

## **The yield and quality of wheat affected by individual and combined application of animal manure and chemical fertilizers**

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### **Abstract**

From the importance and quantity point of view, the cereals, in particular wheat, has the highest level of consumption in the world, and provides about 40 percent of the nutritional energy worldwide, especially in the developing countries. The implementation of this project, which is for the enhancement of yield and quality of wheat, as well as the optimal utilization of chemical fertilizers and performance of the animal manure to the point of reaching sustainable agriculture, defines the objective of this research project. This research has been determining the individual and combined effects of chemical and animal manure on the quantitative and qualitative performance of the bread wheat, advanced type Mahdavi (M-70-12). In this long term experiment, 3 rates of animal manure (0,15,30) tons per hectare and four chemical fertilizer compounds ( $N_0P_0K_0$ ,  $N_{120}P_{45}K_{50}$ ,  $N_{180}P_{90}K_{75}$ ,  $N_{240}P_{135}K_{100}$ ) were applied in a factorial arrangement of complete randomized blocks (R.C.B.D), consisting of 12 treatments, with 3 replications, amounting to 36 plots. The results of the third year of this project indicated that the highest yield belonged to a treatment in which 30 tons of animal manure combined with 180 kg nitrogen, 90 kg phosphorus and 75 kg of potassium. When compared to a treatment in which the chemical fertilizer was used without any animal manure, an increase of 1520 kg was achieved. The maximum grain protein concentration (14.3%) pertained to a treatment in which 15 tons of animal manure, along with  $N_{180}P_{90}K_{75}$ , was used, but in general protein concentration difference were small. The results generally show the importance of simultaneous use of chemical fertilizers and animal manure.

### **Media Summary**

The grain yield and grain protein concentration of wheat can be increased by using animal manure combined with chemical fertilizers. This combination is more effective than each of them used alone.

### **Keywords**

Wheat, quantity, quality, animal manure, chemical fertilizer.

### **Introduction**

The combination of chemical fertilizers and animal manure, will lead to an increase in the accessible water conservation capacity as well as promotion and maintenance of the soil productivity level and control of soil erosion, with increase in the stability of soil structure, by composing the organic and mineral complexes. The use of the chemical fertilizers will result in the increase of plantation remains and in result will prevent the loss of the organic materials of the soil. Tandon (1996), reported that part of the incorporation of nitrogen management (I.N.M), which will cause the full supply of principal nutritional elements required by the plant, in particular nitrogen, through mixed usage of organic and mineral fertilizers, in such a way that 25 to 30 percent of the total crop system of cereals, shall be supplied in this manner. With increase in the animal manure, the micronutrient or less consumed materials will be provided. In addition to above points, the animal manure, by improving the physical structure of the soil, such as penetrability and porosity structure, will lead to increase the propagation of the roots and amelioration of the soil chemical condition and it will increase the soil biological function as well. The addition of the animal manure will result in the soil acidity equilibrium and will moderate the soil temperature and will keep it in a suitable condition. The results of many experiment conducted in the field indicates that presence of animal manure along with the use of chemical fertilizers, will result in the production stability, in long term. So, in the crop system, the effects of the remainder of organic and mineral fertilizers shall be considered, in order to study the economy of the element consumption

(sustainable agricultural systems). Increasing the animal manure, along with chemical fertilizers was studied by Sommerfelt et al. (1998). The results of the mentioned study indicates, that the soil organic materials, has increased considerably and consistency in the use of animal manure, due to continued accumulation of organic materials in the soil, has useful effects on the crop, has resulted in the soil fertility and conservation of the nutrition elements, in a long term period. Malakouti and Humaie (1994), in a 6 year pot experiment period, have compared the use of animal manure, green fertilizer and chemical fertilizer and it has been shown that the amount of the yield, in the pots which received organic materials, were more than the yield of the respective pots and its cause has been the mineralization of organic materials and release of their nutrition elements, as well as absorbability by the plant. Thorn (1999) reported, that the longest experiments on the use of animal manure and chemical fertilizer in the world, at Rothamsted research station, in England, were carried out on bread wheat. These experiments which commenced in 1843, and continued for 50 years, were performed in 5 alternative cycles. In this experiment, the positive impact of animal manure and also the high value of nitrogen fertilizer are quite visible on the bread wheat. Cooke (1984) reported, that where the soil is continuously cultivated, the nutrition elements of the soil, are gradually emptied and it shall be completed by the impact of the chemical fertilizers and animal manures, in order to maintain the overall equilibrium of soil stable fertility. Kouchaki et al. (1998) reported that the right consumption method and precise time of the performance as well as the optimal consumption amount of the animal manure could increase the efficiency of the animal manure consumption. With regard to above results, more research in the field of individual and simultaneous effects of animal manure and chemical fertilizer, about the wheat, is necessary.

