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Analysis of Morphological Trait and Yield Components of Mutant Wheat under Different Levels of Nitrogen

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Abstract: In order to evaluate the reaction of yield and yield components of wheat's mutant lines to different levels of nitrogen in the crop year of 2006-2007, an experiment was conducted as factorial based on completely randomized block design in 4 replicates in the Research Farm of Agricultural, Medical and Industrial Research School in Zaferaniyeh-Karaj-Iran the first factor included 5 genotypes of wheat (Tabasi-the maternal entity, T-65-7-1, T-65-5-1, T-6-67-60, T-65-58-8) and the second factor consisted of 4 levels of nitrogen (100, 140, 180 and 220 kg ha^{-1} urea 46%). The result showed that grain's yield harvest index, number of grain/spike in mutant lines and their parent had significant difference ($p<0.01$) in mutant genotypes, meanwhile, the biological yield and the number of spike m^{-2} were not significant difference ($p<0.05$). The harvest index, number of grains per spike, grain's yield, biologic yield and number of spikes m^{-2}, weight of 1000 grains didn't affected by applying different levels of nitrogen fertilizer.

Key words: Wheat, genotype, nitrogen, yield, yield components

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the strategic products of the country which provides about 50% of the needed calories of the people. Indeed, wheat is the first native agricultural plant that has been discovered by the Man. This plant is cultivated in different parts of the world and more than 22% of the agricultural lands under cultivation of grains cereals are utilized for wheat cultivation. Due to uncontrolled growth of the world's population, particularly in developing countries, maintaining the food supply has become one of the major issues across the globe and the international organizations such as Food and Agriculture Organization (FAO) and the International Atomic Energy Agency (IAEA) have shown a special interest in using nuclear energy to address the agricultural problems.

Likewise in many other parts of the world, wheat has become one of the major cultivated crops (Jorbruksverket, 2004). It has the largest production volume and a wider food application compared to the other cereals (Jorbruksverket, 2004).

In Iran, the agricultural technology, common to the well-developed agricultural countries is available in very limited capacity. Therefore, to address the agricultural issues, domestic research in genetics and mutation are needed to develop a better crop race. Particularly during the last four decades, the application of nuclear techniques to increase the quantity of the agricultural products and to enhance their quality, especially in relation with breeding mutation has become the main goal of the researchers. To examine this statement, we should point out the establishment of more than 1000 varieties of mutants since the application of this technique (Majd and Ardakani, 2003; Gaul, 1966; Guangzu, 1989).

Breeding mutation includes the activities that create a better race through mutation of genetic varieties in structure or character of the plants. The result of these mutations should preserve the desirable characters of parent plant, while significantly improving the characters that needed to be enhanced. Such improvements can be used to create a new variety of the grain. If during the improvement of a special character, one or some of the desirable characters of the parent are adversely affected,

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then we use those as a germ plasma source for the improvement of the race of the grains in future plans. In the agricultural management sector the correct and in time application of chemical fertilizers, especially nitrogen fertilizers, have a more effective role than other factors on the quality and quantity of wheat grain.

The deficiency in this element, causes a decrease in yield, as well as a decrease in protein content of the wheat, Furthermore, it causes a delay in maturity along with an increase in growth, a decrease in resistance to cold weather and development of diseases (Gale, 1986; Heyne, 1984). The application of nitrogen fertilizers in early stages of growth increases the yield and has a smaller impact on the percentage of grain's protein Altman *et al.* (1983). In some instances it has had negative effect on protein content of the grains (Kubba and Ibrahim, 1989). Therefore, the suitable application of nitrogen fertilizers for increasing the product and efficiency are of recent controversies.

The number of spikes m^{-2}, the number of grains per spike and the weight of 1000 grains are important parameters to determine the yield of wheat grains, that under the influence of environmental elements and agricultural management such as amount and the approach time to nitrogen and plant (bush variety) density can cause changes in the grain's yield of wheat (Imam, 2003; Khalaj *et al.*, 2001). It is possible that the yield components undergo changes with the changes of nitrogen and varieties along with the changes of variety and speed of growth and development of bushes, undergo changes and even among them, there also will be a tendency for mutual amends (Emam and Niknejad, 1995; Merhrvar, 2004; Noor Mohammadi *et al.*, 2001; Ayoub *et al.*, 1994).

