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VARIABILITY OF DRY SUBSTANCE ACCUMULATION AND UTILIZATION PARAMETERS OF WINTER WHEAT PLANT

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Some dry substance accumulation and utilization parameters of wheat plant and their influence on grain yield have been studied through a field trial with 20 winter wheat cultivars. The studied parameters value (biological yield, dry substance reutilization, number of grains per spike, 1000 grain mass, plant height, etc.) varried depending of genotypic specificity and environmental conditions. Grain yield was influenced not only by the total dry substance accumulation in plant (i.e. biological yield), but also by this accumulation amount before and after flowering. Yield forming was affected by many parameters, and cultivar range was different for various parameters. The best grain yield was observed in cultivars having elevated values of more than few parameters. The highest mean grain yield was observed in cultivar Tiha, and also high grain yield values were found in cultivars Gruža, Nevesinjka, and Toplica.

Key words: winter wheat, dry substance, utilization parameters

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INTRODUCTION

Photosynthetic activity of green organs and absorption activity of root produce plant dry matter – biological yield. A part of this matter is used for grain filling. That means grain yield depends of biological yield and percent of grain in biological yield, i.e. of harvest index (DONALD and HAMBLIN, 1976; BOROJEVIĆ, 1986). Grain yield also depends of vegetative organs dry matter decrease between flowering and ripening, which is a consequence of previously formed substances reutilization from vegetative organs to grain.

New cultivars productivity improvement is got in part through a greater accumulation of dry matter and nitrogen substances, and partially through a better distribution of these matters between vegetative and reproductive organs, in favour of the last ones (BOROJEVIĆ, 1986).

According to ĐOKIĆ (1986), plant dry substance accumulation and its distribution between vegetative and reproductive organs was similar to accumulation and distribution of nitrogen compounds. A weak negative correlation between grain yield and grain nitrogen content points out to a possibility of selection to simultaneous increase of grain yield and protein content.

MATERIAL AND METHODS

The trial was set in RCB design, with four replications, at the experimental field of the Center for Small Grains in Kragujevac, during 1997/98 and 1999/2000. Twenty Serbian winter wheat cultivars were used for the study. Plant samples were taken in flowering and full ripeness. Samples were split in top three leaves, spike, and the rest of plant in flowering, and in grain, grain cover (glumae), and the rest of plant in full ripeness.

Soil and weather conditions. - The soil was a browning vertisol, with the following properties: pH in H_2O 6.10-6.30, pH in KCl 4.76-4.84, humus content 2.42-2.88%, total nitrogen 0.11-0.15%, available P_2O_5 content less than 1 mg/100g of soil, and available K_2O content 10.3-11.1 mg/100g of soil. Lime is absent until 150 cm. Weather data are given in the Table 1.

Table 1. The average monthly temperature(^{o}C), relative air humidity (%), and precipitation (mm)

	year	MONTHS									Mean/ sum
		X	XI	XII	I	II	III	IV	V	VI	
Temperature	1998	8.7	6.3	3.5	3.7	5.1	3.9	13.3	15.4	21.3	9.02
	2000	11.7	5.1	2.2	-1.7	3.7	6.9	14.9	17.9	21.8	9.17
Relative air humidity	1998	73	74	80	77	69	65	65	74	69	72
	2000	74	82	81	81	73	64	63	61	54	70
Precipitation	1998	120.9	14.5	73.8	57.6	22.2	17.6	44.6	75.7	85.3	512.2
	2000	35.9	40.4	77.7	25.3	37.7	18.8	13.5	34.6	20.6	304.5

RESULTS AND DISCUSSION

The average dry mass of the all cultivars in flowering was 2.23 in 1998, and 1.70 g/plant in 2000 (Table 2). This difference was caused by the drought in the second year of the study. The highest dry substance yield for both studied years was given by Nevesinjka (2.15 g), and the lowest one by cultivars Jarebica and Prima (1.71 g).

The great difference observed between years is a consequence of drought in 2000, especially during reproductive period (Table 3). That fact is also observed by ĐOKIĆ (1986).

