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INFLUENCE OF SEED MATURITY ON EARLY SEEDLING VIGOR IN WHEAT

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ABSTRACT. The influence of seed maturity on seedling dry matter, efficiency of seed weight and variability of seedling dry matter in wheat were investigated. The experiment was performed in semi-controlled conditions in greenhouse. The seeds from four maturity stages (milk, early dough, full dough and full physiological maturity) were grown at microtrial experiment in pots with quartz sand at four replications. Dry matter of seedlings from milk maturity seed ranged from 12.08 mg/ plant (Slavonija) to 18.52 mg/plant (KG-56). Results of seedlings dry matter from seed early dough maturity (26.86 mg/plant) and full dough maturity (27.62 mg/plant) had shown considerable higher values than seedlings from seed milk maturity (15.83 mg/plant). In average the highest value of shoot dry matter had shown seedlings from full dough stage (23.24 mg/plant), which was the same as averaged value for all cultivars and maturity stages (23.38 mg/plant). The highest root dry matter, in average, was found in seedlings from full dough maturity (24.93 mg/plant), and the lowest in seedlings from milk maturity (15.01 mg/plant). The efficiency of seed weight (seedling weight/seed weight) differed in dependence of cultivar and seed maturity, and ranged from 1.19 (Srbijanka) to 1.56 (Zagrebčanka). In average the highest efficiency of seed weight established in milky stage (1.61), and decreased to full phisiological stage (1.14). The analysis of variance was shown that differences of dry matter content of sidlings were highly significant for cultivar, maturity stage and interaction cultivar x maturity stage. The highest impact in total variance for dry matter content of sidlings had variance for the maturity stage (58.05 %), than variance for the cultivar (11.45 %), and the lowest variance for interaction (9.45 %). Variance for both maturity stage and cultivar was higher for seedling shoot (65.27 %, 16.05 %, respectively) than for seedling root (46.10 %, 9.89 %, respectively).

INTRODUCTION

The rate of seedlings growth or seedling vigor in cereals is reported to be influenced by seed size, seed protein content, germination resistance and genotype (RIES & EVERSON, 1973). The relative importance of these factors is of significance if seedling

vigor is to be used as a selection criterion for yield improvement in cereal breeding (EVANS & BHATT, 1977a). The seedling stage begins with the appearance of the first leaf and ends with the emergence of the first tiller. Up to six seminal roots and three leave support the plant at this stage. The crown of the plant usually becomes noticeably distinct after the third leaf has emerged.

The seed quality of wheat is depends of maturity stage and agroecological conditions. For realisation good sed quality it need harvest in the moment of favorable seed maturity stage. Harvesting after full physiological stage causes reduce seed yield and seed quality of wheat (PUCARIĆ & UJEVIĆ 1986). There are many ways of characterizing seed quality, but the main indicators of quality are seed size and seed efficiency. These two seed quality traits of wheat are in positive correlations with seedling vigor and growing in the beginning of the growing.

Early seed formation occurs during the milk stage. The developing endosperm starts as a milky fluid that increases in solids as the milk stage progresses. Seed size increases rapidly during this stage. Seed formation is completed during the dough development stage. The seed accumulates most of its dry weight during dough development. The transport of nutrients from the leaves, stems, and spike to the developing seed is completed by the end of the hard dough stage. The developing kernel is physiologically mature at the hard dough stage even though it still contains approximately 30 percent water. The seed loses moisture, and any dormancy it may have had, during the ripening stage.

The aim of this study was to examine influence of seed maturity to seedling dry matter, and seedling vigor, particularly efficiency of seed weight from different seed maturity in divergent wheat cultivars.

MATERIAL AND METHODS

Winter wheat cultivars (KG-56, Srbijanka, Lepenica, Ljubičevka, Oplenka, Jugoslavija, Nizija, Slavonija, Zagrebčanka and Baranjka) were grown on experimental field at Small Grains Research Centre, Kragujevac. The stage of maturity determined with grain moisture content, color and grain consistency (PAVLIČIĆ, 1964). The stages of maturity was described previusly (ZEČEVIĆ *et al*., 2005).

The spike was hand-treshing and grains dried on room temperature to dry air condition. The wheat seeds from the various stages of maturity (milky, early dough, full dough and full physiological) were grown at microtrial experiment and were sown in pots with quartz sand. The seedlings vigour was determined by method EVANS & BHATT (1977a). Method is consisting in following: fifty seeds of ten cultivars were sown in microtrial experiment in semi-controlled conditions in greenhouse in pots quartz with sand at four replications. The pots with seedlings were regular watered. Seedlings were harvested twenty seven days after planting. Seedlings were uprooted carefuly and washed in tap water to remove sand particles and blotted dried. Than samples were dried in dryer at 75^{o} C whole to constant mass. The dry seedlings or shoots were weighed and the data subjected to an analysis of variance. Efficiency of grain weight was calculated as a ratio of dry weight of seedling/dry weight of grain.