Based on most of the reports except a few exceptional cases, the increase in the amount of nitrogen up to 200 kg ha^{-1} (e.g., pure nitrogen causes an increase in the number of spikes during the harvest). The effect of nitrogen on the number of grains in a spike is usually positive, however, it has a smaller effect compared to the effect of nitrogen on the spikes m^{-2}. From statistical point of view, in some of the cases, it is significant and in other cases it had some negative effects. The results of the different experiments have shown that with respect to environmental and climatic conditions, it is possible that, the weight of 1000 grains increases decreases or stays the same (Emam and Niknejad, 1995; Ayoub *et al.*, 1994; Noor Mohammadi *et al.*, 2001).

On the basis of final result, we see the priority of the mutant lines resulted from Tabasi variety to maternal parent, in which the mutant lines have better quality in most of the characteristics. The mutant line had the maximum grains yield because of lower degree of lodging, although among the number of spikes m^{-2}, the maximum number of grains per spike and the weight of grains in one spike they had the maximum yield of grains and the mutant line T-65-7-1 also had the highest harvest index.

The Tabasi variety has small grains and heavy, also the lowest number of grains per spike and lowest number of grains per spike and the lowest number of grains m^{-2}, therefore, due to shortage of sinkage, more photosynthetic material has reached to each grain and because of that the weight of 1000 grain to the hectoliter weight was high.

MATERIALS AND METHODS

This study has been done in 2006-2007 in the research farm of the Nuclear Research Center of Agriculture and Medicine, AEQI (NRCAM) of Iran in Zafaranieh district of KARAJ at the elevation of 1300 above the sea level at 35 51' of Northern latitude and 51 6' Eastern longitude and the goal of study was to show the effects of nitrogen on yield and yield components of mutant lines of wheat caused by nuclear techniques, which soil, like climate and water is one of the most changeable parameters in agricultural production. In this experiment one of the factors is nitrogen fertilizer therefore before the experiment, we took ten random soil samples from the depth of 0-15 cm and 15-30 cm and finally we prepared four compound samples that is 2 samples from each depth and we sent them to the laboratory of Tehran's institute of soil and water for analyzing, because we wanted to study the situation of productivity and limitation factors in the soil for cultivation of wheat.

In the laboratory, the soil was dried in free air condition and then they were crushed and grinded and were passed through 2 mm sieve Then according to the international and standard method which is used in Tehran's institute of soil and water and with the help of super developed equipments (atomic absorption), the micro elements and the main elements of the soil and total nitrogen which are very important for the plants were measured.

After the analysis of the soil in the laboratory, the physical and chemical properties of the analyzed soil have been provided in Table 1.

The experimental plan used was factorial and in the form of complete random blocks with 4 replicates in which the first f actor included five genotypes of wheat (Tabasi the maternal entity, T-65-7-1, T-65-5-1, T-6-67-60, T-65-58-8) and the second factor consisted of four levels of nitrogen (100, 140, 180 and 220 kg ha^{-1} urea 46%) the mutant lines of wheat have been resulted from radiation of Gamma rays to the Tabasi wheat variety, that have been

Table 1: physicochemical characteristics of trial field soil before planting

Item	Depth (cm)	Texture	Percent of saturation	EC dS m^{-1}	pH	TNV ---------- (%)------------	Organic carbol	N ---------------(ppm) ------------	P (AVA)	K (AVA)	FE -------------------mg kg^{-1}------	ZN	CU	MN
1	0-15	CL	47	1.57	7.9	16.5	1.05	0.095	21	310	3.4	0.80	2.2	18
2	15-30	CL	47	1.15			1.04	0.093	22	320	4.6	0.74	2.2	18
Normal	Comparison	Loamy sandy	-	<6	6.5-7.5	5-10	1-2	>0.2	10-15	30-350	4-4.2	1-2	0.8-1	5-8

