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THE EFFECT OF NITROGEN FERTILIZER WITH VAM MYCORRHIZAL INOCULATION ON YIELD AND NUTRIENTS UPTAKE BY TWO WHEAT (*Triticum aestivum* L.) VARIETIES GROWN IN CLAY SOIL

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ABSTRACT

Field experiment was carried out at Kafr El-Sheikh Agriculture College Farm during 2000/2001 season, using split-split plots design with four replicates. The nitrogen fertilizer (urea 46% N), was applied at the rate of 60 kg N/fed. Urea was added in 3 different ways. One dose applied at sowing, two equal doses at sowing and tillering stages and three equal doses at sowing, tillering and booting stages. The effect of vesicular arbuscular mycorrhizal fungi (VAM) was studied, inoculation with one VAM (*Glomus fasciculatum*).

The effect of doses of nitrogen fertilizer with and without (VAM) inoculation (mycorrhizal fungi), ultimately maximize the yield of two wheat varieties, Sakha 69 and Giza 155, and the uptake of some nutrients. The results showed that, the doses of nitrogen fertilizer caused a high significant increase in what grains and straw yield, where the highest mean values were 3.090 and 2.853 ton/fed. for grain yield and 4.305 and 3.893 ton/fed. for straw yield with two wheat varieties Sakha 69 and Giza 155 respectively with inoculation mycorrhizal fungi. Nitrogen fertilizer had also affected positively nitrogen uptake by wheat grain and straw. The highest mean values 43.49 and 44.73 kg N/fed. for grain and 15.79 and 14.01 kg N/fed. for straw yield with variety Sakha 69 and Giza 155, respectively, with inoculation. N-fertilizer as three doses increased significantly P-uptake by wheat grains and straw. The highest mean values (12.01 and 11.90 kg/fed.) for grain and (4.85 and 4.21 kg/fed.) for straw with variety Sakha 69 and Giza 155 respectively were found, with inoculation with mycorrhizal fungi. Potassium uptake increase by increasing doses of N-fertilizer. The highest mean values of K-uptake (14.06 and 11.41 kg/fed.) for grain and (55.79 and 50.27 kg/fed.) for straw yield were found with variety Sakha 69 and Giza 155 respectively, with mycorrhizal inoculation. The significant effect of inoculation with mycorrhizal was indicated by increasing the nitrogen, phosphorus and potassium uptake by grain and straw yields of wheat plants.

INTRODUCTION

The soils of arid and semi arid regions, such as Egypt, are characterized by their low content of organic mater and deficiency in major nutrient elements. Wheat crop is one of the most important cereal crops in Egypt. Integrated nutrient management strategies involving chemical fertilizers and bio-fertilizers have been suggested to enhance the sustainability of crop production (Manske *et al.,* 1998). The bioinoculants help the expansion of root systems and better seed germination and plant growth (Manske *et al.,* 1995). Inoculation with vascular *Arbuscular mycorrhiza* (VAM) has been found to increase the availability of phosphorus and other nutrients in crop plants because of its symbiotic associations with plant roots,

colonizing cortical tissues and extending hyphae into the rhizosphere (Hetrick *et al*., 1996).

High grain yield of wheat with high grain N-content was resulted by splitting N-fertilizer into several doses (Youssef and El-Saady, 1999). Nitrogen sources had a beneficial effect on wheat yield, but due to the activity of microorganisms in soil, part of this nitrogen is subjected to loss by leaching and volatilization. The lost part causes environmental pollution which has adverse effect on human health and increases the cost of wheat production. The effect of splitting nitrogen fertilizer on grain yield and other yield components, with inoculation mycorrhizae fungi were important subject which needs more research works. The objective of this study was to investigate the effect of nitrogen dose with and without VAM inoculation on the yield of two wheat varieties Sakha 69 and Giza 155 and the uptake of N, P, K nutrients, together with nitrogen recovery and nitrogen use efficiency.

