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SEED DRY MATTER ACCUMULATION OF WHEAT IN DIFFERENT MATURITY STAGES

Veselinka Zečević[1], Desimir Knežević[2] and Danica Mićanović[3]

[1] *Small Grains Research Centre, Kragujevac, Serbia*
e-mail: joca@kg.ac.yu
[2] *Faculty of Agriculture, University of Priština, Zubin Potok, Serbia*
[3] *Serbian Chamber of Commerce, Belgrade, Serbia*

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ABSTRACT. Dinamics of gathering of seed dry matter in divergent wheat cultivars in dependence of seed degree maturity were investigated. There were included 10 winter wheat cultivars (KG-56, Srbijanka, Lepenica, Ljubičevka, Oplenka, Jugoslavija, Nizija, Slavonija, Zagrepčanka and Baranjka). Investigated cultivars differentiated according to length of vegetative period. The investigation was carried out in microtrial on experimental field of Small Grains Research Centre, Kragujevac, on smonitza soil during two years. Spikes of these cultivars were sampled at four grain maturity stages (milk, early dough, full dough, and full physiological). The standard laboratory methods were used for determination seed dry matter content, seed water content and thousand-grain weight. The results presented in this work indicated that the degree of seed maturity influenced significantly on its dry matter content, water content and thousand-grain weight. In the course of seed maturity the water concentration decreased and the dry matter content increased, because of accumulation of organic and inorganic matter in seed. This increasing is registered to full physiological maturity. The highest seed dry matter had Lepenica cultivar at full physiological phase and second growing season (91.94%), and the lowest Oplenka at milky stage and first season (27.40%). Thousand-grain weight was increased from milky to full dough stage, and then decreased in full physiological maturity. The highest value of this trait was found at full dough maturity in Oplenka cultivar (51.95g) and the lowest in milky stage at Baranjka cultivar (15.65g).

Key words: seed, dry matter, wheat, maturity.

INTRODUCTION

The seed is complex and considerable biological system which used to growing and preserving of the most number of plant species. Furthermore, the seed is important source of food for people and animals. Store seed food uses as energy source in the beginning of growing process and early seedling vigor in wheat (EVANS & BHAT, 1977; ZEČEVIĆ *et al*., 2006). Seed quality is very complex trait and it depends of maturity stage, beside the rest.

During the seed maturity dry matter content is increased. The highest dry matter increase in seed is done in milky and dough stages. After that at the full physiological maturity dry matter content are decreased and break at the beginning or at full maturity stage in dependence of agro-climatic conditions (ZAPRYANOV, 1971).

An understanding of wheat growing and development is essential to achieving optimum productivity in wheat. At physiological maturity, the crop has reached maximum possible yield, and grains, which are no longer growing, merely lose water. From there on, the crop is subject to an increasing risk of yield loss due to damage from different sources (lodging, preharvest sprouting, hail, and biological stress). The most precise method of determining the time of physiological maturity in crops is to follow grain dry matter accumulation after anthesis (CALDERINI *et al*., 2000).

The aim of this study was to examine influence of seed maturity to seed dry matter accumulation, seed water concentration and thousand-grain weight in divergent wheat cultivars.

MATERIAL AND METHODS

Winter wheat cultivars (KG-56, Srbijanka, Lepenica, Ljubičevka, Oplenka, Jugoslavija, Nizija, Slavonija, Zagrepčanka and Baranjka) were grown on experimental field at Small Grains Research Centre, Kragujevac during two years. The experiment was designed as a randomized block with five replications. The cultivars were chosen because of their differences in grain filling period. Spikes of these cultivars were sampled at four grain maturity stages (milk, early dough, full dough, and full physiological). The stage of maturity determined with seed moisture content, color and seed consistency (PAVLIČIĆ, 1964). Stages of maturity was described previously (ZEČEVIĆ *et al*., 2005, 2006). During all vegetative period, especialy from seed forming

to full maturity stage, it done physiological observations and registered the most important changes in some growing stages.

The spike was hand-treshing and than samples were dried in dryer at 105^{o} C whole to constant mass, and than dry matter content and water content were calculated. Samples for determining thousand seed weight was dried on room temperature to dry air condition, and was measured by standard method (2 x 500 grains).

The analysis of variance was performed according to a random block design with three factors, and the significant differences between the averages values were evaluated by LSD-test (HADŽIVUKOVIĆ, 1991).

