GENOTYPIC SPECIFICITY OF WINTER WHEAT NITROGEN ACCUMULATION ON AN ACID SOIL

Nebojša DELETIĆ, Slaviša STOJKOVIĆ, Vladan DJURIĆ, Milan BIBERDŽIĆ, Slaviša GUDŽIĆ

University of Priština, Faculty of Agriculture Kosovska Mitrovica – Zubin Potok - Lešak
Jelene Anžujske bb, 38228 Zubin Potok, Serbia,
Corresponding author: ndeletic@gmail.com

Abstract: *This paper presents the two year results of an investigation dealing with productivity, as well as genotypic specificity of nitrogen accumulation, of twenty recently developed Serbian winter wheat cultivars, on the acid soil typed as eutric vertisol. Soil pH value in water of the cultivated layer was between 5.41 and 5.83, and in KCl it was between 4.15 and 4.37. Titration acidity amounted 17.89 ccm. The following traits were studied: nitrogen accumulation in flowering, nitrogen accumulation yield, nitrogen accumulation in grain and straw, as well as the total nitrogen accumulation. There were obvious differences among cultivars regarding amount of accumulated nitrogen by flowering stage. In the first year of investigation this parameter varied from 25.70 mg in the cultivar Prima to 34.20 mg per plant in Kremna. Much lower values were observed in the second year, from 14.53 mg in the cultivar NS Rana 5 to 22.37 mg in Milica. The lowest average nitrogen accumulation yield during reproduction period amounted 3.23 mg in the cultivar Pobeda, while the lowest one was 11.78 mg in the cultivar Tiha. During the first year, the lowest value of nitrogen accumulation in straw was shown by the cultivar Gruža (5.4 mg), and the highest one by Nevesinjka (13 mg per plant). This parameter in the second year ranged from 6.0 mg in the cultivar Tera to 12.0 mg in Renesansa. During the first year the lowest nitrogen accumulation in grain was observed in the cultivar Toplica (26.3 mg), and the highest one in Gruža (42.0 mg). Those values in the second year of the study ranged from 9.8 mg (Tera) to 16.0 mg (Tiha). The lowest total nitrogen accumulation was reached by the cultivar Prima (26.45 mg), and the greatest one by Tiha (37.00 mg).*

Key words**:** *winter wheat, nitrogen, soil, acidity*

INTRODUCTION

Nitrogen fertilizers are widely used for increasing grain yield and protein content of bread wheat. However, farmers must optimize their use in order to decrease environmental risks and production costs (LE GOUIS et al., 2008). For that reason, efficiency of plant nitrogen use becomes a trait of the greatest importance in studying and breeding of all plants, so of wheat too (HIREL et al. 2007). The core of the problem is to increase nitrogen accumulation in plants not by increased amounts of nitrogen fertilizers added, but by creating genotypes with a better ability of their root system to uptake higher quantities of nitrogen from soil. On the other hand, in order to get higher values of grain yield, that process necessarily have to be followed by an increased photosynthetic intensity. If not, only higher concentration of nitrogen in grain and straw could be reached, and nitrogen utilization efficiency of plants would be significantly lowered (STOJKOVIĆ, 2001).

One can often hear a statement that over 60% of soils in Serbia are acid. According to the Report on Soils' Status published by the Ministry of Environment and Spatial Planning of the Republic of Serbia (2009), during last ten years that percent is characteristic for central Serbia, while in Vojvodina soil acidity status is incomparably better. It is stated in this report that the percent of acid soils (on the basis of 25,118 samples from 2008) in central Serbia was 52.1%, with additional 29.2% of mildly acid soils. Percent of acid soils is also high throughout the world, so there is plenty of references dealing with parameters of nitrogen metabolism on

acid soils (BEDNAREK and RESZKA, 2009), and a great effort is directed to establishment of genetic specificity of nitrogen metabolism parameters, as well as to those parameters' inheritance mode (LE GOUIS et al., 2008; HABASH et al., 2007).

This study has been aimed to investigate genetic specificity of nitrogen accumulation in twenty recently developed Serbian winter wheat cultivars on an acid soil.

MATERIAL AND METHODS

The trials were set on the soil typed as eutric vertisol, which was acid. Soil acidity of cultivated layer, measured as pH value in water, ranged between 5.41 and 5.85, while this value in KCl was between 4.15 and 4.37. Titration acidity of the soil amounted 17.89 ccm, and humus percent was from 2.13 to 2.54%. The investigation lasted two years, and twenty recently developed Serbian winter wheat cultivars were included. The following traits were studied: nitrogen accumulation during flowering stage, nitrogen accumulation yield during reproductive period, nitrogen accumulation in straw, nitrogen accumulation in grain, as well as the total nitrogen accumulation. The trials were set in random complete block design (RCBD), with four replications in each year. The obtained data were processed by analysis of variances, and statistical significance of differences among genotypes was estimated in general by F test. Statistical significance of differences between particular genotypes each other was established by comparing with the least significant differences (lsd test).