MATERIALS AND METHODS

Field experiment was conduced at the experimental farm of the Faculty of Agriculture, Kafr El-Sheikh during 2000/2001 season to study the effect of nitrogen fertilizer with and without inoculation of mycorrhizae fungi on wheat growth. This nitrogen fertilizer (urea 46% N) was applied at the rate of 60 kg N/fed. The N was applied in these equal doses. The first dose was added at sowing and the other two doses were applied at tillering and booting stages as (i) one dose at sowing (N_1), (ii) two equal doses at sowing and tillering (N_2) and (iii) three equal doses at sowing, tillering and booting (N_3). The vesicular-arbuscular mycorrhizal fungi (VAM) treatment included with and without VAM inoculation. In soil treated with VAM (*Glomus fasciculatum*) the fungus was chapped into small pieces and mixed with soil at the time of sowing. This fungus has also been shown to coloniase roots of wheat up to 50% (e.g. Zhu & Smith 2001). One phosphorus level was applied at 7.75 kg P_2O_5 per feddan as super phosphate (15.5% P_2O_5) before sowing. One potassium level was applied at 24 kg K_2O/fed as potassium-sulphate (48% K_2O) before the first irrigation.

Composite soil samples, from experimental field, collected from the surface layer (0-30 cm), before cultivation. The samples were air, dried, crushed, and sieved through a 2 mm sieve. The physical and chemical analysis of the soil were done according to Page (1994). Data presented in Table (1) showed the main physical and chemical properties of the experimental soil.

Two wheat (*Triticum aestivum* L) varieties: Sakha 69 and Giza 155 were used as the tested plants. The experimental plots were sown with two varieties of wheat in 25 November 2000 season using split-split plots design. The other agriculture practices were followed as usual.

Plants harvest:

At maturity, plants were collected from each plot, and the straw and grains yield were measured.

Table (1): The main physical and chemical properties of the experimental soils.

Parameters	Value
Particle size distribution	
Sand, %	20.10
Silt, %	20.80
Clay, %	59.10
Texture class	Clayey
Available N, mg kg^{-1}	33.6
Available P, mg kg^{-1}	9.8
Available K, mg kg^{-1}	223
Soil pH (1: 2.5) suspension	8.00
EC (dS/m) soil paste extract	2.82
Organic matter %	1.71
Soil paste analysis (mM/L)	
Ca^{++}	6.8
Mg^{++}	2.8
Na^{+}	17.8
K^{+}	0.8
CO^{--}_3	n.d
HCO^{-}_3	6.0
Cl^{-}	11.40
SO^{--}_4	10.8

n.d = not detected

Plant analysis:

The collected plants were first washed by tap water then by distilled water, dried in an oven at 65°C for 48 hrs, ground in stainless steel mill. The over dried plant material was wet digested with $HClO_4$ and H_2SO_4 according to Chapman and Pratt (1961). The phosphorus and potassium concentrations of the digested grains and straw were measured using spectrophotometers and flame photometer, respectively according to Page (1994). Also, total nitrogen of the digested grains and straw was determined using conventional method of microkjeldahl according to Page (1994).

- Nitrogen use efficiency (NUE) was calculated by using the following equation (Moll *et al.,* 1982).

$$NUE = \frac{\text{Grain yield of treatment (kg/fed.)} - \text{grain yield of control (kg/fed.)}}{\text{Total N added (kg N/fed.)}}$$

- Nitrogen recovery of fertilizer (%) was calculated for each treatment according to the following equation by Crasswell and Godwin (1984):

N recovery of fertilizer % =

$$\frac{\text{N uptake from frtilized plot} - \text{N uptake from untreated check plot}}{\text{N fertilizer applied}} \times 100$$

- Protein concentration was calculated from total nitrogen multiplied by 6.25 according to A.O.A.C. (1980).

$$\text{Harvest index \%} = \frac{\text{Grain yield per feddan}}{\text{Total grain and straw yield per fed.}} \times 100$$

The field experiment was conduced in split-split plots design with four replicates. The main plots was nitrogen doses, sub-plots included varieties of wheat and sub sub plots were related to mycorrhizae treatment.

Data obtained were analyzed statistically according to the procedures outlined by Cochran and Cox (1960).

