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ESTIMATION OF WINTER WHEAT VARIETIES SUITABILITY FOR DIFFERENCE GROWTH OF LANDSCAPE CONDITIONS

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Abstract: Our investigations confirmed a relation between concentration of nutrient substances in plants, their loss from soil and peculiarities of relief, variety genotype and the limits of adaptability. Winter wheat is a culture by its requirements to growth conditions. Generally, north exposition of the slope made up more favourable conditions for wheat vegetation. We recommended varieties Peremoga, Odeska n/k, Albatros for growing under these conditions according to grain productivity. Varieties like Istok, Spartanka and Samarska can be grown to reach high level of grain protein content. Variability of these traits between varieties was higher under slope conditions than on flat land. Only variety Samarska was not affected in terms of protein content under every condition. At the same time, all genotypes depended on growth conditions to reach high level of grain yield. We established that wheat grains contain more microelements than straw. At the same time the lead and nickel uptake was more in the straw samples. Thus, the influence of the relief on microelements and heavy metals content in the winter wheat grain and straw is ambiguous.
Keywords: winter wheat, varieties, yield, nutrients uptake, slope conditions

1. INTRODUCTION

In the past, wheat research was more focused on improving yield of the crop, the plant breeders having ignored the importance of growth conditions (Witcombe et al, 1996; Miflin, 2000). By "conditions" we understand the relief of lands for cultivation and exposition of land slopes which determine the properties of wheat yield and the protein content of grains (Dawson et al, 2011). These two traits together actually define the overall quality of wheat whether it is good or poor (Gepts, Hancock, 2006). Grain yield in wheat is one of the most important and complex character affected directly or indirectly by gene present in plant (Bhutta et al., 2005; Rangare et al, 2010) as well as the interaction of environment (Tester, Langridge, 2010; Serpolay et al, 2011). This has been in response to the pressure for an adequate food supply caused by constantly increasing population in Ukraine and the world as a whole (Martynov, Dobrotvorskaya, 2006; Mba et al, 2012). Wheat (Triticum aestivum L.) is the world's leading cereal grain and the most important food crop, occupying top position in Ukraine's agriculture with 48% area among cereals and contributing with 38% of the total food grain production in the country (Vaschenko, Nazarenko, 2015; Nazarenko, 2015). Therefore, evaluation of new wheat cultivars with high genetic potential for yield, its components (Slafer, Andrade, 1993) and quality traits (Sperling et all, 2001) has become a permanent goal in the plant industry programs (Reif et al, 2005; Tuberosa and Salvi, 2006).

Disequilibrium in appearance of different nature-agricultural factors of a region determines discrepancy in land using. High-level of lands tillage, complicated landscape and high amount of technical cultivars lead to soil degradation. Erosion of slope soils is one of the main components of this problem (Kharytonov et all, 2016). Due to this fact we investigated cultivars demands under different types of slopes. One of the main nature factors of erosion is a land relief, resistance of soils after erosion, plants soil defending function, climate and hydrometeorology conditions. They determined balance of wet, character of winter, intensity of water erosion. Erosion soils are performed on slopes and intensity of erosion process depends on the peculiarity of slopes.

Here we reported about winter wheat variety demands to different relief conditions and problems of minerals losses which were caused by these demands.

2. MATERIAL AND METHOD

Experiments were conducted on the teaching farm of Dnipropetrovsk State Agrarian-Economic University. The farm coordinates are: 48°30'N lat. and 35°15' E long. The station is lying 245 meters above the sea level. The air temperature during wheat growing season (September/July) is 8 - 11°C; the average rainfall is about 400 - 550 mm in vegetation season respectively. The field station of Dnipropetrovsk State Agrarian-Economic University has been used for many years as an area for intensive agricultural production and research (Kharytonov et.al. 2004 Kharytonov et.al, 2009). It is located far away from the city of Dnipropetrovsk (25-30km) enough to avoid industrial pollution effect. The research field occupies an area of 14 hectares and it is crossed by three ravines.

One of them is of 30 m depth with a slope of > 7°, the other two have the slopes up to 3°. Comparison of the received information regarding the crop yield with the landscape features offers the possibility to differentiate the agricultural resource potential of the area. Studies were performed on plain (full-height normal soil), on the northern exposition slope (low eroded soil), the slope of the southern exposure (middle level of erosion). Special attention was paid to the one of the three ravines: flat terrain, slopes of the southern and the northern exposure.

Winter wheat seeds were procured form the department of breeding and seed farming of DSAEU. The recommended agronomic practices were followed. Estimation of total yield per plot and its components was conducted from 2013 to 2015. The trial was set up as a randomized block design method with three replications and with a plot size of 20 m^2 in 3 replications (Dospehov, 1985).

Normal cultural practices, including fertilization, were done whenever it was necessary. From the agrochemical investigation it resulted that soils of station have more than average fertilization and a high content of nutrition substances (not less than 30 - 40 mg/kg of nitrogen content, mostly provided by potassium, while slopes of south exposition have a low content of phosphorus). Nevertheless, slopes of south exposition contain main mineral elements two-three times less than in the case of flat lands. The nitrogen and phosphorus concentration in plant samples was estimated using Kjeldahl method. Total P concentrations of the applied residues were determined by sulphuric acid digestion (Thomas et al., 1967). Potassium was determined with flame photometry. Trace elements were determined with method of atomic absorption spectrophotometry.

