RESEARCH ARTICLE **(Open Access)**

Effect of nitrogen fertilizer level on the grain yield, some qualitative and technological indices of Triticum aestivum L.

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Abstract

Experiment was conducted to determine the effect of different nitrogen levels on five bread wheat varieties (*Triticum aestivum* L.). The experiment was laid out in randomized complete block design, having four replications, plot size of 10 m^2. N doses used were 0, 50, 100, 150 and 200 kg/ha. The grain production of each variant was analyzed for the following traits: grain yield, thousand kernels weight, test weight, protein content, wet gluten content, sedimentation (SDS), as indirect indices of the quality of bread. Results showed that increasing N fertilizer resulted in increased of all analyzed indices. Grain yield were statistically similar at doses of 150 and 200 kg N/ha. However, dose of 200 kg N/ha, significantly increased the protein, and wet gluten content. Likewise were studied and several other indices related directly with bread-making quality as alveograph indices (W and the ratio P / L). The data showed that these indices have been improved by increasing the quantity of N used, which inevitably improve bread quality.

Key words: Bread-making quality, grain yield, protein and wet gluten content, sedimentation, test and 1000 grains weight, W and the ratio P / L

1. Introduction

The protein content of wheat grains varies in broad limits from 6 up to 25%, depending on the growing conditions. Genetic variation of this trait is much smaller than that caused by the growing conditions so, it is difficult to increase it through genetic improvement process [1,2]. Terman et al. [15] noted that protein content varied more widely among locations than among varieties at the growing location [15]. Differences among cultivars tended to be greatest under optimum growth conditions On the other hand, the availability of nitrogen determines the content of protein in the grain of wheat. Using of high nitrogen doses provide the increase of productivity of wheat grain, [1,18]. Higher grain yields are usually associated with lower protein concentration [13, 1]. Protein content and protein quality have been also shown to be significant for baking quality [6]. Fredericson et al. ë] found that protein content was positively correlated with wet gluten content, farinogram dough stability and bread loaf volume [5]. Ittu [6] estimates that for improving the protein content, selection should be made for high nitrogen uptake ability until anthesis and for extension of nitrogen uptake during the grain filling period [6]. There is a strong negative relationship between grain protein content and grain yield. Breeders try to compensate this relationship by selecting combinations having both protein content and grain yield higher than the average.

Physical properties of wheat flour dough are determined by its protein components, particularly of gluten content. Reserve protein (gluten) is specific to wheat tissue. These tissues are the only places of the gluten synthesis and accumulated in relatively late, compared to the starch accumulation. The use of mineral nitrogen leads to the increase of reserve proteins Gluten is described as a very elastic material that remains after completely rinsing of starch from the dough. It is characterized by two important features, elasticity and viscosity. Bread-making characteristics depend to a large extent by the quantity and quality of gluten [7]. It consists of a group of complex proteins, gliadina and glutenina, which are insoluble in water. Changing of the ratios between protein fractions leads to change of gluten properties [7]. Gluten structure has a major impact on dough rheological properties.

Gluten quality determines the ability of the dough to absorb CO_2 during fermentation in order to provide the volume of bread and not crumbling [12,17].

The high doses of N treatments increase the ratio of subunits with high and low molecular weight. The volume of bread, water absorption ability and the quality of bread are improved with increasing quantities of nitrogen used during vegetation [9,14]. According to Lopez and Bellindo nitrogen fertilization

has a greater effect on wheat quality and commercial parameters than in its yield [10]. Studies conducted in Italy [3], showed that to achieve high content of protein and to optimize the bread making qualities is required high levels of nitrogen fertilizer (200 kg / ha), when to ensure high yields the sufficient doses are up to 100 kg / ha. However, very high protein content (above 17%,) sometimes is associated with deterioration of bread making qualities [15,16]. Also, Bushuk et al. (1978), studying the impact of protein content in wheat flour (in levels from 9.3 - 16.4%), found that with the increase of its level in flour, especially in samples of flour over 16% protein, bread volume decreased [4].