RESULTSAND DISCUSSION

1- Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on grain yield:

Table (2) indicated that the grains yields of wheat varieties (Sakha 69 and Giza 155) were highly significantly increased with increasing nitrogen doses. The highest mean values of grain yield were 3.090 and 2.853 ton/fed. for Sakha 69 and Giza 155, with mycorrhizae inoculation respectively. On the other hand, the lowest mean values (0.640 and 0.668 ton/fed.) for variety Sakha 69 and Giza 115 were obtained with mycorrhizae inoculation were observed by the control treatments, respectively. Such increase in grain yield with nitrogen fertilizer doses, may be attributed to the increase of yield components which are integrated with each others and finally reflected on grain yield. Similar results were reported by El-Desoky *et al.* (2000), Warraich *et al.* (2002) and Muhammad (2001). The obtained results, clearly show that inoculation with mycorrhizal fungi produced highly significant grain yield of wheat (3.090 and 2.853 ton/fed.) with variety Sakha 69 and Giza 155, respectively. The lowest mean values (0.588 and 0.577) ton/fed.) without mycorrhizae inoculation were observed in the control treatments for both varieties, respectively. These results are in a harmony with those obtained by Arafa (1995). Also Khan (1972) found that mycorrhizal treated maize and wheat seedlings planted in a field, grew much better and yielded more grains than the uninoculated seedlings. Data in Table (2) also showed that application has a highly significant effect on grain yield of the two wheat varieties.

Table (2): Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on grain yield (ton/fed.).

Variety	N-dose	Inoculation with mycorrhizae	Without inoculation
Sakha 69	Control	0.640 ^{d}	0.588 ^{d}
	N_1	2.500 ^{c}	2.105 ^{c}
	N_2	2.738 ^{b}	2.238 ^{b}
	N_3	3.090 ^{a}	2.405 ^{a}
Giza 155	Control	0.668 ^{c}	0.577 ^{c}
	N_1	2.650 ^{b}	2.170 ^{a}
	N_2	2.638 ^{b}	2.033 ^{b}
	N_3	2.853 ^{a}	2.083 ^{b}

DMRT comparison	2-M means at each N * V		2-N means at each V * M		2-V means at each N *M	
	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01
	0.073	0.099	0.087	0.121	0.083	0.115

2. Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on straw yield:

Table (3) showed that straw yields of wheat varieties (Sakha 69 and Giza 155) were highly significantly increased with increasing N. The highest mean values were 4.305 and 3.893 ton/fed. with inoculation for Sakha 69 and Giza 155, respectively. These results agree with those reported by El-Desoky *et al.* (2000) and Muhammad (2001). The lowest mean values (0.715 and 0.725 ton/fed.) for Giza 155 and Sakha 69, respectively were found with the control. The highly significant effect on straw yield of the two wheat varieties were found with inoculation with mycorrhizal fungi. The highest mean values were recoded as 4.305, 3.275 and 3.893, 2.863 ton/fed. with Sakha 69 and Giza 155, respectively, with and without with inoculation mycorrhizal fungi. These results are in a harmony with those obtained by El-Desoky *et al.* (2000).

Table (3): Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on straw yield (ton/fed.).

Variety	N-dose	Inoculation with mycorrhizae	Without inoculation
Sakha 69	Control	0.725 ^{d}	0.66 ^{d}
	N_1	3.500 ^{c}	2.913 ^{c}
	N_2	3.763 ^{b}	3.068 ^{b}
	N_3	4.305 ^{a}	3.275 ^{a}
Giza 155	Control	0.715 ^{c}	0.53 ^{c}
	N_1	3.658 ^{b}	2.998 ^{a}
	N_2	3.623 ^{b}	2.810 ^{b}
	N_3	3.893 ^{a}	2.863 ^{ab}

DMRT comparison	2-M means at each N * V		2-N means at each V * M		2-V means at each N *M	
	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01
	0.141	0.191	0.142	0.196	0.142	0.196

3. Effect of N-fertilizer, mycorrhizae inoculation and variety on N-uptake of grain and straw yields:

Table (4) showed that nitrogen had high significant effect on N-uptake by the two wheat varieties. The highest mean values of N-uptake (44.73 and 43.49 kg N/fed.) in grains of Giza 155 and Sakha 69 were found with mycorrhizae inoculation, respectively. Similar results were reported by Auti *et al.* (1999) and Rawat and Pareek (2003). The lowest mean values of N-uptake (7.01 and 7.07 kg N/fed.) in grains were found by Giza 155 and Sakha 69 in the control treatments, respectively.