RESULTS AND DISCUSSIONS

Results of F test revealed no statistically significant differences among the investigated genotypes regarding nitrogen accumulation by the flowering stage (tab. 1). It is obvious that this parameter had much higher values in the first year of investigation. In the first year it was within range from 25.70 mg/plant in the cultivar Prima to 33.40 mg/plant in the cultivar Nevesinjka, with the average value of 30.59 mg/plant. In the second year, the lowest nitrogen accumulation by the flowering stage was observed in the cultivar NS Rana 5 (14.53 mg/plant), and the highest one in the cultivar Milica (22.37 mg/plant), while the mean value was 17.89 mg/plant. As the average for both years variation interval was from 20.57 mg/plant in the cultivar Prima to 26.48 mg/plant in the cultivar Milica.

Values of nitrogen accumulation yield (tab. 1) also were significantly higher in the first year than in the second one, and in the second year there were several negative values. Differences among genotypes were significant according to F test, and among particular genotypes each other in many cases they were greater than lsd values for both probabilities of error ($P<0.05$ or $P<0.01$). Variation interval in the first year of investigation was between 3.70 mg/plant (Takovčanka) and 15.80 mg/plant (Evropa 90), and in the second one between -4.01 mg/plant (Milica) and 8.77 mg/plant (Renesansa). As the average for both years the lowest nitrogen accumulation yield during reproductive period amounted 3.23 mg/plant in the cultivar Pobeda, and the highest one 11.78 mg/plant in the cultivar Tiha.

Unlike the other studied parameters, nitrogen accumulation in straw was pretty equal in both years of investigation (tab. 2). Differences among genotypes were significant according to F test, and particular comparisons followed the same tendency. During the first year, values of this parameter were in range from 5.60 (Tera) to 13.00 mg/plant (Nevesinjka), while in the second year they were between 6.00 (Tera) and 12.00 mg/plant (Renesansa). Mean values for both years of the study showed the variation interval from 5.80 (Tera) to 10.55 mg/plant (Nevesinjka).

Table 1

Nitrogen accumulation in flowering and NA yield in reproductive period (mg/plant)

Cultivar	Nitrogen accumulation in flowering			Nitrogen accumulation yield		
	I	II	average	I	II	average
1.Pobeda	32.70	19.20	25.95	7.80	-1.53	3.23
2. NS Rana 5	33.00	14.53	23.76	5.90	5.73	5.81
3. Evropa 90	27.20	16.17	21.68	15.80	1.12	8.46
4. Milica	30.60	22.37	26.48	13.10	-4.01	4.54
5. Jarebica	26.20	17.32	21.76	10.80	6.30	8.55
6. Kremna	34.20	17.98	26.09	9.50	2.84	6.17
7. Prima	25.70	15.44	20.57	8.40	3.36	5.88
8. Renesansa	31.90	15.74	23.82	9.00	8.77	8.88
9. Tera	29.20	16.95	23.07	8.10	-1.06	3.52
10. Nevesinjka	33.40	21.96	27.68	16.90	-2.84	7.03
11. Takovčanka	28.70	17.98	23.34	3.70	5.11	4.40
12. Gruža	32.60	19.37	25.98	14.80	3.28	9.04
13. Toplica	28.80	17.78	23.29	4.40	7.15	5.77
14. Bistrica	29.30	18.76	24.03	8.00	2.06	5.03
15. KG 100	28.30	19.01	23.65	12.00	3.05	7.52
16. Pesma	31.90	18.98	25.44	15.60	1.59	8.59
17. Zlatka	32.90	17.90	25.40	5.70	5.42	5.56
18. Prva	32.70	14.69	23.69	8.60	2.12	5.36
19. Mina	29.50	18.31	23.90	6.20	2.05	4.12
20. Tiha	33.10	17.32	25.21	15.00	8.56	11.78
Average	30.59	17.89	24.24	9.98	2.96	6.46
LSD 0.05		6.08			4.27	
LSD 0.01		8.32			5.84	

Nitrogen accumulation in grain (tab. 2) was almost three times higher in the first year of the study than in the second one. Differences among genotypes were significant according to F test, but comparisons with lsd values showed significant and highly significant differences only when comparisons were done between genotypes from the ends of the variation series. During the first year of investigation this parameter ranged from 26.50 mg/plant in the cultivar Takovčanka to 42.00 mg/plant in the cultivar Gruža, and in the second one it was from 9.80 mg/plant in the cultivar Tera to 16.00 mg/plant in the cultivar Tiha. Mean values for both years of the study showed the variation interval from 19.25 mg/plant (Prima) to 27.10 mg/plant (Tiha).