stabilized after five years of selection in the agricultural section of the Atomic Energy Organization of Iran. The land used in experiment was in a fallow state for one agricultural year before we start our experiment. For preparation of the land and planting bed, the land was first tillage, then for leveling of the land we used disc and leveler twice. The dimension of each experimental plot was 5 m by 2 m. Each plot had four rows of culture and the width of furrow bank was 50 cm. To avoid any marginal affects two rows were left uncultured. After the tillage operation of the soil, with respect to the amount of needed seed for each plot the seeding operation was done on Nov. 10th, 2006 on distinct rows manually; then, the watering of the experimental farm was performed. The fertilization treatments were done in 3 steps, 1/4 during culture (i.e., top dress) 2/4 at the end of tillering and first stage of stem elongation and finally 1/4 of fertilizer was used at the end stage of booting. To determine the ultimate yield, after omitting ½ m from each side of a cultured line, the culture from the 2 interior lines was done and different quantitative and qualitative characters were measured. Here we discuss some of the important findings. Experimental data was analyzed in SAS and MSTAT-C software, then the comparison of averages of each character with the help of Duncan range test in a probable surface area of 5% were made.

Which the nitrogen content in the soil is not stable and due to washing of soil with water nitrogen goes away from soil and its content in the soil is reduced rapidly and its shortage is always felt.

In the soil of this farm the total amount of nitrogen has been reported as trace and its shortage is highly felt. While one of the important factors used in this experiment was nitrogen, this important element was added to the soil as fertilizer.

RESULTS AND DISCUSSION

Grain's yield (Economical): According to our variance analysis, the effect of genotype on the grain's yield was significant ($p<1\%$).The comparison of average values showed that, the mutant lines: T-65-58-8, T- 66- 67-60 and T-65-7-1 were jointly placed in the first group A (Table 2), had the maximum grain's yield. In these mutant lines, due to their lower height in comparison to the Tabasi variety (i.e., their maternal parent), they had lower lodging hence there was no negative effect on the yield of the grains. Although, among the genotypes there were not significant differences in terms of the weight of 1000 grains. However, due to the existence of high number of spikes m^{-2} and the maximum number of grains per spike in the mentioned mutant lines the maximum yields were observed in these lines and the mutant line T-65-5-1 and the Tabasi variety were jointly placed in the second group. On the other hand the effect of different levels of nitrogen on the grain's yield was not significant. Nevertheless, the fertilizer level of 180 kg ha^{-1} urea 46% had a better yield with respect to the other levels of nitrogen. An increase in nitrogen fertilizer from 180 kg ha^{-1} urea 46% to 220 kg ha^{-1} urea 46%, caused the number of grains in a spike to decrease and as a result the grain's yield was decreased. Based on the results of the variance analysis, the reciprocal effects of genotype and fertilizer, were not significant, but the comparison of averages to those in Duncan's method indicates that the mutation line T-65-58-8 with the fertilizer level of 180 kg ha^{-1} urea 46%, had the highest grain's yield and the mutation with the fertilizer level of 100 kg ha^{-1} Urea 46% had the lowest grain's yield.

Camberato *et al.* (1996), Campbell *et al.* (1993) and Zebarth and Sheard (1992) mentioned that the increase in yield along with high levels of nitrogen relates to the increase of number of grains m^{-2} (i.e., number of spikes m^{-2} and the number of grain/spike) because of the increase in the levels of nitrogen fertilizer, there will be a linear increase of the yield. Also, the analysis of the coefficient of correlation of grain's yield with Harvest Index and biologic yield had revealed a positive correlation which was significant (i.e., $p<1\%$) it also has had a positive correlation with the weight of grains $spike^{-1}$ and it was significant ($p<0.05$). It also, has had positive correlation with the number of Grains in one spike but it were not statistically significant. These findings confirm by the Ayoub *et al.* (1994), Day *et al.* (1978), Fischer (1993) and Musick *et al.* (1994).