RESULTS AND DISCUSSION

Seed dry matter accumulation in different maturity stages

The investigated cultivars were grown in different sesons. Average temperature, precipitation and humidity in first season were 10.7^{o}C, 675.1mm and 73.5%, respectively, but in second season these parameters were 11.6^{o}C, 471.0mm and 72.6%, respectively. The average temperature and precipitation in both growing seasons were 11.2^{o}C and 573.05mm, respectively. Difference between seasons in temperature was only 0.9^{o}C, but in precipitation difference was higher and amounted about 204.1mm. Grain fill duration depended of growing season because of different climatic conditions. The highest differences between seasons were in the period from milky to early dough stage i.e. in stage of intensive seed dry matter accumulation. Duration of some investigated stages depended of environmental conditions and cultivars what agree with previous studies (PAVLIČIĆ, 1964, JEVTIĆ, 1981).

Dry matter content is increased during seed maturity in wheat (Table 1). In average for all investigated cultivars and growing season dry matter content was: in milky stage 33.45%, in early dough stage 55.34%, in full dough stage 73.55%, and in full physiological stage 89.12%. Analysis of variance was conducted to determine the effect of seed maturity, cultivar and environmental factors to dry matter accumulation. The differences in dry matter content between some maturity stages were highly significant. The highest dry matter content was at Lepenica cultivar in full physiological stage (91.71%) and the lowest at Oplenka in the milky stage (30.02%). In the cultivar x growing season interaction the highest seed dry matter content was at Jugoslavija cultivar in the first season of investigation (67.28%), and the lowest at Slavonija in the second season (56.03%). At the maturity stage x season interaction the highest seed dry matter content was in full physiological maturity and second growing season (89.16%),

and the lowest in the milky stage and first season (30.09%). These differences were highly significant. Cultivar x stage x season interactions showed that Lepenica (91.94%) had the highest seed dry matter content in full maturity and second season, but Oplenka had the lowest dry matter in milky stage and first season (27.40%).

Table 1. Average values of seed dry matter content in different maturity stages (%)

Cultivar	Growth stages						Average
	Milk	Early dough		Full dough	Full physiological		
KG-56	32.54	56.95		76.92	89.48		63.97
Srbijanka	37.47	56.40		70.37	88.50		63.18
Lepenica	34.88	58.47		75.68	91.71		65.18
Oplenka	30.02	54.03		76.68	87.34		62.02
Ljubičevka	30.30	54.86		73.76	88.74		61.92
Jugoslavija	31.16	55.84		74.80	91.13		63.23
Zagrepčanka	37.00	48.52		72.46	90.38		62.09
Nizija	36.06	57.97		73.20	87.92		63.79
Slavonija	33.67	48.41		72.10	88.49		60.67
Baranjka	31.36	61.92		69.52	87.54		62.58
Average	33.45	55.34		73.55	89.12		62.86
LSD	A	B	C	AB	AC	BC	ABC
0.05	1.20	0.76	0.77	2.40	1.70	1.07	3.40
0.01	1.58	1.00	1.01	3.17	2.24	1.42	4.48

Legend: A - cultivar; B - growth stage; C - growing season

In average for two seasons in full physiological maturity cultivars Lepenica and Jugoslavija showed the highest dry matter accumulation (91.71% and 91.13%, respectively), with lowest water content in seed. Our results showed that the duration of grain filling is determined principally by genotype, environmental factors and genotype-environment interactions, what agree with previous studies (WHEELER *et al*., 1996; PANOZZO & EAGLES, 1999; PANOZZO *et al.,* 2001). KOBATA *et* al. (1992) found that a water stress imposed at anthesis, or over the first few days after anthesis, causing a reduction in yield components. In our results a negative relationship between seed dry matter and seed water concentration was determined what is in agreement with obtained results by CALDERINI *et al*., 2000. Our results, as well as results from CALDERINI I *et al*. (2000), showed that the values of seed dry matter accumulation and water concentration are consistently related during most of the grain filling period. Seed dry matter

increasing during maturity stages is caused by accumulate organic and inorganic matter in seed. Grain fill duration always positively correlated with physiological maturity (TALBERT *et al*., 2001).

Seed water content in different maturity stages

Table 2. Average values of seed water content in different maturity stages (%)

Cultivar	Growth stages						Average
	Milk	Early dough		Full dough	Full physiological		
KG-56	67.72	43.06		23.08	11.18		36.26
Srbijanka	62.54	43.60		29.64	11.51		36.82
Lepenica	65.12	41.53		24.32	8.30		34.82
Oplenka	69.98	45.97		23.32	14.16		38.36
Ljubičevka	69.70	45.12		26.24	11.27		38.08
Jugoslavija	68.84	44.16		25.21	8.88		36.77
Zagrepčanka	63.00	51.48		27.54	9.60		37.90
Nizija	63.94	42.03		26.68	12.10		36.19
Slavonija	66.33	51.60		27.90	11.40		39.31
Baranjka	68.64	38.30		30.48	12.48		37.48
Average	66.58	44.68		26.44	11.09		37.20
LSD	A	B	C	AB	AC	BC	ABC
0.05	1.27	0.80	0.81	2.53	1.79	1.13	3.58
0.01	1.67	1.05	1.07	3.34	2.36	1.49	4.72

