germination, seedling growth, barley, wheat varieties

INTRODUCTION

Barley and wheat production depends to a considerable extent on selecting the best varieties for a particular area. Germination stage is greatly variable and is determined by genetic factors. Seedling vigorous may be caused by genotypic variations.

The germinating seedling undergoes a net loss in dry weight due to the high respiration rate and some exudation and leakage through the seed coat. As the epicotyl and radicle begin to grow they gain weight rapidly, at the expense of the endosperm, which undergoes a rapid weight loss as the food reserves are broken down and transported away. The storage carbohydrates, fats and proteins decrease rapidly in the endosperm and cotyledon during germination[1]. Germination is regarded to be finished when the radicle breaks through the seed coat. This moment also marks the onset of seedling growth. Seed size does not alter germination but affects growth, development and yield. Bigger seeds have several advantages when compared to smaller seeds, such as faster seedling growth, higher number of fertile tillers per plant and higher grain yield[2]. The advantage of bigger seeds is demonstrated when the crop is grown under environmental stresses, particularly drought[3]. Large seeds produce improved crop stand, which out-yield the crops derived from small seeds[4]. Rapid and uniform crop stand is an important for better quality produce. If seeds germinate erratically over a long time, seedling growth will not be uniform and plants will mature over a wider period.

However, lower test and seed weight, lower seed protein content and considerably shorter coleoptile length in the seedlings are also associated with dwarfing. The shorter coleoptile length in some genetic backgrounds or cultivars, causes emergence problems and erratic stands[5], especially when low soil moisture conditions are present at planting and deeper planting depths are used in an attempt to overcome the soil moisture problem[6]. Genotypes having long coloptiles have to be selected for deep planting. The length of the coleoptile limits sowing depth and its length changes with genotype, increasing only slightly when seeds are sown deeper[7]. Semi-dwarf wheat has shorter coleoptiles than tall wheat. After the radicle emerges from the seed, the first main shoot leaf emerges. It is enclosed within the coleoptile for protection as it penetrates the soil. As a result, the seeding depth should not exceed the length that the coleoptile can grow, usually no more than 7.6 cm. Acevedo *et al*.[8] used barley genotypes varying in their coleoptile length in a sowing depth experiment in northern Syria. At the driest location (Breda) they observed that deep plantings (7 to 10 cm) had a better crop establishment in those cases where long coleoptile genotypes were used. Early sowings are usually done prior to the first rain. In this case sowing depth has to be increased to avoid a false start of the crop (enough rain to germinate the seeds but not enough to carry the germinated seed to the next rainfall event). The main problem of deep sowing wheat is the decrease in plant emergence and plant vigor[9].

Dry matter content is a component of seedling vigour. Dry matter accumulation is an important factor in seed yield and tolerance of plants to insect, weed and disease stress. Faster dry matter content accumulation means faster growth, which allows plants to better tolerate many stresses.

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Wheat and barley germination may occur between 4 and 37°C , optimal temperature being from 12 to 25°C . The temperature might be between 5 to 15°C to obtain the best germination and emergence and good stand in the winter seasons.

The aim of the present investigation was to determine the seedling characters in some wheat and barley varieties during grain germination.

MATERIALS AND METHODS

This laboratory study was conducted in the University of Yüzüncü Yıl, Van, Turkey. In this study, Bülbül-89, Anadolu-86, Karatay-94, Yesevi-93, Tarm-92, Tokak-157/37, (two rowed barley) Çetin-2000, Aydanhanım-2000 (six rowed barley) barley varieties and Süzen-97, Harmankaya-99, Altay-2000, Kutluk 94, Tir (bread wheat) wheat varieties were used as a plant material. 1000 seed weight are changed between 43.6 and 58.3 g among to barley varieties and 37.6 and 43.9 among to wheat varieties.

The seeds released were subjected to a germination test for 8 days in seed germinator (4x70x40 cm) (in 4 replicates of 25 seeds each). The germination spirals being equipped with a paper wick and a paper substrate are placed on the glass plate (7x40 cm). The wick is being led through slots in the germination plate and reaches into the water bath below, thus supplying the required humidity to the paper substrate. Seed germinator was kept at room temperature, with no special lighting. Seeds were surface sterilized in a solution containing 1% w/v Ca(OCl)2 for 10 min and washed 5 times with sterile water due to minimize microbial effects.

This laboratory study was conducted in the first week of June, 2004 year to evaluation of Germination Rate (GR.) (%) (4 days), Germination Rate (GR) (%) (8 days), Coleoptile Length (CL) (cm), Residual Seed Dry Weight (RSDW) (g), Shoot Dry Matter Weight (SDMW) (g), Root Dry Matter Weight (RDMW) (g), Total Dry Matter (TDM) (g) and Dry Weight Ratio (DWR) (%) changes in some wheat and barley varieties during grain germination. The experimental design was a Randomized Complete Block with four replications.