## Materials and Methods

The experiment was conducted at Tehran province (Karaj). The soil type was calcixeric-xerorthente. The total soil N and C was about 0.09% and 0.5% respectively. The average annual rainfall is about 200 mm. There is supplemental irrigation generally. The wheat-maize rotation is common. After the soil test, in the middle of Aug, the seed bed was prepared, then a surface compound soil sample (0 – 30 cm) was taken for chemical and physical analysis. In this experiment, 12 fertilizer treatments, four levels of chemical fertilizer: F0=N<sub>0</sub>P<sub>0</sub>K<sub>0</sub>, F1=N<sub>120</sub>P<sub>45</sub>K<sub>50</sub>, F2=N<sub>180</sub>P<sub>90</sub>K<sub>75</sub>, F3=N<sub>240</sub>P<sub>135</sub>K<sub>100</sub>, and three levels of animal manure E0=0, E1=15, E2= 30 ton per hectare were utilized. Some chemical compound of animal manure was (nitrogen 2%, phosphorus (P<sub>2</sub>O<sub>5</sub>) 1.5%, potassium (K<sub>2</sub>O) 2%). The same treatments were applied to the same plots each year. Manure and potassium and phosphorus fertilizer with 1.3 nitrogen fertilizer were applied before seeding, and the rest of the nitrogen fertilizer, in two times, in intervals of one month, starting from March 21. The Mahdavi variety was used. The average grain yield of this variety in Karaj area is about 4.5 ton/ha. The rate of the consumed water, according to the water requirement of high productivity items, in the respective moderate zone were determined and with regard to problems of Karaj weather, the supplementary irrigation, was carried out by calculating the annual rainfall, at 5 to 7 times, in form of leakage irrigation, 2 times in fall and 3 to 5 times in spring, in intervals of 15 days. All the management operations, including weeding and operations against parasite plants, were carried out by (2-4-D) and plantation pest control and the control of the diseases was performed by spraying, and other operations, such as giving nitrogen fertilizer, during keeping precisely and uniformly, for all the plots. The study was carried out in the form of scheduling random complete blocks (R.C.B.D), with 12 treatments, in 3 replications, in a total figure of 36 plots. In the first half of June, the crop of each piece, at the scale of 10 m<sup>2</sup>, was harvested, and then the performance of straw and grain was determined. The comparison of the averages was carried out by the method of multi-field test (D.M.R.T). Finally, the individual effect of each fertilizer, on various levels, and joint effects of chemical and animal manures, was studied on the qualitative and quantitative performance of wheat type Mahdavi.

## Results and Discussion

The results of the first year of this project, indicated that the highest yield (3 tons/ha) obtained from E<sub>1</sub>F<sub>2</sub> treatment, in which 15 tons of animal manure along with 180 kg nitrogen, 90 kg phosphorus and 75 kg potassium, was used (Table 1). The limitation of water in this year was one reason for low grain yield.

**Table 1: The effect of different treatments on the grain yield in first year, 2000-2001 (ton/ha)**

Chemical fertiliser Manure	F0=N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	F1= N <sub>120</sub> P <sub>45</sub> K <sub>50</sub>	F2= N <sub>180</sub> P <sub>90</sub> K <sub>75</sub>	F3= N <sub>240</sub> P <sub>135</sub> K <sub>100</sub>
E0=0 ton/ha	1.60	2.52	2.66	2.20
E1=15 ton/ha	1.54	1.46	3.00	1.74
E2=30 ton/ha	1.96	1.94	2.42	1.72

The results of the second year indicated that the highest yield (3.27 tons/ha) achieved by E<sub>2</sub>F<sub>3</sub> treatment, in which 30 tons of animal manure along with 240 kg nitrogen, 135 kg phosphorus and 100 kg potassium, was used (Table2).