Biologic yield: On the basis of results from the variance analysis and the comparison of averages, statistically,there is not significant differences between genotype and different levels of nitrogen, and the reciprocal effect of fertilizer and genotype was not seen but with respect to the results, the increase of biologic yield in the fertilizer level of 220 kg ha^{-1} urea 46% is because of that most of the consumed nitrogen has been

Table 2: Means comparison of Yield and Yield Components affected by cultivar and fertilization in Mu-tant Lines of Tabasi

Treatments	Grain yield	Biologic yield	Harvest index	No. of spike m^{-2}	No. of grains in spike	wt. of 1000 grains
Cultivar						
Tabasi	4/6219^{b}	17/9063^{a}	26/044^{b}	653/30^{a}	37/944^{b}	44/85^{a}
T-65-7-1	5/2828^{a}	17/5000^{a}	30/369^{a}	556/41^{a}	48/625^{a}	43/53^{a}
T-65-5-1	4/7734^{b}	17/2813^{a}	27/769^{b}	559/34^{a}	48/650^{a}	42/81^{a}
T-66-67-60	5/3375^{a}	17/4063^{a}	30/844^{a}	623/10^{a}	46/635^{a}	43/60^{a}
T-65-58-8	5/6891^{a}	18/45319^{a}	30/956^{a}	585/39^{a}	51/581^{a}	41/55^{a}
Fertilizer						
N100	5/0850^{a}	17/7750^{a}	28/720^{ab}	626/47^{a}	45/645^{a}	41/630^{a}
N140	4/8825^{a}	17/7125^{a}	27/695^{b}	608/31^{a}	45/785^{a}	42/00^{a}
N180	5/3088^{a}	17/4625^{a}	30/545^{a}	543/80^{a}	47/663^{a}	44/44^{a}
N220	5/2875^{a}	17/8875^{a}	29/825^{ab}	603/46^{a}	47/665^{a}	44/91^{a}
Significance						
Cultivar (C)	**	n.s	**	**	**	n.s
Fertilizer (F)	n.s	n.s	n.s	n.s	n.s	n.s
C.F	n.s.	n.s	n.s	n.s	n.s	n.s
CV (%)	12.70156	12.00623	11.75687	20.84409	16.89848	12.20610

The maean with same letter(s) have no significant deference at $p \leq 1\%$, n.s: Not significant

used for the increase in the growth of the plant and had lesser effect in the natal growth in such a way that had the lower number of spikes m^{-2}. Alcoz and Hons (1993), Camberato and Back (1996), Fischer (1993) and Zebarth and Sheard (1992) have done a lot of researches in this field.

They also announced: the increase in biologic yield due to consumption of fertilizer is the result of positive effect of nitrogen on the growth which caused the increase in tiller and its remaining and increase in the height of the plant, also the increase of the diameter of the main stem and increase in the grain's yield. The result of correlation coefficient of biologic yield with the grain's yield had a positive correlation and were significant ($p<1\%$).

Harvest index: On the basis of results from variance analysis between the effect of genotypes on the harvest index was significant ($p<1\%$). As it was a seen in the grain's yield in the harvest index also with respect to the comparison of averages with Duncan method, mutant lines: T-65-58-8, T-66-67-60 and T-65-7-1 with the maximum harvest index were placed in group A and the mutant line : T-65-5-1 and Tabasi variety with the lowest harvest index were placed in the last group B. The effect of fertilizer (different levels of nitrogen) on the harvest index, with respect to the result of variance analysis, was not significant. But the comparison of averages showed that the fertilizer level of 180 kg ha^{-1} urea 46% with respect to the grain's yield had the highest harvest index and placed in the first group A and the fertilizer level of 220 kg ha^{-1} urea 46% and 100 kg ha^{-1} urea 46% jointly, were placed in group A and B and the fertilizer level of 140 kg ha^{-1} Urea 46% was alone placed in the last group B (Table 2). As it was seen, the effect of different levels of nitrogen on harvest index were not significant, but with increase of the nitrogen was a little decrease in the harvest index which probably this was due to more effect of nitrogen to the increase of plant's growth and small decrease of harvest index in fertilizer level of 220 kg ha^{-1} which have been confirmed in many other researches and also the reciprocal effect of fertilizer and genotype on the basis of result of variance analysis were not significant statistically, but the comparison of Duncan average shows that the mutant line T-65-58-8, with the fertilizer level of 180 kg ha^{-1} urea 46% in the first group A had the highest harvest index.