Legend: A - cultivar; B - growth stage; C - growing season

Seed water content was different in dependence of maturity stage, growing season and investigated cultivars (Table 2). In milky stage water content was above 68% at cultivars Oplenka, Ljubičevka, Jugoslavija and Baranjka (68.98%, 69.70%, 68.84% and 68.64%, respectively. Differences between these cultivars were not significant, except between Oplenka and Baranjka. In milky stage Zagrepčanka and Srbijanka had the lowest water content in seed. The differences between growing seasons for the same cultivar was highly significant and ranged from 4.40% (Jugoslavija) to 14.51% (Srbijanka). Baranjka was exception, in which differences of seed water content between growing seasons was not significant (0.52%). Early dough stage characterized some a little seed water content in comparison with milky stage. In average seed water content in this stage was above 50.00%, only in two cultivars Slavonija and Zagrepčanka (51.60% and 51.48%, respectively). In other cultivars seed water content was above 40.00%, except at Baranjka

(38.30%). Differences between growing seasons were high significant because of differences of climatic factors. Higher seed water content was in the second season because of higher precipitation and lower temperature in the beginning of dough stage.

During maturity water content in seed decreased and in full dough stage ranged from 23.08% (KG-56) to 30.48% (Baranjka). Differences between growing seasons were very significant because of cultivars were made this stage in very different climatic conditions. In full physiological stage seed water content in average ranged from 8.30% (Lepenica) to 14.16% (Oplenka). In this stage differences between growing seasons were lower than in other stages because of the similar climatic conditions in both seasons.

Thousand-grain weight (TGW) in different maturity stages

Table 3. Average values of thousand-grain weight (TGW) in different maturity stages (g)

Cultivar	Growth stages				Average
	Milk	Early dough	Full dough	Full physiological	
KG-56	21.60	46.00	50.21	48.32	41.53
Srbijanka	20.35	41.33	46.08	47.19	38.74
Lepenica	19.50	38.92	39.80	38.99	34.30
Oplenka	18.55	42.46	51.95	46.70	39.92
Ljubičevka	18.54	40.30	50.79	47.76	39.35
Jugoslavija	17.42	38.17	44.74	42.29	35.66
Zagrepčanka	19.25	25.86	33.29	30.70	27.28
Nizija	21.84	38.54	41.16	40.35	35.47
Slavonija	20.10	28.42	36.66	35.35	30.13
Baranjka	15.65	37.08	35.05	35.62	30.85
Average	19.28	37.71	42.97	41.33	35.32

LSD	A	B	C	AB	AC	BC	ABC
0.05	1.09	0.69	0.71	2.18	1.54	0.98	3.09
0.01	1.44	0.91	0.94	2.88	2.04	1.29	4.07

Legend: A - cultivar; B - growth stage; C - growing season

Wheat grain weight is a function of rate and duration of grain growth and is affected by photosynthate supply (LI *et al*., 2000). The results of thousand-grain weight are presented in Table 3. As the moisture of the seed decreased, the values obtained TGW increased. Significant differences in TGW were observed for cultivars, phases and investigated season. TGW is increased to full dough stage in which was maximum

value (42.97g). This trait in average for all cultivars and growing season was: in milky stage 19.28g, in early dough 37.71g, in full dough 42.97g, and in full physiological 41.33g. Cultivar x stage interaction have shown that Oplenka cultivar had the highest TGW at full dough stage in average for two season (51.95g), but the lowest TGW was established at Baranjka in milky stage (15.65g). In the cultivar x growing season interaction the highest TGW was found in the first season at KG-56 (41.92g) and the lowest at Zagrepčanka in the second season (26.09g). The cultivar x stage x growing season interactions showed that Oplenka had the highest TGW in the second season and full dough maturity (52.65g), and the lowest had Baranjka in the second season and at milky stage (14.18g). The differences among some maturity stages and interactions were highly significant.

Thousand-grain weight values had tendency of increasing from milky stage to full dough stage, and then TGW decreasing to full physiological maturity. It may be explain because in the mature seeds are done biochemical processes and dry matter is decreasing because of seed respiration, especially in high humidity (ZAPRYANOV, 1971, JEVTIĆ, 1981). Thousand-grain weight was significantly affected by cultivar and maturity, it increased with increased maturity.

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