**Table 2: The effect of different treatments on grain yield in second year, 2001-2002 (ton/ha)**

Chemical fertiliser Manure	F0=N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	F1= N <sub>120</sub> P <sub>45</sub> K <sub>50</sub>	F2= N <sub>180</sub> P <sub>90</sub> K <sub>75</sub>	F3= N <sub>240</sub> P <sub>135</sub> K <sub>100</sub>
E0=0 ton/ha	2.98	2.92	3.14	2.67
E1=15 ton/ha	2.75	2.12	3.00	2.86
E2=30 ton/ha	3.23	2.55	2.86	3.27

The high grain protein concentration (GPC) (16.6%) obtained from E1F2 treatment (Table 3). In second year again the yield was low due to limitation of water but GPC was high. This result agree with the result reported by Lotfollahi (1996) that when grain yield is limited by factors other than N (e.g. water) the yield response is low or some time negative, while GPC continues to increase. There may be a negative correlation between grain yield and GPC in this case.

**Table 3: The effect of different treatments on grain protein % (GPC) in second year**

Chemical fertiliser Manure	F0=N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	F1= N <sub>120</sub> P <sub>45</sub> K <sub>50</sub>	F2= N <sub>180</sub> P <sub>90</sub> K <sub>75</sub>	F3= N <sub>240</sub> P <sub>135</sub> K <sub>100</sub>
E0=0 ton/ha	15.38	16.08	16.45	16.11
E1=15 ton/ha	15.97	16.45	16.58	16.10
E2=30 ton/ha	16.32	16.38	16.51	15.85

The results of the third year of this project, indicated that the highest performance of the wheat (4.65 tons/ha) pertained to the E<sub>2</sub>F<sub>2</sub> treatment, in which 30 tons of animal manure along with 180 kg nitrogen, 90 kg phosphorus and 75 kg potassium, was utilized, which in comparison to the E<sub>0</sub>F<sub>3</sub> treatment in which,

only the chemical fertilizers with no animal manure was used, showed an increase of 1520 kg/ha (Table No 4). These results confirm the results achieved in the first year

**Table 4: The effect of different treatments on grain yield in third year, 2002-2003 (ton/ha)**

Chemical fertiliser Manure	F0=N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	F1= N <sub>120</sub> P <sub>45</sub> K <sub>50</sub>	F2= N <sub>180</sub> P <sub>90</sub> K <sub>75</sub>	F3= N <sub>240</sub> P <sub>135</sub> K <sub>100</sub>
E0=0 ton/ha	3.50 AB	3.20 AB	3.47 AB	3.13 B
E1=15 ton/ha	4.08m AB	3.53 AB	3.24 AB	2.87 B
E2=30 ton/ha	3.11 B	3.65 AB	4.65 A	3.32 AB

Also, the results conform to the results of the work carried out by Thorne (1999) and Tandon (1996) and with that of Rastgar (1993). In the third year, 2002-2003, this wheat performance project had better conditions than in the first year and the second year. The combined use of animal manure and chemical fertilizers, not only increased the yield but it also increased the GPC as well. In the third year the highest (GPC) (14.30%) was acquired from a fertilizer compound of E<sub>1</sub>F<sub>2</sub>, but the difference was not significant compared with other treatments (Table 5).

**Table 5 : The effect of different treatments on grain protein % (GPC) in third year.**

Chemical fertiliser Manure	F0=N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	F1= N <sub>120</sub> P <sub>45</sub> K <sub>50</sub>	F2= N <sub>180</sub> P <sub>90</sub> K <sub>75</sub>	F3= N <sub>240</sub> P <sub>135</sub> K <sub>100</sub>
E0=0.00 ton/ha	13.77 A	14.04 A	14.15 A	13.45 A
E1=15 ton/ha	13.41 A	13.95 A	14.30 A	13.62 A
E2=30 ton/ha	13.56 A	14.19 A	13.20 A	13.30 A

### Conclusion

It can be concluded that by using animal manure combined with chemical fertilizer the yield and quality of wheat will increase.

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