Data presented in Table (4) showed that N-fertilizer had high significant effect on N-uptake of wheat straw. The highest mean values of N-uptake (15.79 and 14.01 g N/fed.) in straw were found by Sakha 69 and Giza 155 with inoculation, respectively.

The lowest mean values of N-uptake (1.86 and 1.89 kg N/fed.) for straw were found by Giza 155 and Sakha 69 without inoculation, respectively.

Table (4): Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on N-uptake by grain and straw (kg/fed.)

Variety	N-dose	Grain		Straw	
		Inoculation with mycorr.	Without inoculation	Inoculation with mycorr.	Without inoculation
Sakha 69	Control	7.76 ^{d}	7.07 ^{d}	2.12 ^{d}	1.89 ^{d}
	N_1	35.31 ^{c}	59.47 ^{c}	11.57 ^{c}	9.50 ^{c}
	N_2	38.67 ^{b}	31.33 ^{b}	13.29 ^{b}	10.56 ^{b}
	N_3	43.49 ^{a}	33.73 ^{a}	15.79 ^{a}	11.72 ^{a}
Giza 155	Control	8.36 ^{c}	7.01 ^{c}	2.06 ^{c}	1.86 ^{b}
	N_1	38.82 ^{b}	31.49 ^{a}	12.02 ^{b}	9.71 ^{a}
	N_2	38.99 ^{b}	29.29 ^{b}	12.55 ^{b}	9.68 ^{a}
	N_3	44.73 ^{a}	31.10 ^{ab}	14.01 ^{a}	10.22 ^{a}

DMRT comparison	Grain						Straw					
	2-M means at each N * V		2-N means at each V * M		2-V means at each N *M		2-M means at each N * V		2-V means at each N *M		2-V means at each N *M	
	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01
	1.238	1.66	1.34	1.86	1.20	1.65	0.55	0.75	0.56	0.77	0.58	0.79

4. Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on P-uptake of grain and straw:

Table (5) showed that nitrogen significantly increased P-uptake in grain of the two wheat varieties. The highest mean values of P-uptake (12.1 and 11.90 kg P/fed.) in grains by the two wheat varieties, Sakha 69 and Giza 155 were found with three N-doses added and with mycorrhizael inoculation, respectively.

Table (5): Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on P-uptake of grain and straw (kg/fed.)

Variety	N-dose	Grain		Straw	
		Inoculation with mycorr.	Without inoculation	Inoculation with mycorr.	Without inoculation
Sakha 69	Control	2.51 ^{d}	2.35 ^{d}	0.59 ^{d}	0.53 ^{d}
	N_1	9.17 ^{c}	7.92 ^{c}	3.31 ^{c}	2.62 ^{c}
	N_2	10.6 ^{b}	8.67 ^{b}	4.06 ^{b}	3.17 ^{b}
	N_3	12.01 ^{a}	9.92 ^{a}	4.85 ^{a}	3.62 ^{a}
Giza 155	Control	2.67 ^{c}	2.31 ^{b}	0.58 ^{d}	0.53 ^{c}
	N_1	10.50 ^{b}	7.86 ^{a}	3.37 ^{c}	2.70 ^{b}
	N_2	10.77 ^{b}	7.49 ^{a}	3.92 ^{b}	2.85 ^{ab}
	N_3	11.90 ^{a}	7.87 ^{a}	4.21 ^{a}	3.02 ^{a}

DMRT comparison	Grain						Straw					
	2-M means at each N * V		2-N means at each V * M		2-V means at each N *M		2-M means at each N * V		2-V means at each N *M		2-V means at each N *M	
	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01
	0.384	0.52	0.384	0.53	0.37	0.50	0.25	0.34	0.23	0.31	0.24	0.33