The result of correlation coefficient showed that the harvest index with the biologic yield was significant and negative correlation ($p<1\%$) and have positive correlation and significant with grain's yield and with the weight of 1000 grains and the number of grains per spike had positive correlation and was significant ($p<5\%$) and with the number spike m^{-2} had negative correlation and was significant ($p<1\%$).

The number of spikes m^{-2}: On the basis of variance analysis the effect of genotype and different levels of nitrogen fertilizer and reciprocal effect of fertilizer and genotype were not significant, but the results showed that the Tabasi variety had the highest number of spikes m^{-2} of course with highest height of the main stem and length of spike was small, with the minimum grain's yield and this is the main reason for the lodging of this variety, but in other mutant lines, in comparison with Tabasi variety in spite of lower number of spikes m^{-2} they had more grains/spike, therefore, the grain's yield in these mutant lines has been more than Tabasi variety. The effect of different levels of nitrogen fertilizer and reciprocal effect between fertilizer and genotype to the number of spikes m^{-2} were not significant on the basis of the variance analysis.

Ayoub *et al.* (1994), Campbell *et al.* (1993) and Mossedaq and Smith (1994) said that the use of high levels of nitrogen has positive effect on the number of spikes m^{-2} but the result of this experiment were not significant. the correlation coefficients showed that, there was a negative correlation between the number of spikes m^{-2} with the harvest index. And it was significant ($p<1\%$) and the number of grains m^{-2}, number of spikes per bush percentage of fertile tillers was significant ($p<1\%$).

The number of grains in spike: On the basis of result of variance analysis, the effect of genotype to the number of grains in spike was significant ($p<1$ %). In such a way that all the mutant lines placed in group A and the Tabasi variety alone placed in the second group B (Table 2) and although, the Tabasi variety had the maximum number of spikes m^{-2} but due to severe lodging and the short length of the spikes had the minimum number of grains $spike^{-1}$, this indicates that with the increases of number of grains in spike in mutant line in comparison to Tabasi variety the grain's yield increases in mutant lines and one of the created priorities of mutant lines is the character of number of grains in spike, which is of most important component of the yield and the number of grains/spike has a direct relation with grain's yield, which Samboomnarman *et al.* (1988) agreed with this relation. The effect of different levels of nitrogen fertilizer and the reciprocal effect of fertilizer and genotype and the number of grains in spike was not significant. The comparison of averages in reciprocal effects of fertilizer and genotype showed that the mutant line T-65-7-1 with the fertilizer level of 100 kg ha^{-1} urea 46% had the maximum number of grains in spike and reason for that is the short length of stem and long length of spike and the Tabasi variety with the fertilizer level of 100 kg ha^{-1} urea 46% had the minimum number of grains in spike, which the short length of spike and the long length of stem was the reason in this variety. Arzani (1999) said that studies on growth of spikes has shown that the increase of consumable nitrogen accompanied by the speed of formation of spikelet, improvement of their fertility and excess the number of grain in spike let and the length of spike and the effect of nitrogen on the length of the period of formation of spikelet. With respect to the comparison of the number of grains in spike and the length of spike, we can find that, the reason for increasing the number of grains in spike in the research, has been due to the increase of numbers of grains in spikelet (because of improvement in the fertility of floret and the effect of increase in the number of spikelet in spike is negligible. the increase in the number of grains in spike due to the increase in consumption of nitrogen have been reported by Ezat Ahmadi *et al.* (1998), Ayoub *et al.* (1994), Fischer *et al.* (1993), Mascangi and Sabbe (1991), Wahhab and Hussein (1957) and Boquet and Johnson (1987) meanwhile, the reason for small decrease in the number of grains in spike in high levels of nitrogen fertilizer (2209 kg ha^{-1} urea 46%) could be, due to consumption of extra nitrogen for the plant's growth and increase of the stem length in which the plant in this case is like grass of course it might also possible that, when the plant has access to extra nitrogen the consumption of this extra nitrogen fertilizer can cause disorders in the plant, and these disorders can have negative effect on the improvement and increase of length of spike and the number of grains in the spike at the fertility phase the result of correlation coefficient showed that there was a positive correlation which was significant ($p<5\%$) and with the length of spike and number of the spikes in unit area, and the weight of grains in spike, it had positive correlation and was significant ($p<1\%$).All the sources have mentioned the positive correlation between the number of grains in spike and the grain's yield (Aminpour *et al.*, 2000; Zillmann *et al.*, 2006). In this experiment also the positive correlation between the number of grains in spike and the grain's yield was seen, but it was not significant.