2. Materials and method

Five soft wheat cultivars, Dajti, LVS, Progres, David x Mec, and Bilancia were grown at ATTC of Lushnja. Cultivars differ in terms of biological characteristics, productive and technological qualities. The experiment was laid out in randomized complete block design with four replications. The original plot size was 5 m long and 2 m wide. An area of 6 m^2 was harvested The treatments, included nitrogen at four levels (0, 50; 100; 150; and 200 kg N ha^{-1} N fertilization) was applied in different stages of wheat development (at stage of three leaves 20% , at tillering 25%, at joint 30% , and on advanced stage of joint or about two weeks before the heading 25%).

The main features analyzed were: yield, 1000 grains weight, hectolitre weight, grain protein content, wet gluten content in grain, sedimentation (SDS) as indirect indicators and alveograph indicators (W, P, L and P / L), as a direct indicator of bread making qualities of wheat flour. N content of wheat grain and flour was determined by the improved Kjeldahl method. Percent protein determined by multiplying N in the wheat grain and flour by the factor 5.7. Moisture, test weight, and experimental milling were determined by standard procedures. Wet gluten was determinate by washing the dough with a buffered solution of sodium chloride

To evaluate the bread-making quality of the different cultivars, grain samples from each plot were individually milled with an experimental mill. Flour quality was evaluated in terms of gluten strength (W) and the ratio between resistance (P) and extensibility (L) of dough as deter-mined after ICC method using the Chopin alveograph

The data collected were subjected to variance analysis. Mean comparison was done by 1 % and 5% probability level

3. Results and discussions

Crop yield is a complex character depending upon a large number of environmental, morphological and physiological characters. In present study, yield were significantly affected by nitrogen level. In our investigation (Table 1) increased N dose, increase significantly the yield of the five cultivars. This yield was significant for N50, N100 and N150. Grain yield were statistically similar at doses of 150 kg N/ha and 200 kg N/ha. However, dose of 200 kg N/ha, significantly increased the protein content, compared to dose of 150 Kg N/ha. Among the cultivars, Dajti had the highest grain yield, followed by Bilancia, Progress, LVS and David x Mec. Undoubtedly increase the level of N, affect the main yield components, as the number of productive tillers, number of grains per spike etc, ensuring their positive impact on increasing of grain yield [8,9,10]

Table 1 Effect of different N doses on grain yield

Level of N	*Yield kv/ha*					***Mean according to N doses***
	Dajti	LVS	Progres	Davxmec	Bilancia	
N0	36.4	32.1	33.5	33.1	32.6	**33.5c**
N50	42.3	39.5	39.2	37.4	40.3	**40.0b**
N100	61.7	49.1	50.6	48.6	60.8	**54.1ab**
N150	65.3	54.0	54.3	48.2	60.9	**56.5a**
N 200	63.4	54.5	55.7	45.8	60.9	**56.0a**
Mean q/ha	53.8a	45.8b	46.7b	42.1c	51.1a	
LSD 0.05			3.4			
LSD 0.01			4.1			

The test weight of wheat grain depends on the grain size, shape and density. Results obtained in some studies unambiguously show that the effects of certain cropping practices and climatic factors were not identical in different varieties [11,13].The our data (Table 2) showed that the value of test weight varies, depending on the cultivars and N doses used, indicating that this trait is genetically controlled, but it

is influenced by cultivation practice also. The smallest changes in the test weight occurred over nitrogen fertilizer rates The nitrogen rate of 50 and 100 kg nitrogen per hectare increased the test weight (84.3 kg) in the variety David xMec and later the test weight gradually decreased up to 150 kg nitrogen per hectare (84.0 kg). According to results of this study, large differences in test weight existed among the stated varieties.The highest value of test weight was observed in David x Mec cultivar, while the lowest value in Progres. Industry standards requirements, for test weight of soft wheat are over 76 kg / hl. So, increasing amount of N used increases test weight, starting at 50 kg / ha N until to 100 kg/ha N. Further increasing of N doses used, didn't influence on further increasing of this trait, even in some cases noted a tendency of it reducing.