Data in Table (5) showed that P-uptake in grain yield of wheat with three N-fertilizer doses added by wheat variety Sakha 69 was higher than that of Giza 155. Table (5) also showed that P-uptake increased by increasing N-fertilizer doses with the two wheat varieties, Sakha 69 and Giza 155 (Grain and straw). The beneficial effect of VAM inoculation on the growth and yield of the plant has been largely attributed to high phosphorus P uptake, concentration and consequently better P nutrient of mycorrhizal treated plants. The increased uptake of P by mycorrhizal treated plants is mainly due to absorption and translocation of P from plant roots (Bass, 1990 and Korthari *et al.,* 1991).

The lowest mean values of P-uptake (2.31 and 2.35 kg/fed.) in grain by two wheat varieties, Giza 155 and Sakha 69 were found without VAM inoculation, respectively and the highest mean values of P-uptake (4.85 and 4.21 kg P/fed.) in straw by Sakha 69 and Giza 155 were found with N application and with VAM inoculation, respectively. Similar results were obtained by Papakosta (1994). On the other hand, the lowest mean values of P-uptake (0.53 kg/fed.) in straw by the two wheat varieties were found in both control treatment. Phosphorus is an important nutrient taken up by mycorrhizal fungi and transported to the host plant. Some authors reported that extensive colonization occurs mainly in plants in soils grown of low fertility (Khalil *et al.,* 1992 and Gehring and Whitham, 1994).

5. Effect of N-fertilizer, mycorrhizal inoculation and wheat variety on K-uptake in grain and straw:

Table (6) showed that K-uptake significantly increased with N-application for the two wheat varieties: Sakha 69 and Giza 155.

Table (6): Effect of N-fertilizer, mycorrhizae inoculation and wheat variety on K-uptake in grain and straw (kg/fed.)

Variety	N-dose	Grain		Straw	
		Inoculation with mycorr.	Without inoculation	Inoculation with mycorr.	Without inoculation
Sakha 69	Control	2.11 ^{d}	1.93 ^{d}	7.46 ^{d}	6.69 ^{d}
	N_1	10.67 ^{c}	9.03 ^{c}	39.38 ^{c}	32.57 ^{e}
	N_2	12.00 ^{b}	10.01 ^{b}	45.21 ^{b}	36.79 ^{b}
	N_3	14.06 ^{a}	11.61 ^{a}	55.79 ^{a}	42.23 ^{a}
Giza 155	Control	2.15 ^{c}	1.91 ^{b}	7.29 ^{d}	6.63 ^{c}
	N_1	10.25 ^{b}	8.00 ^{a}	40.99 ^{c}	33.45 ^{b}
	N_2	10.37 ^{b}	7.86 ^{a}	43.45 ^{b}	33.52 ^{b}
	N_3	11.41 ^{a}	8.13 ^{a}	50.27 ^{a}	36.77 ^{a}

DMRT comparison	Grain						Straw					
	2-M means at each N * V		2-N means at each V * M		2-V means at each N *M		2-M means at each N * V		2-V means at each N *M		2-V means at each N *M	
	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01	L.S.D 0.05	L.S.D 0.01

	0.49	**0.67**	**0.51**	**0.71**	**0.50**	**0.69**	**1.71**	**2.32**	**1.78**	**2.47**	**1.77**	**2.44**

The highest values of K-uptake (14.06 and 11.41 kg/fed.) in grain by two wheat varieties (Sakha 69 and Giza 155) were found with N_3 treatment with VAM inoculation, respectively. These results are supported by El Yamany (1994), and El Beyali *et al.* (2001). Concentration of K were higher in mycorrhizal than in non-mycorrhizal plants (Bressan *et al.,* 2001; Liu *et al.,* 2002). Results in Table (6) clearly showed that nitrogen application caused significant effect on potassium uptake in straw higher than in grains.

The highest mean values of K-uptake (55.79 and 50.27 kg/fed.) were obtained by straw yield with the two wheat varieties (Sakha 69 and Giza 155) with N_3 treatment with mycorrhizal inoculation, respectively. Similar results were reported by El-Beyali *et al.* (2001) who concluded that, addition of nitrogen at 3 physiological stages of growth (tillering, booting and before maturity) increased potassium content and uptake.