Seedling emergence was observed after 4 days and 8 days. Four days after sowing, when the biggest plant was 4 cm tall (including root) we counted the ones that had germinated. Data were collected every 4 days over a period of 8 days from the date of sowing. At the end of the experiment (8 days) all the seedlings were carefully uprooted and sliced using a sharp blade in the root and shoot portions for biomass measurements and determined the dry matter content, the root and shoot samples were oven-dried at 70°C for 48 h.

In this study, coleoptile length were measured after reaching the maximum length as indicated by the emergence of the primary leaf from the coleoptile tip. Eight days after sowing, the length of the coleoptile for each grain was measured in cm and recorded. All root and shoot materials were separated from seed, then these seeds were oven-dried at 70°C for 48 h. Residual seed dry weight was obtained by this method.

Dry weight ratio used in germination was worked out by dividing amount of dry matter used in producing root (radicle) and plumules by the total dry weight. Total dry matter (g) and dry weight ratio (%) was calculated as:

- Total Dry Matter (TDM) = Shoot Dry Matter Weight (SDMW) + Root Dry Matter Weight (RDMW)
- Dry Weight Ratio (DWR)=Total Dry Matter (TDM)\Total Dry Matter (TDM)+Residual Seed Dry Weight (RSDW)[10]

Data were subjected to analysis of variance using a Completely Randomized Design. Differences between any two means were determined using a Duncan separation with a $p \leq 0.05$ and $p \leq 0.01$.

RESULTS AND DISCUSSIONS

Barley varieties: Germination rate was similar (non-significantly) at 4th day in all barley varieties. All varieties were germinated at same time. Germination rate was changed between 97.5 and 100% in barley varieties at 4th day (Table 2).

There were non significant germination rate among barley varieties at 8th day during germination. Similar findings were found at 8th day as 4th day's results and germination rate were changed between 98.75 and 100%. Rapid and uniform crop stand is a important for better production. If seeds germinate erratically over a long time, seedling growth will not be uniform and plants will mature over a wider period.

Coleoptile lengths were obtained differently ($p<0.01$) among to barley varieties. Coleoptile length were changed between 3.18 and 3.81 cm among to varieties. The longest coleoptile length were obtained with 3.81 cm from the cultivar Karatay-94. The shortest one was found from cv. Anadolu-86 (Table 2). Kirkby[7] reported that coleoptile length changed with genotype. Cultivars have the longest coleoptile length to be selected for deep planting and drought stress conditions[6,9]. Acevedo *et al.*[8] used barley genotypes varying in their coleoptile length in a sowing depth experiment in northern Syria. At the driest location (Breda) they observed that deep plantings (7 to 10 cm) had a better crop establishment in those cases where long coleoptile genotypes were used.

Table 1: Analysis of variance of some characters of germinating barley varieties

		Means of square							
Source	Df	GR (4th day) (%)	GR (8th day) (%)	CL (cm)	RSDW (g)	SDMW (g)	RDMW (g)	TDM (g)	DWR (%)
Blocks	3	4.78	0.11	0.002	3.82^{-6}	1.74^{-6}	5.05^{-7}	1.27^{-5}	12.90
Varieties	7	3.85ns	1.10ns	0.186**	4.80^{-5}**	1.42^{-5}**	1.08^{-5}**	4.26^{-5}	201.53**
Error	21	8.09	1.51	0.015	7.36^{-6}	1.84^{-6}	1.73^{-6}	9.78^{-6}	18.47
Total	31								

ns, non-significant; **, p<0.01

Table 2: Some characters of winter barley varieties in germination

Varieties	GR (4th day) (%)	GR (8th day) (%)	CL (cm)	RSDW (g)	SDMW (g)	RDMW (g)	TDM (g)	DWR (%)
Bülbül-89	97.50	99.25	3.21d45	0.02451a1	0.01231b23	0.00623cd23	0.01854bc2	42.78d5
Anadolu-86	98.00	99.25	3.18d5	0.01972bc1-3	0.01018c3	0.00468d3	0.01486c2	44.21d45
Karatay-94	98.25	100.00	3.81a1	0.01777cd23	0.01678a1	0.00944ab1	0.026221a	59.66a12
Yesevi-93	99.00	99.00	3.47c2-4	0.02223b12	0.01254b23	0.00750bc12	0.0200bc12	47.53cd3-5
Tarm-92	97.50	98.75	3.51bc23	0.01868bc1-3	0.01273b23	0.00805a-c12	0.02104b12	52.77bc2-4
Tokak-157/37	100.00	100.00	3.69ab12	0.02200a-c12	0.01244b23	0.00789a-c12	0.01781bc2	48.11cd3-5
Çetin-2000	99.75	100.00	3.43c2-5	0.01538d3	0.01186bc23	0.00753bc12	0.01939bc2	55.72ab1-3
Aydanhanım-2002	99.25	100.00	3.38cd3-5	0.01451d3	0.01377b2	0.00980a1	0.02115b12	62.00a1