Weight of 1000 grains: The result of variance analysis indicates that, the effect of genotype and fertilizer, and also the reciprocal effect of fertilizer and genotype on the weight of 1000 grains were not significant. with respect to the comparison of the averages the Tabasi variety with the lowest number of grains in spike, had the maximum weight of 1000 grains and the mutant line T-65-58-8, with the maximum grain's yield and high number of grain's spike, had the lowest weight of 1000 grains. the result of experiments shows, in high levels of nitrogen, the weight of 1000 grains and the weight of hectoliter have had increased, and the reason for that, is the filled ness(solid) of grains due to consumption of high levels of nitrogen. The reciprocal effect between genotype and fertilizer on the weight of 1000 grain was not significant, but the comparison of averages shows that, the mutant line T-65-58-8, along with the nitrogen fertilizer level of 100 kg ha^{-1} urea 46% had the lowest weight of 1000 grains. Also, with a little study about the number of grains in unit area and the weight of 1000 grains we can find that with increase in the number of grains in unit area (number of grains in spike and the number of spikes in unit area), the number of sources have increased and lower amount of photosynthesis element has allocated to them, therefore, as the number of sources increases, the lower amount of photosynthesis element reaches to them and as a result, the weight of 1000 grains decreases. Boquet and Johnson (1987), Musick *et al.* (1994) and Pearman *et al.* (1987) have mentioned that it decreases or does not have any effect. The result of correlation coefficient showed that the weight of 1000 gains has negative correlation with the biologic yield (p<1%) and was significant with positive correlation with the harvest index and weight of grains in spike (p<5%).

CONCLUSIONS

With respect to effects of genotypes on yield and yield components, we can come to this conclusion, that the mutant line T-56-58-8, had the most grains' yield and the least grain's yield belongs to Tabasi Variety and whereas, the Tabasi variety has the maximum number of spikes m^{-2}, but with respect to severe lodging in this variety of wheat, the number of grain's in spike, the weight of 1000 grains, harvest index and biologic yield of Tabasi were significant decreased, consequently, with regards to the above results and increase of biologic yield and harvest index, mutant lineT-65-58-8 had more grain's yield than Tabasi variety

With respect to influences of different levels of nitrogen fertilizer on yield and yield components on mutant lines of wheat and Tabasi parent variety, we can conclude that although, these mutant lines have good resistance to lodging and excellent acceptance of fertilizer, but from yield's point of view, they did not have good fertilization acceptance and on high levels of nitrogen we saw a non significant increase in yield. Of course lack of increase of significant grain's yield on high levels of nitrogen could be explained by Milsi theory (critical percentages): The limitation of minimum percent of food elements in texture, the increase of one unit of food element causes increase of yield, but it does not increase the percentage of food elements (in this experiment, the percent of nitrogen of grain and grain's protein are not increased).

In the limitation of adjustment of deficiency, as the food element are increases, both, yield and percent of food elements are increased, (in this experiment levels of nitrogen N100, N140, N180) were taken into account, but, in the Lux limitation, the increase of one food element has a low influence on yield, but increases the constituent of food elements (N220). With respect to economical factor and decrease of inputs for a stabilized agriculture and to protect the environment we can recommend the minimum level of fertilization that is, N100 for mutant lines.

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