6. Interaction effect between N, inoculation with mycorrhizal and wheat variety on yield and uptake of nutrients:

6.1.Grain and straw yield:

Table (7) showed that nitrogen fertilizer, mycorrhizal fungi and varieties of wheat, had a highly significant effect on grain and straw yields of wheat plants, due to the interaction between treatments used in the experiments.

Table (7): Interaction effect between N, inoculation with mycorrhizal and wheat variety on yield and uptake of nutrients.

Interaction	Grain yield ton/fed.	Straw yield (ton/fed.)	N-uptake grain kg/fed.	P-uptake grain kg/fed.	K-uptake grain kg/fed.	N-uptake straw kg/fed.	P-uptake straw kg/fed.	K-uptake straw kg/fed.
N_0	0.618	0.688	7.55	2.46	2.02	1.98	0.56	7.02
N_1	2.356	3.267	33.77	8.86	9.50	10.70	3.0	36.60
N_2	2.411	3.316	34.73	9.38	10.06	11.52	3.50	39.74
N_3	2.608	3.584	38.26	10.42	11.30	12.94	3.92	46.27
F-test	**	**	**	**	**	**	**	**
L.S.D 0.05	0.1042	0.1421	1.67	0.421	0.562	0.523	0.1653	1.87
L.S.D 0.01	0.1497	0.204	2.39	0.605	0.807	0.751	0.237	2.68
M_1	2.222	3.023	32.02	8.76	9.13	10.42	3.11	36.23
M_2	1.785	2.405	25.14	6.80	7.31	8.14	2.38	28.58
F-test	**	**	**	**	**	**	**	**
V_1	2.038	2.776	28.53	7.89	8.93	9.55	2.84	33.26
V_2	1.959	2.651	28.80	7.67	7.51	9.01	2.65	31.54
F-test	**	**	*	**	**	**	**	**
N.M	**	**	**	**	**	**	**	**
N.V	**	**	**	**	**	**	**	**
V.M	**	N.S	**	**	**	N.S	N.S	N.S
N.V.M.	N.S	N.S	N.S	**	N.S	N.S	N.S	N.S

6.2. N-uptake of grain and straw:

Table (7) showed that nitrogen fertilizer had a highly significant effect on N-uptake in grain and straw with mycorrhizal treatments. Also, there were highly significant effects on N-uptake by grain and straw yield due to the interaction between treatments used in the experiments (N x M, N x V and V x M), except the interaction between nitrogen fertilizer, mycorrhizal

inoculation and variety of wheat (N x M x V) which were non significant in the N-uptake by grain and straw.

6.3.P-uptake in grain and straw:

Table (7) indicated that the interaction of nitrogen, inoculation with mycorrhizal and wheat variety, had highly significant effects on P-uptake by grain and straw. The interaction between treatments (N x M and N x V), except the interaction between treatments (N x M x V) showed no significant effect on the P-uptake by straw yield of wheat, while showed significant effect on the P-uptake by grain.

6.4.K-uptake in grain and straw:

Table (7) indicated that the interaction of nitrogen, inoculation with mycorrhizal and wheat variety had highly significant effects on K-uptake by grain and straw. The interaction between treatments (N x M, N x V and V x M), except the interaction between treatments (N x M x V) showed no significant effects on K-uptake by grain and straw, while the interaction effects between inoculation with mycorrhizal and wheat variety (M x V) showed no significant effects on K-uptake by straw yield of wheat plants.

7.Harvest index (%) of Sakha 69 and Giza 155 wheat varieties:

Table (8) indicated that the harvest index (HI) decreased with increasing N-fertilizer. The highest values were recorded with Giza 155 as compared to Sakha 69. These results are supported by Wagan *et al*. (2002).

Table (8): Effect of N-fertilizer, mycorrhizal inoculation and wheat variety on harvest index (%).