Difference indicated with same letter(s) are non-significant (<0.05); Numeral (0.01)

There was a market decrease in the dry weight of seed and an increase in dry weight of embryonic axis in the first 8 days. For all varieties, 8th day after germination, residual seed dry weight decreased, while shoot plus root dry weight increased. Residual seed dry weight differences (p<0.01) was obtained among barley cultivars (Table 1). Residual seed dry weight was changed between 0.02451 and 0.01451 g. The highest residual seed dry weight was found from cv. Bülbül-89 with 0.02451 g. The lowest residual seed dry weight obtained from cv. Aydanhanım-2000. High residual seed weight of barley variety shows lower dry matter content accumulations (Table 2). Faster dry matter content accumulation means faster growth, which allows plants to better tolerate many stresses.

Eight barley cultivars used in this experiment to evaluate its dry weights. There were significant differences (p<0.01) in shoot dry matter weight among to barley varieties (Table 1). Shoot dry matter weights were changed between 0.01678 and 0.01018 g. The highest shoot dry matter weight was obtained from cultivar Karatay-94 and the lowest one was obtained from cv. Anadolu-86 with 0.01018 g (Table 2).

Barley cultivars having high seed test weight gave strong shoot in this experiment. Spilde[2] reported that bigger seeds have several advantages when compared to smaller seeds, such as faster seedling growth, higher number of fertile tillers per plant and higher grain yield.

Eight barley cultivars used in this experiment to evaluate their root dry weights. There were significant differences (p<0.01) in root dry matter weight among barley varieties. Root dry matter weights were changed between 0.00980 and 0.00468 g. The highest root dry matter weight was obtained with 0.00980 g from cultivar Aydanhanım-2000 and the lowest root dry matter weight was obtained from cv. Anadolu-86 with 0.00468 g. Barley cultivars having high seed test weight gave strong root in this experiment (Table 1 and 2).

Some differences (p<0.01) in total dry matter weight (root plus shoot dry weights) were observed among cultivars (Table 1). Total dry matter weight was changed 0.2622 to 0.01486 g and the highest total dry matter weight was observed with 0.2622 g from cv. Karatay-94. The lowest total dry weight was obtained from Anadolu-86. Root and shoot dry weights of Karatay-94 were greater than all other barley cultivars (Table 2). Seedlings that had the greatest shoot dry weight tended to have the greatest root dry weight. This suggests the possibility of selecting for larger root systems simply by selecting for high shoot dry weight in the seedling stage.

There were significant differences (p<0.01) in dry weight ratio among barley varieties (Table 1). Karatay-94 and Aydanhanım-2000 were greater than all other barley cultivars in dry weight ratios. Dry weight ratio was changed between 42.78 and 62.00% and the highest dry weight ratio was observed with 62.00% from cv. Aydanhanım-2000. The lowest one was obtained from Bülbül-89 with 42.78%. Anadolu-86 gave similar results as cv. Bülbül-89 (Table 2).

Wheat varieties: Germination rate was different significantly (p<0.01) at 4th day during germination among wheat varieties. Germination rate was changed between 91.25 and 99.00% in wheat varieties at 4th day after sowing. The lowest germination rate was determined from cv. Kutluk and similar germination rate was obtained in other varieties. The best performance was obtained from cv. Altay-2000 with 100% (Table 3 and 4).

Table 3: Analysis of variance of some characters of wheat varieties germination

		Means of square							
Source	Df	GR (4th day) (%)	GR (8th day) (%)	CL (cm)	RSDW (g)	SDMW (g)	RDMW (g)	TDM (g)	DWR (%)
Blocks	3	2.37	4.81	0.03	1.48^{-6}	2.52-6	2.46^{-7}	1.9671^{-6}	2.82
Varieties	5	41.994**	14.57**	3.65**	4.81^{-5}**	1.08^{-6}ns	1.41^{-6}ns	1.5145^{-6}ns	161.9**
Error	15	1.14	3.01	0.04	1.50^{-6}	1.09^{-6}	1.12^{-6}	2.9331^{-6}	9.92
Total	23								