Total accumulation of nitrogen (tab. 2) in the first year of investigation was two times greater than in the second one. Differences among genotypes were significant according to F test, and comparisons with lsd values showed a similar tendency as when nitrogen accumulation in grain was considered. Values of the first year were between 32.40 (Takovčanka) and 50.30 mg/plant (Nevesinjka), and of the second one between 15.90 (Tera) and 25.90 mg/plant (Tiha). As the average for both years, values of total nitrogen accumulation were within limits from 26.45 (Prima) to 37.00 mg/plant (Tiha).

Table 2

Nitrogen accumulation in straw, in grain, as well the total NA (mg/plant)

Cultivar	NA in straw			NA in grain			total NA		
	I	II	average	I	II	average	I	II	average
1.Pobeda	8.30	7.40	7.85	32.20	10.50	21.35	40.50	17.90	29.20
2. NS Rana 5	6.30	8.40	7.35	32.60	11.80	22.20	38.90	20.30	29.60
3. Evropa 90	8.20	7.00	7.60	34.80	11.10	22.95	43.00	18.10	30.55
4. Milica	9.80	6.60	8.20	33.90	11.70	22.80	43.70	18.40	31.05
5. Jarebica	6.40	11.50	8.95	30.60	12.10	21.35	37.00	23.60	30.30
6. Kremna	6.10	7.80	6.95	37.60	13.10	25.35	43.70	20.80	32.25
7. Prima	6.60	7.80	7.20	27.50	11.00	19.25	34.10	18.80	26.45
8. Renesansa	6.60	12.00	9.30	34.30	12.50	23.40	40.90	24.50	32.70
9. Tera	5.60	6.00	5.80	31.70	9.80	20.75	37.30	15.90	26.60
10. Nevesinjka	13.00	8.10	10.55	37.30	11.00	24.15	50.30	19.10	34.70
11. Takovčanka	5.90	7.90	6.90	26.50	15.10	20.80	32.40	23.10	27.75
12. Gruža	5.40	9.10	7.25	42.00	13.60	27.80	47.40	22.60	35.00
13. Toplica	6.90	11.90	9.40	26.30	13.10	19.70	33.20	24.90	29.05
14. Bistrica	7.70	8.20	7.95	29.60	12.40	21.00	37.30	20.80	29.05
15. KG 100	7.80	8.90	8.35	32.50	13.10	22.80	40.30	22.10	31.20
16. Pesma	8.70	8.70	8.70	38.80	11.90	25.35	47.50	20.60	34.05
17. Zlatka	8.00	8.60	8.30	30.60	14.70	22.65	38.60	23.30	30.95
18. Prva	10.10	6.70	8.40	30.70	10.10	20.40	40.80	16.80	28.80
19. Mina	6.80	7.60	7.20	28.90	12.70	20.80	35.70	20.40	28.05
20. Tiha	9.90	9.90	9.90	38.20	16.00	27.10	48.10	25.90	37.00
Average	7.70	8.50	8.10	32.80	12.40	22.60	40.50	20.90	30.70
LSD 0.05 LSD 0.01		1.31 1.79			9.76 13.35			9.55 13.07	

CONCLUSIONS

On the basis of the study, dealing with genetic specificity of nitrogen accumulation in twenty recently developed Serbian winter wheat cultivars on an acid soil, we can conclude the following:

– There was not any significant difference among cultivars regarding amount of nitrogen accumulation by flowering stage. Average values for both years of this parameter varied within levels from 20.57 mg in the cultivar Prima to 26.48 mg per plant in the cultivar Milica;

– During the same period, the lowest average nitrogen accumulation yield in reproductive period amounted 3.23 mg in the cultivar Pobeda, and the highest one 11.78 mg in the cultivar Tiha;

– The smallest value of nitrogen accumulation in straw during the investigation had the cultivar Tera (5.80 mg), and the greatest one had Nevesinjka (10.55 mg per plant);

– The lowest average nitrogen accumulation in grain was given by the cultivar Prima (19.25 mg), and the highest one by Tiha (27.10 mg per plant);

– The lowest total nitrogen accumulation was observed in the cultivar Prima (26.45 mg), and the highest one in the cultivar Tiha (37.00 mg per plant).

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