Grain yield was affected not only by dry substance total accumulation, but also by this accumulation ratio before and after flowering. The observed greater positive correlation between grain yield and dry substance accumulation after flowering, in regard to the period before flowering, is also given in the previous reports (ĐOKIĆ, 1986; 1989; LOFFLER *et al.* 1985, COX *et al.*, 1985). Absence of a significant correlation between grain yield and dry matter of vegetative organs in full ripeness, i.e. straw, points to an effect of vegetative organs activity duration to grain yield.

Tab. 2. Biological yield in flowering, dry matter yield, and dry matter reutilization

Cultivar	BY in flowering			DM yield			DM reutilization		
	1998	2000	mean	1998	2000	mean	1998	2000	mean
1.Pobeda	2.27	1.73	2.00	1.47	1.00	1.23	0.29	-0.12	0.08
2. NS Rana 5	2.52	1.73	2.12	1.08	1.04	1.06	0.72	-0.19	0.26
3. Evropa 90	2.19	1.57	1.88	1.64	1.10	1.37	0.20	-0.27	-0.03
4. Milica	2.27	1.98	2.12	1.51	0.49	1.00	0.23	0.24	0.23
5. Jarebica	1.86	1.56	1.71	1.59	1.43	1.51	0.17	-0.50	-0.16
6. Kremna	2.41	1.78	2.09	1.16	1.08	1.12	0.84	-0.16	0.34
7. Prima	1.86	1.56	1.71	1.20	1.27	1.23	0.36	-0.40	-0.02
8. Renesansa	2.28	1.73	2.00	1.17	1.28	1.22	0.59	-0.41	0.09
9. Tera	2.16	1.63	1.89	1.16	0.79	0.97	0.60	-0.05	0.27
10. Nevesinjka	2.40	1.91	2.15	2.44	1.03	1.73	-0.26	-0.11	-0.18
11.Takovčanka	2.45	1.68	2.06	1.09	1.40	1.24	0.47	-0.41	0.03
12. Gruža	2.33	1.67	2.00	1.43	1.29	1.36	0.83	-0.35	0.24
13. Toplica	2.20	1.76	1.98	1.65	1.74	1.69	-0.11	-0.82	-0.49
14. Bistrica	2.20	1.68	1.94	0.76	1.25	1.00	0.78	-0.37	0.22
15. KG 100	2.21	1.76	1.98	1.59	1.05	1.32	0.31	-0.18	0.06
16. Pesma	2.31	1.68	1.99	1.46	1.54	1.50	0.50	-0.50	0.00
17. Zlatka	2.30	1.79	2.04	1.25	1.07	1.16	0.49	-0.16	0.16
18. Prva	2.19	1.44	1.81	1.64	1.07	1.35	0.20	-0.29	-0.04
19. Mina	2.02	1.62	1.82	1.02	1.01	1.01	0.68	-0.20	0.24
20. Tiha	2.25	1.75	2.00	1.83	1.81	1.82	0.17	-0.67	-0.25
MEAN	2.23	1.70	1.97	1.46	1.19	1.32	0.40	-0.29	0.05
LSD 0.05	0.257			0.227			0.36		
0.01	0.352			0.311			0.49		

Grain number per spike was correlated negatively with 1000 grain mass (r= -0,345). We also found a highly significant correlation between grain number and grain yield (r=0,785).

One can see in tab. 4 that grain yield rose by increased grain number, which is in accordance with the data of FISCHER *et al.* (1977). 1000 grain mass ranged from 37g (Kremna) to 49g (Gruža) in 1988, and from 34g (Kremna) to 42g (Gruža, Toplica, and KG-100). A significant positive correlation between grain yield and 1000 grain mass was also found (r= 0,529).

The mean values of harvest index are given in tab. 3. Drought in the second year of investigation caused a small biological yield. For that reason, harvest index was much lower in the second year (31%) than in the first one (51%). Weather conditions also affected plant heigth. A lower plant heigth in the second year can be observed for the all cultivars except Kremna, Prima, and Prva. Harvest index showed a dependence of plant heigth, so it was lower in cultivars with higher plant such as Toplica and Bistrica, than in cultivars with lower plant such as KG 100 (Table 4). This is in accordance with KUMAKOV (1967).