Mathematical processing of the results was performed by the method of analysis of variance, the variability of the mean difference was evaluated by Student's t-test, the grouping of lines by grain productivity was performed by cluster analysis, factor analyses was conducted by module ANOVA. In all cases standard tools of the program Statistica 6.0 were used.

3. RESULTS

Regarding to data obtained (table 1 and 2) winter wheat responded to growth condition, which showed in yield and uptake of mineral elements from soil. As we can see from the previous table we obtained high grain yield on slope of north exposition, especially for varieties Peremoga, Odeska n/k, Albatros. After analyse of specificity of macro elements losses with winter wheat stems and expenditures which had been requested for obtaining 1 ton of grain we determined that uptake of main nutrient components are directly depended on grain yield. Nitrogen uptake on flat interfluves varied from 144 to 183 kg/ha, phosphorus 42-52 kg/ha, potassium 105-107 kg/ha during seven years. On the north exposition slope discrepancy in yield depended on varieties was not so clear compared to that on flat. The nitrogen losses from soil with yield were 161-176 kg/ha, phosphorus 45-63 kg/ha, potassium 123-143 kg/ha. Nutrient loses from soil with yield on south exposition slope were considerably lower: nitrogen 111-134 kg/ha, phosphorus 35-42 kg/ha, potassium 85-104 kg/ha.

From the table 1 we can see that winter wheat require a considerable quantity of nitrogen 30.1-35.8 kg. This variation is explained by biological peculiarities of variety. Bezosta 1 needed 35.6 kg of nitrogen while Spartanka 30.1 kg. On the other hand, variety Albatros, with less expenditure in nitrogen (31.5 kg), under flat conditions gave us greater yield than Bezosta 1. Losses of phosphorus for wheat growth varied from 7.9 to 10.7 kg under flat conditions. The lowest amount was necessary for variety Bezosta 1 and the higher was for Istok. The potassium uptake was 23.0-25.7 kg and there were fewer variables. Under north exposition slope conditions short-stem varieties Odeska n/k, Albatros needed the lowest kg amount in nitrogen (31.0), while the highest amount was necessary for Istok (35.1kg) and Spartanka (34.5 kg). According to requirements in phosphorus variety Istok was the first (12.6 kg) and Spartanka was the last (9.1 kg). The relation between potassium expenditure and the variety was the same as in the case of nitrogen. Demand in one was lowest for Odeska n/k and Albatros (22.7). The highest amount of nitrogen needed was 25.8-26.0 kg. Winter wheat on north exposition slope required 28.0-33.0 kg of nitrogen, 8.5-11.1 kg of phosphorus and 23.3-27.2 kg of potassium for 1 ton of grain depending on variety. Assaying average uptake of nutrient substances from soil we are able to conclude about the common influence on this parameter of both slope exposition and variety features (table 2).

Table 1. Uptake and expenditure of main nutrient elements /N, P, K/ with winter wheat stems

Variety	Yield, t/he	Uptake from soil kg/he			For 1 tonne of grain, kg		
		N	P	K	N	P	K
Flat							
Peremoga	49.0	171	52	126	34.9	10.6	25.7
Istok	47.5	148	51	119	31.2	10.7	25.1
Odeska n/k	54.4	183	50	127	33.6	9.2	23.3
Bezosta 1	42.5	152	42	105	35.8	7.9	24.7
Spartanka	48.9	147	47	125	30.1	9.6	24.4
Samarska	45.9	144	44	112	31.3	9.6	24.4
Albatros	51.4	162	50	118	31.5	9.7	23.9
Average	48.5	158	43	119	32.6	10.0	24.5
Slope of north exposition							
Peremoga	55.1	176	57	143	31.9	10.3	26.0
Istok	49.0	172	63	126	35.1	12.9	25.7
Odeska n/k	55.5	172	58	126	31.0	10.5	22.7
Bezosta 1	49.5	170	50	123	34.3	10.1	24.8
Spartanka	49.3	170	45	127	34.5	9.1	25.8
Samarska	49.8	161	52	125	32.3	10.4	25.1
Albatros	54.5	169	55	124	31.0	10.1	22.8
Average	51.8	170	54	127	32.8	10.4	24.7
Slope of south exposition							
Peremoga	40.9	134	39	104	32.7	9.5	25.4
Istok	35.6	106	37	97	29.8	10.4	27.2
Odeska n/k	36.9	122	41	86	33.1	11.1	23.3
Bezosta 1	36.5	111	34	93	51.3	8.6	26.2
Spartanka	36.1	114	37	92	31.5	10.2	25.5
Samarska	36.3	118	35	97	32.5	8.6	26.7
Albatros	42.1	118	42	103	28.0	10.0	24.5
Average	37.6	118	38	96	31.4	10.1	25.5

Table 2. Coefficient of nutrient elements utilization from soil on different types of relief, %