Grain mass depends on the date of sowing and harvest, quantity of nitrogen fertilizer, conditions for wheat growing, density of sowing, climate etc. An effective translocation of assimilative from leaves and straw into grain is especially important for obtaining the mass of 1,000 grains, and there is an genetic difference between wheat varieties The results of our study indicated a slight significant increase of 1000 weight grain until at doses up to 50 kg / ha N, while the further increase of N amount influenced negatively on this trait, leading in its decrease of all cultivars. This trend has been reported in other studies, by many authors above mentioned. According of Table 2, Dajti cultivar had a 1000 grains weight 42.1 g (N_0), reaches highest value of 42.6 g (N_{50}) and finally sits on 42.2, 41.1 g, respectively at N_{150} and N_{200} kg/ha. Such a thing is observed to the other cultivars. Studies of some authors, has proved that the mass of grains per spike, the mass of 1,000 grains and the number of grains per spike were the most important components of yield, and that they could be used as a selection criteria to increase the wheat grain yield.

Table 2. The impact of different doses of N on the test weight and 1000 grain mass

Level of N	*Test weight*					*1000 grain mass*				
	Dajti	LVS	Progres	Davxmec	Bilancia	Dajti	LVS	Progres	Dxm	Bilancia
N0	81.8	83,2	80.7	83.3	82.2	42.1	46.6	43.0	39.7	41.5
N50	83.0	83.9	81.6	84.3	83.2	42.6	47.4	43.7	39.4	41.8
N100	82.8	84.2	81.8	84.3	83.2	42.2	46.3	42.4	39.4	41.7
N150	82.7	84.1	81.7	84.0	83.1	42.2	46.5	42.9	38.7	41.8
N200	83.0	83.9	81.3	84.1	83.1	42.1	46.1	42.7	38.7	40.6
Mean	82.7	81.9	81.4	84.0	82.9	42.2	46.6	42.9	39.2	41.7
LSD 0.05	**0.99**					N.S.				

The data regarding the **grain protein** content (Table 3) show that there were significant differences in the quality of five wheat cultivars tested. The amount of nitrogen also significantly affected the quality of grain protein. Interaction among the five cultivars and five nitrogen doses was found to be significant. Evidently protein content increased as amount of nitrogen was increased from the control level to 200 kg/ha. Maximum grain protein content (15.1%) was noted at the highest dose of 200 kg/ha in cultivar David x Mec. The minimum grain protein content (9.6%) was recorded in the control (N0) for Dajti cultivar. The ratio of proteins has an effect on the quality of the flour for different end uses [17], so it is possible that increased N application rates will affect cultivars differently for baking quality. The grain protein content of the five wheat cultivars averaged over doses of nitrogen showed that grains of David xMec contained maximum grain protein content (14.0%) followed by LVS (13.3%) and Bilancia (12.7%). Dajti (12.5%). Progres produced the lowest grain protein content (12.1%). Positive responses to increasing nitrogen have been associated with increase in grain protein content. David xMec proved to be the best in protein content which might be due to its better genetic response to the applied nitrogen. This was confirmed by Banziger et al.[1], who reported that genotypic variability in grain protein content may be affected not only by physiological traits but also by N supply in the soil.

Wet gluten content have shown similar tendency as sedimentation value. Both of these quality components directly depend by grain protein content, especially by storage protein components. Gliadins and glutenins are the main components of storage proteins and have a positive influence on gluten quality. In our study the minimal and maximal values were 18.5 to 30.4 % in different cultivars and at different levels of N fertilizer used.

In general, as nitrogen increased the wet gluten content also increased in all cultivars. Wet gluten content was the highest in N150 and N200 variants

(respectively 27.6 and 27.9%) in average for all cultivars , and the lowest in N0 variant (20.5%). Among cultivars, David x Mec produced highest wet gluten values (30.4%), and Progres lowest value (23.6%)

Table 3. The impact of different N doses on the protein content

N doses	*Protein content (%)*				
	Dajti	**LVS**	**Progres**	**David x mec**	**Bilancia**
N0	9.6	11.4	10.6	12.3	11.1
N50	12.7	12.9	11.7	13.5	12.3
N100	13.1	13.8	12.5	14.2	12.8
N150	13.6	14.2	12.6	14.9	13.4
N200	13.5	14.4	13.0	15.1	13.1
Mes	**12.5**	**13.3**	**12.1**	**14.0**	**12.7**
LSD 0.05			**0.58**		