Tab. 3. Grain harvest index, biological yield of mature plants, and grain yield per spike

Cultivar	Harvest index			BY of mature plants			Grain yield per spike		
	1998	2000	Mean	1998	2000	mean	1998	2000	mean
1.Pobeda	47	32	39	3.77	2.73	3.25	1.76	0.88	1.32
2. NS Rana 5	54	31	42	3.55	2.77	3.16	1.91	0.85	1.38
3. Evropa 90	48	31	39	3.99	2.67	3.33	1.92	0.83	1.37
4. Milica	42	29	35	3.79	2.47	3.13	1.74	0.73	1.23
5. Jarebica	52	31	41	3.43	2.99	3.21	1.78	0.93	1.35
6. Kremna	56	32	44	3.59	2.86	3.22	2.00	0.92	1.46
7. Prima	55	31	43	3.06	2.83	2.94	1.69	0.87	1.28
8. Renesansa	52	29	40	3.45	3.01	3.23	1.78	0.87	1.32
9. Tera	54	31	42	3.29	2.42	2.85	1.77	0.74	1.25
10. Nevesinjka	55	31	43	3.99	2.94	3.46	2.19	0.92	1.55
11.Takovčanka	46	32	39	3.50	3.08	3.29	1.58	0.99	1.28
12. Gruža	60	30	45	3.78	2.96	3.37	2.23	0.90	1.56
13. Toplica	52	27	39	3.87	3.54	3.70	2.02	0.96	1.49
14. Bistrica	47	30	38	3.70	2.94	3.32	1.75	0.88	1.31
15. KG 100	51	31	41	3.77	2.81	3.29	1.91	0.87	1.39
16. Pesma	52	32	42	3.76	3.22	3.49	1.96	1.04	1.50
17. Zlatka	50	32	41	3.54	2.86	3.20	1.75	0.91	1.33
18. Prva	53	31	42	3.86	2.51	3.18	2.06	0.78	1.42
19. Mina	50	31	40	3.77	2.63	3.20	1.50	0.81	1.15
20. Tiha	49	32	40	4.10	3.56	3.83	2.00	1.14	1.57
MEAN	51	31	41	3.68	2.75	3.21	1.86	0.89	1.37
	Year(A)	Cultivar(B)	AxB	Year(A)	Cultivar(B)	AxB	Year(A)	Cultivar(B)	AxB
LSD 0.05	1.317	4.828	8.220	0.166	0.611	1.040	0.074	0.273	0.466
0.01	1.746	7.025	13.633	0.221	0.888	1.725	0.099	0.398	0.773

We found a significant correlation between grain yield and harvest index, which can be seen in previous reports too (PACCAUD *et al.*, 1985; KOSTIĆ and

ĐOKIĆ, 1988). HEITHOLT (1990), PETROVIĆ *et al*. (1994), and PETROVIĆ *et al*. (1995) point out to a higher grain yield in genotypes with a higher harvest index.

In the first year of study dry substance growth ranged from 0.76g (Bistrica) to 2.44g (Nevesinjka), and in the second year from 0.49g (Milica) to 1.81g (Tiha). The highest average dry matter growth in both years was observed in cultivar Tiha (1.82g), and the lowest one in cultivar Tera (0.97g) (Table 2). As for the other parameters, dry substance growth of the most of cultivars was much lower in the second year of investigation than in the first one. Cultivars showing a higher dry substance growth in the second year can be considered as better tolerant to drought. Cultivars showing a higher dry substance growth in reproductive period showed also a higher values of grain yield.

Dry substance reutilization differed significantly between the first and the second year. In the first year it ranged from -0.26 (Nevesinjka) to 0.84 (Kremna). In the second year dry substance reutilization was negative. Correlation coefficient between dry substance reutilization and grain yield was 0.72.