The following parameters were computed: the average value ($\bar{x}$); the coefficient of variation (V) as an index of relative variability of the trait, and the significant differences between the averages values were estimated by LSD-test (HADŽIVUKOVIĆ, 1991). The analysis of variance was performed according to a random block design with two factors. Components of variance was calculated by allowing the calculation of the components of

variance (σ^2_g-genetic, σ^2_{gl}-interaction; σ^2_E-environment; σ^2_f-phenotypic) by FALCONER (1981).

RESULTS AND DISCUSSION

Shoot dry matter

The results of seedlings shoot dry matter are displayed in Table 1. According to the results shoot dry matter in seedlings depended significantly of seed maturity stage. Seedlings from seed milky maturity ranged from 12.08 mg/ plant (Slavonija) to 18.52 mg/plant (KG-56). Results of seedlings from seed dough maturity (26.86 mg/plant; 27.62 mg/ plant) had shown considerable higher values of dry matter than seedlings from seed milky stage (15.83 mg/plant). In average the highest value of dry matter had shown seedlings from full dough stage (23.24 mg/plant), which was the same as averaged value for all cultivars and maturity stages (23.38 mg/plant). In average all cultivars had shoot dry matter above 20 mg/plant, except Slavonija (17.57 mg/plant).

Table 1. Seedling dry matter of shoot in wheat (mg/plant)

Cultivar	Growth stages				Average
	Milk	Early dough	Full dough	Full physiological	
KG-56	18.52	29.23	33.82	25.37	26.73
Srbijanka	14.92	27.69	26.79	23.26	23.06
Lepenica	16.77	29.05	25.26	23.62	23.68
Oplenka	16.52	31.63	31.27	24.71	26.03
Ljubičevka	16.61	26.42	28.89	24.00	23.98
Jugoslavija	14.72	23.75	27.14	19.26	21.22
Zagrebčanka	14.99	22.36	23.85	21.85	20.76
Nizija	15.73	28.13	28.44	30.92	25.80
Slavonija	12.08	21.15	22.53	14.53	17.57
Baranjka	17.40	29.21	28.24	24.92	24.95
Average	15.83	26.86	27.62	23.24	23.38

Root dry matter

Root dry matter depended significantly of cultivar and seed maturity (Table 2). The results have shown that seedling root dry matter from milky seed maturity ranged from 12.74 mg/plant (Baranjka) to 18.64 mg/plant (Oplenka). The highest root dry matter, in average, was found in seedlings from full dough maturity (24.93 mg/plant), and the lowest in seedlings from milk maturity (15.01 mg/plant). Root dry matter in seedlings from full dough maturity differed significantly than root dry matter in seedlings from full physiological maturity. Also, differences between root dry matter in seedlings from milky and other stages were highly significant. In average for seedlings from all maturity stages the highest root dry matter had KG-56 (26.20 mg/plant), and the lowest Baranjka (18.35 mg/plant). Seed maturity influenced

significantly on shoot and root dry matter. Dry matter in both (root and shoot) increased from milky to full dough maturity stage. The lowest shoot and root dry matter in seedlings from seed milky stage can be explained by low seed weight and low reserve in seed endosperm to produce roots and shoots. Plants from milky maturity seed in the beginning have poor growing because of low reserve in seed endosperm, but in the late growing its make up plants from mature seed (BABAYAN, 1960). Seeds from dough mature produced vigorously seedlings with higher dry matter because of higher seed weight and higher reserve in seed endosperm (BOYD *et al.*, 1971; PUCARIĆ & UJEVIĆ, 1986); especially of higher nitrogen content in large seed because of intensity of dry matter accumulation in wheat seedling is mainly depending of nitrogen content in seed (PANTIĆ & ĐOKIĆ, 1975). The results of dry matter of seedlings from dough and full maturity seeds agree with previous studies (YASEEN *et al*., 2004).

Table 2. Seedling dry matter of root in wheat (mg/plant)

Cultivar	Seed growth stages				Average
	Milk	Early dough	Full dough	Full physiological	
KG-56	17.10	28.68	32.92	26.09	26.20
Srbijanka	15.60	26.05	21.56	19.60	20.70
Lepenica	15.26	23.88	20.76	20.96	20.22
Oplenka	18.64	24.90	23.64	17.94	21.28
Ljubičevka	13.63	19.35	33.97	25.07	23.00
Jugoslavija	13.46	20.01	19.40	22.05	18.73
Zagrebčanka	13.26	17.66	25.76	20.35	19.26
Nizija	16.40	25.50	24.79	28.37	23.76
Slavonija	13.97	22.41	26.98	19.91	20.82
Baranjka	12.74	20.30	19.49	20.86	18.35
Average	15.01	22.87	24.93	22.12	21.23

The maturity stage has high influence to intensity of seedling growing (seedling vigor). Seed from early growth stages give not so much well grown seedling because of less dry matter content in seed. Seedlings which produced from later seed maturity stage were vigorously as a result of more dry matter content in seed. Plants which arise from large seed show better early vigor as a result of more dry matter content in large seed.