ns, non-significant; **, p<0.01

Table 4: Some characters of wheat varieties in germination

Varieties and lines	GR (4th day) (%)	GR (8th day) (%)	CL (cm)	RSDW (g)	SDMW (g)	RDMW (g)	TDM (g)	DWR (%)
Aytin	99.00a1	99.75a1	3.10cd23	0.01079c3	0.00973	0.00708	0.01680	60.89a1
Süzen-97	99.00a1	99.50a1	3.27bc23	0.01103c3	0.00965	0.00568	0.01534	59.05a1
Harmankaya-99	98.75a1	99.00a1	2.80de34	0.01937a1	0.00952	0.00593	0.01545	44.18c3
Altay-2000	100.00a1	100.00a1	2.50e4	0.01256c3	0.01011	0.00636	0.01647	56.68a12
Kutluk	91.25b2	95.00b2	3.54b2	0.01673b2	0.01012	0.00653	0.01653	48.47bc3
Tir	98.75a1	99.50a1	5.21a.1	0.01594b2	0.01095	0.00547	0.01642	50.86b23

Difference indicated with same letter(s) are non-significant (p<0.05); Numeral (p<0.01)

There were significant differences (p<0.01) in germination rate among wheat varieties at 8 th day during germination. Similar findings were found at 8th day as results of germination at fourth day and germination rate were changed 95.00 and 100% (Table 3 and 4).

Coleoptiles lengths were different (p<0.01) among wheat varieties that obtained. Coleoptile length were changed between 2.50 and 5.21 cm in wheat varieties. The longest coleoptile length was obtained with 5.21 cm from homebred mixed population line Mixed population line Tir. The shortest one was found from cv. Altay-2000 with 2.50 cm (Table 3 and 4). Mixed population line Tir is favourable cultivar for deep planting. The shortest coleoptiles length in some genetic backgrounds or cultivar, causes emergence problems and erratic stands[5]. Cultivars have the longest coleoptile length to be selected for deep planting and drought stress conditions[6,9].

Among to all wheat varieties, 8th day during germination, residual seed dry weight decreased while shoot plus root dry weight increased. There were significant differences in residual seed dry weight (p<0.01) among wheat cultivars was obtained (Table 3 and 4).

Residual seed dry weight was changed between 0.01079 and 0.01937 g. The highest residual seed dry weight was obtained from Harmankaya-99. The lowest residual seed dry weight obtained with 0.01079 g from cv. Aytin. Almost all storage matter of cv. Aytin's seed was used in 8 day germination period. High residual seed weight of wheat variety shows lower dry matter content accumulations. Faster dry matter content accumulation means faster growth, which allows plants to better tolerate many stresses (Table 4).

There were not significant differences in shoot dry matter weight among to wheat varieties. Shoot dry matter weights were changed between 0.01095 and 0.0952 g. Grieve and Francois[4] reported, large seeds produce improved crop stand, which out-yield the crops derived from small seeds. The cultivars have similar test weights that were used in this study, so similar shoot dry matter weight was obtained in all wheat cultivars (Table 3 and 4).

Six wheat cultivars used in this germination experiment to evaluate root dry weights. There were not significant differences in root dry matter weight among to wheat varieties. Root dry matter weight was changed between 0.0708 g and 0.0547 g. Similar root dry matter weight was obtained in all wheat cultivars (Table 3 and 4).

There were not significant differences in total dry matter weight among to wheat varieties. Total dry matter weights were changed between 0.01534 and 0.01680 g. Similar total dry matter weight was obtained in all wheat cultivars (Table 3 and 4).

There were significant differences in dry weight ratio (p<0.01) among wheat cultivars was obtained. Aytin and Süzen-97 were greater than all other wheat cultivars in dry weight ratios. Dry weight ratio was changed between 44.18 and 60.89% and the highest dry weight ratio was observed from cv Aytin. The lowest one was obtained from Harmankaya-99 with 44.18% (Table 3 and 4).

According to the results given above, both barley and wheat varieties of the seeds were germinated 98-100% at 4 day during germination. Similar findings were obtained at 8th days. Barley cultivars having high seed test weight gave strong shoot and root in this experiment. First marked things in results of study, wheat homebred mixed population line Tir gave the longest coleoptile length with 5.21 at 8th day during germination. This line is favourable cultivar for deep planting as results of this study results. In addition, mixed population line Tir might

use in cereal breeding programme to improve new varieties which has long coleoptile and high seed yield. Acevedo *et al.*[8] observed that deep plantings (7 to 10 cm) had a better crop establishment in depth experiment and at the driest location where long coleoptile genotypes were used. Having shorter coleoptile are not favourable varieties for semi-arid region same as same our region.

In this study, having bigger seeds varieties had strong radicle and shoots which has sported by Spilde[2] and Grieve and Francois[4].

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