Tab. 4. Number of grains per spike, 1000 grain mass, and plant heigth

Cultivar	No of grains per spike			1000 grain mass			Plant heigth		
	1998	2000	Mean	1998	2000	mean	1998	2000	mean
1.Pobeda	37	24	30	48	39	43	87	78	82
2. NS Rana 5	42	24	33	43	39	41	85	80	82
3. Evropa 90	45	25	35	43	38	40	92	80	86
4. Milica	40	24	32	43	37	40	87	78	82
5. Jarebica	40	29	34	44	38	41	85	78	81
6. Kremna	54	28	41	37	34	35	74	77	75
7. Prima	43	28	35	40	37	38	67	76	71
8. Renesansa	41	27	34	44	39	41	84	74	79
9. Tera	40	21	30	46	37	41	76	73	74
10. Nevesinjka	54	28	41	41	38	39	83	73	78
11.Takovčanka	42	26	34	38	36	37	96	79	87
12. Gruža	46	25	35	49	42	45	82	74	78
13. Toplica	41	26	33	49	42	45	90	80	85
14. Bistrica	40	21	30	43	39	41	85	80	82
15. KG 100	47	23	35	42	42	42	80	67	73
16. Pesma	52	30	41	38	37	37	82	73	77
17. Zlatka	44	25	34	40	38	39	76	75	75
18. Prva	51	22	36	41	37	39	75	76	75
19. Mina	38	27	32	40	40	40	83	75	79
20. Tiha	47	31	34	43	37	40	90	79	84
MEAN	44	26	35	43	38	40	83	76	79
	Year(A)	Cultivar(B)	AxB	Year(A)	Cultivar(B)	AxB	Year(A)	Cultivar(B)	AxB
LSD 0.05	1.744	6.395	10.888	1.012	3.711	6.317	1.568	5.748	9.786
0.01	2.314	9.304	18.057	1.342	5.399	10.477	2.079	8.363	16.230

CONCLUSION

The higher grain yield values in 1998 are a result of favorable conditions until flowering, which created a high value of 'start mass' of plants during flowering, great leaf area, and number of grains per spike. The lower mean grain yield in 2000 is obtained because of drought and high temperature during grain filling.

Grain yield increase of some cultivars was mostly caused by accumulation, and in the others by dry matter utilization, but in some cultivars both factors were equally significant.

Despite the fact that biological and economical yield, and harvest index consequently, are hereditarily determined, those parameters differ under influenced by weather and agrotechnical factors.

The best-looking crops in autumn can give a worse yield than the others. If there is a drought or high temperature in flowering and grain filling, disbalance between assimilative source and receiver could happen. Consequently, a significant part of assimilatives is spent for green mass maintenance, and is not translocated in grain.

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VARIJABILNOST POKAZATELJA AKUMULACIJE I ISKORIŠĆAVANJA SUVE MATERIJE U BILJCI PŠENICE

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Izvod

U ogledu sa 20 sorata ozime pšenice izučavani su neki pokazatelji akumulacije i iskorišćavanja suve materije u biljci i njihov uticaj na prinos zrna. Utvrđeno je da vrednosti pokazatelja (biološki prinos, žetveni indeks zrna, reutilizacija suve materije, broj zrna po klasu, masa 1000 zrna, visina biljaka i dr.) variraju u zavisnosti od genotipske specifičnosti kao i od uslova spoljne sredine. Prinos zrna nije zavisio samo od ukupne akumulacije suve materije u biljci tj. biološkog prinosa, već i od odnosa ove akumulacije u periodu do cvetanja i posle cvetanja. Na formiranje prinosa uticalo je više pokazatelja, redosled sorata po visini pojedinih pokazatelja se menjao. Najbolji prinosi su dobijeni u sorata kod kojih je veći broj pokazatelja imao povećane vrednosti. Od ispitivanih sorti najveći prosečan prinos zrna ostvarila je sorta Tiha, a sorte koje su se još istakle po prinosu su: Gruža, Nevesinjka i Toplica.

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