Table 4. The impact of different N doses on the wet gluten content

N doses	*Wet gluten %*					
	Dajti	LVS	Progres	Dxm	Bilancia	Mean values according to N
N0	19.2	21.4	18.5	23.1	20.3	20.5
N50	22,3	25.3	22.1	26.7	23.6	24.0
N100	24.2	27.5	24.4	28.6	24.8	25.9
N150	26.8	28.9	26.7	29.9	25.7	27.6
N200	27.0	29.6	26.3	30.4	26.3	27.9
Mean	23.9	26.3	23.6	27.8	24.1	
LSD 0.05	**3.2**					

Sedimentation In this study, the sedimentation value was determined as one of important parameters for bread-making quality. Well known that Zeleny sedimentation value is important quality component because it is in significantly positive correlation with bread volume and quality ([10, 17].In this study, sedimentation value depends significantly to genotype and highly influenced by agro ecological factors and plant nitrogen nutrition (Table 5). In this investigation, the highest sedimentation value was established in N150 and N200 variant for five investigated cultivars. Sedimentation value was increasing with nitrogen increasing from N0 to N200 variants at five cultivars. Cultivar David xMec (51.8 ml) have shown higher mean sedimentation values than other cultivars in all investigated variants of N application. The sedimentation value varied from 27 ml (Progres in N0 variant) to 61 ml (David xMec in N150 and N200 variants). These results are in accordance with the results, which are published by Tohver et al [15].

Table 5. The impact of different N doses on the SDS values

Level of N	*SDS*				
	Dajti	LVS	Progres	Davxmec	Bilancia
N0	34	32	27	36	31
N50	42	38	34	47	36
N100	46	49	42	54	47
N150	52	56	49	61	52
N200	51	56	51	61	54
Mean	45	46.2	36.6	51.8	44
LSD 0.05			**4.78**		

The rheological characteristics of a dough are expressed as the resistance of the dough to stretching and its extensibility until it begins to rupture. In this study, the observed non-significant difference in rheological properties due to increasing application of nitrogen fertilizer could suggest that the traits are affected more by genotype rather than by environment in which varieties are grown. In our study, the W values of dough improved gradually when the applied fertilizer dose increased, but a higher dose of N also improve the values of L, but not P, which leads to a better ratio P / L (Table 6). Such a positive effect of N, on the L value is also observed by other authors [10. 2]. This refers to the reduction of N losses, due to

its split application (four times) and translocation of stored pre-anthesis assimilates to the grain.

Table 6. The impact of different N doses on alveograph properties

N level	*Alveograph W*					*P/L ratio*				
	Dajti	LVS	Progres	Davxmec	Bilancia	Dajti	LVS	Progres	Davxmec	Bilancia
N0	147	154	140	164	154	2.1	2.21	2.18	1.98	1.99
N50	158	168	152	181	173	1.97	1.96	2.06	1.91	1.95
N100	176	195	169	197	186	1.97	1.92	1.95	1.85	1.88
N150	186	201	183	208	199	1.83	1.87	1.92	1.76	1.85
N200	190	198	182	212	204	1.84	1.87	1.88	1.75	1.86
Mean	171.2	183.2	165.2	192.4	183.2	1.94	1.98	2.0	1.85	1.9

4. Conclusions

Nitrogen is an important constituent of plant and is the most frequently deficient element. Demand for nitrogen is the greatest during periods growth and declines towards maturity. The investigation proved that the quantity of nitrogen fertilizers had considerable effect mainly on the grain yield, and less effect on the other analyzed traits. However, increasing nitrogen rates from 0-200 kg/ha increased the grain yield, test weight, thousand grain weight, protein and wet gluten content, sedimentation value. Also, increasing doses of N increased gradually W values, but reduces the P / L ratio, which results in better bread making qualities.

5. References

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