The efficiency of seed weight (seedling weight/seed weight) differed in dependence of cultivar and seed maturity (Table 3), and ranged from 1.19 (Srbijanka) to 1.56 (Zagrebčanka). In average the highest efficiency of seed weight established in milky stage (1.61), and decreased to full physiological stage (1.14). Efficiency of seed weight decreased from milky seed maturity to full physiological seed maturity. It can be explain because of that smaller seed has higher effect to production of seedling dry matter, what agree with previous studies (PANTIĆ & ĐOKIĆ, 1975; ĐOKIĆ & LOMOVIĆ, 1988;

LOMOVIĆ *et al*., 1994). Other authors are reported that rate of seedlings growth or seedling vigor in cereals is reported to be influenced by seed size, seed protein content, germination resistance and genotype (RIES & EVERSON, 1973; EVANS & BHATT, 1977a; 1977b).

Table 3. Efficiency of seed weight (dry weight of seedling/dry weight of seed) in wheat

Cultivar	Seed growth stages				Average
	Milk	Early dough	Full dough	Full physiological	
KG-56	1.62	1.29	1.33	1.08	1.33
Srbijanka	1.48	1.30	1.07	0.92	1.19
Lepenica	1.54	1.36	1.13	1.18	1.30
Oplenka	1.93	1.36	1.04	0.94	1.32
Ljubičevka	1.62	1.13	1.22	1.04	1.25
Jugoslavija	1.55	1.16	1.07	1.00	1.20
Zagrebčanka	1.45	1.90	1.42	1.46	1.56
Nizija	1.46	1.47	1.30	1.41	1.41
Slavonija	1.28	1.95	1.27	0.99	1.37
Baranjka	2.13	1.21	1.36	1.33	1.51
Average	1.61	1.41	1.22	1.14	1.38

The seedling dry matter variabilty

The analysis of variance was shown that differences of dry matter content of sidlings were highly significant for cultivar, maturity stage and interaction cultivar x maturity stage (Table 4, 5 and 6). The highest impact in total variance for dry matter content of sidlings had variance for the maturity stage (58.05 %), than variance for the cultivar (11.45 %). Higher variance for maturity stage (65.27 %) and cultivar (16.05 %) were established for seedlings shoot than for seedlings root (46.10 %, 9.89 %, respectively). Seed maturity had higher influence to variability of seedlings dry matter than cultivar. Higher variability for seed maturity can be explain by different seed weight or seed size in different maturity stages what is in agreement with results obtained by EVANS & BHATT (1977) who have shown that fifty-three percent of the variation in seedling vigor was attributed to variation in seed size and protein content. According to the results variation coefficient for seedlings was 12.78 %. It was established higher variation coefficient for the root dry matter (15.03) than for the shoot dry matter (10.21), what agree with investigation obtained by QAYYUM KHAN *et al*. (2002).

Table 4. Phenotypic variance of seedling dry matter of wheat

Source of variation	DF	MS	Ft	Components of variance		LSD	0.01	0.05
				δ^2	%			
Replication	3	53.257	-	-	-	Cultivar	5.32	4.02
Cultivar	9	379.455	11.49**	17.95	11.45	Maturity stage	3.36	2.54
Maturity stage	3	3733.220	113.08**	91.02	58.05	Cultivar x maturity stage	10.64	8.05
Cultivar x maturity stage	27	92.292	2.80**	14.82	9.45	V=12.78 %		
Error	117	33.013	-	33.01	21.05			
Total	159	-	-	156.8	100.0			

Table 5. Phenotypic variance of seedling shoots dry matter of wheat

Source of variation	DF	MS	Ft	Components of variance		LSD	0.01	0.05
				δ^2	%			
Replication	3	23.283	-	-	-	Cultivar	2.21	1.67
Cultivar	9	128.131	22.50	7.03	16.05	Maturity stage	1.40	1.06
Maturity stage	3	1159.986	203.69	28.61	65.27	Cultivar x maturity stage	4.42	3.34
Cultivar x maturity stage	27	15.673	2.75	2.49	5.68	V=10.21%		
Error	117	5.695	-	5.70	13.00			
Total	159	-	-	43.83	100.00			

Table 6. Phenotypic variance of seedling root dry matter of wheat

Source of variation	DF	MS	Ft	Components of variance		LSD	0.01	0.05
				δ^2	%			
Replication	3	7.908	-	-	-	Cultivar	2.95	2.23
Cultivar	9	94.325	9.29**	3.69	9.89	Maturity stage	1.86	1.41
Maturity stage	3	723.837	71.31**	17.21	46.10	Cultivar x maturity stage	5.90	4.46
Cultivar x maturity stage	27	35.277	3.48**	6.28	16.82	V=15.03 %		
Error	117	10.150	-	10.15	27.91			
Total	159	-	-	37.33	100.00			

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