Variety	Flat			Slope of north exposition			Slope of south exposition		
	N	P	K	N	P	K	N	P	K
Peremoga	61.7	55.9	16.7	67.7	87.7	19.9	73.2	76.4	22.5
Istok	53.4	54.8	15.8	66.2	86.9	17.5	67.9	72.5	21.0
Odeska n/k	66.1	53.8	15.8	66.2	89.2	17.5	66.7	80.3	18.6
Bezosta 1	54.9	45.2	13.9	65.4	76.9	17.1	60.6	86.7	20.1
Spartanka	53.1	50.5	16.6	65.4	69.2	17.5	62.3	72.5	19.9
Samarska	52.0	47.3	14.8	61.9	80.0	17.4	64.5	68.6	21.0
Albatros	58.5	53.8	15.6	65.0	84.6	17.2	64.5	82.4	22.3
Average	57.1	51.6	15.8	65.4	82.1	17.7	65..6	74.2	20.8

Table 3. Uptake of microelements and heavy metals with winter wheat grains and straw under different relief conditions

Relief element	Zn		Mn		Cu		Pb		Ni		Fe	
	mg/kg	g/ha	mg/kg	g/ha	mg/kg	g/ha	mg/kg	g/ha	mg/kg	g/ha	mg/kg	g/ha
Grain												
Flat	22.2	1077	22.0	1067	3.9	189	2.0	93	3.2	155	43.0	2086
Slope of north exposition	20.5	1062	28.9	1497	4.6	238	2.0	104	1.5	78	41.5	2150
Slope of south exposition	24.3	914	23.6	887	4.1	154	2.0	75	2.5	94	31.3	1241
Valley floor	23.0	1633	26.0	1846	3.4	241	2.5	178	1.1	78	32.3	2293
Straw												
Flat interfluve	4.3	250	17.0	407	3.1	180	2.9	168	3.0	175	73.0	4248
Slope of north exposition	2.7	168	15.0	933	2.8	174	2.8	174	1.6	100	18.0	1120
Slope of south exposition	1.6	72,0	5.0	226	2.5	90	2.6	117	0.9	41	15.0	671
Valley floor	1.6	136	5.7	486	2.8	239	1.7	145	0.8	68	12.6	1074

Results of general uptake of microelements calculation are presented in tables 3 and 4. We can notice that the grain of wheat contains more microelements than the straw. At the same time, the lead and nickel uptake was higher in the straw samples. Influence of relief on microelements and heavy metals content is ambiguous.

On the other hand we have to regard downward of some microelements (Zn, Mn, Fe) in straw on the slopes and valley floor. When we determined uptake of microelements from soil with winter wheat yield we observed that meaningful quantity of iron (1918-6334 g/ha), zinc (986-17669 g/ha), manganese (1113-3430 g/ha) take out with winter wheat and wasted out of the field.
Uptake of copper was 244-479 g/ha, lead 193-323 g/ha, nickel 135-330 g/ha. Uptake of elements on the south exposition slopes were considerably less than on flat interfluves and slope of north exposition.
Grain quality of winter wheat yield depended on variety and relief (table 5). High protein content has been identified in the grains of three varieties Istok, Spartanka and Samarska. Slope of north exposition are preferable for higher protein content than flat ones.

Table 4. General uptake of microelements and heavy metals with yield under different relief conditions

Relief element	Fe g/ha	Zn g/ha	Mn g/ha	Cu g/ha	Ni g/ha	Pb g/ha
Flat interfluve	6334	1327	1474	369	330	252
Slope of north exposition	3270	1230	2430	412	178	278
Slope of south exposition	1918	986	1113	244	135	192
Hollow	3366	1789	2332	479	146	323
M	3722	1333	1837	376	197	261
Cv	50.0	25.2	35.2	26.3	45.9	21.0

Table 5. Protein content in winter wheat grains depending on variety and relief, %

Variety	Flat	Slope of north exposition	Slope of south exposition
Peremoga	16.4	14.8	15.5
Istok	14.3	16.7	15.0
Odeska n/k	15.8	14.3	15.1
Bezosta 1	16.3	15.5	15.3
Spartanka	14.8	16.2	13.7
Samarska	14.8	15.3	15.1
Albatros	15.0	14.7	14.3
M	15.2	15.4	15.0
Cv	6.7	5.6	2.5

4. CONCLUSIONS

To sum it up our investigations confirmed the relation between concentration of nutrient substances in plants, their loss from soil and peculiarities of relief, variety genotype and limits of adaptability. Winter wheat is an average culture according to its requirements of growth conditions. Generally, north exposition created more favourable conditions for wheat vegetation. We recommended varieties Peremoga, Odeska n/k, Albatros for growing under these conditions in terms of grain productivity and varieties Istok, Spartanka and Samarska in terms of grain protein content. Variability of these traits between varieties was higher under slope conditions than on flat land. Only variety Samarska didn't register changes of protein content under each condition. All genotypes depended on growth conditions by grain yield at high level.
We established that wheat grains contain more microelements than the straw. At the same time, the lead and nickel uptake was higher in the straw samples. The influence of relief on microelements and heavy metals content in the winter wheat grain and straw is ambiguous.

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