Variety	N-doses	Inoculation with mycorr.	Without inoculation mycorr.
Sakha 69	Control	46.89	47.12
	N_1	41.67	41.95
	N_2	42.12	42.18
	N_3	41.14	42.34
Giza 155	Control	48.30	52.12
	N_1	42.01	41.99
	N_2	42.13	41.98
	N_3	42.14	42.11

8. Nitrogen recovery (%) as affected by N-fertilizer, inoculation with mycorrhizal and wheat varieties:

Table (9) showed that N recovery by what varieties Sakha 69 surpassed that the wheat var. Giza 155 where the values were 82.34 and 80.63% for Sakha 69 and Giza 155, respectively under inoculation treatment. It is also clean that N-recovery increased by increasing N-doses and inoculation with mycorrhizal. Where the values were 82.34, 60.81% and 80.63, 54.09% for Sakha 69 and Giza 155, respectively. These results agree with those reported by Blankenou *et al.* (2000).

Table (9): Effect of N-fertilizer doses, inoculation with mycorrhizal and variety of wheat plants on recovery of N-fertilizer (%).

Variety	N-doses	Inoculation with mycorr.	Without inoculation mycorr.
Sakha 69	N_1	61.66	50.01
	N_2	70.13	54.87
	N_3	82.34	60.81
Giza 155	N_1	67.45	53.89
	N_2	68.64	51.22
	N_3	80.63	54.09

9. N-use efficiency (N.U.E.) by wheat as affected by N-fertilizer, inoculation and two wheat varieties:

Table (10) indicated that N.U.E. has increased by increasing N doses where the values were 40.83 and 36.42 kg grain/kg N. It is also clear that N.U.E. increased by increasing N doses and inoculation with mycorrhizal where the values were 40.83, 30.28 and 36.42, 25.10 kg grain/kg N for variety Sakha 69 and Giza 155, respectively. These results agree with those reported by El-Desoky *et al.* (2000) who found that with dose N application 3 weeks after sowing, stem elongation and heading, N use efficiency for grain production in bread wheat (32.71 kg grain/kg N application) was recorded. Similar results were observed by Rahman *et al.* (2002), Youssef and El-Saady (1999) and Amer (2005).

Table (10): N-use efficiency by wheat as affected by N-fertilizer, inoculation with mycorrhizal and wheat varieties.

Variety	N-doses	Inoculation with mycorr.	Without inoculation mycorr.
Sakha 69	Control	-	-
	N_1	31.00	25.28
	N_2	34.96	27.50
	N_3	40.83	30.28
Giza 155	Control	-	-
	N_1	33.03	26.55
	N_2	32.83	24.27
	N_3	36.42	25.10

10. Crude protein content (%) in grains as affected by N-fertilizer, inoculation with VAM and wheat varieties:

Table (11) showed that the crude protein contents in grains of the two wheat varieties had increased (10.89%, 9.77% for Giza 155 and Sakha 69, respectively) by increasing nitrogen fertilizer doses. Similar results were reported by El-Beyali *et al.* (2001) and Ayoub *et al.* (1995) who showed that grain protein concentration of wheat increased consistently with increasing N-fertilizer doses.

Table (11): The crude protein content (%) in grains of wheat as affected by N-fertilizer, inoculation with mycorrhizal and two wheat varieties.

Variety	N-doses	Inoculation with mycorr.	Without inoculation mycorr.
Sakha 69	Control	8.42	8.35
	N_1	9.81	9.72
	N_2	9.81	9.72
	N_3	9.77	9.74
Giza 155	Control	8.69	6.45
	N_1	10.17	10.08
	N_2	10.27	10.22
	N_3	10.89	10.37

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تأثير التسميد النيتروجينى مع التلقيح بفطر الميكوريزا على المحصول وامتصاص المغذيات بصنفى قمح ينموان بالاراضى الطينية

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أجريت تجربة حقلية بمزرعة كلية الزراعة بكفرالشيخ فى موسم 2001/2000م على صنفين من القمح صنف سخا 69 وصنف جيزه 155 وكان التصميم الإحصائى المتبع هو تصميم القطع المنشقة مرتين وكان مصدر السماد النيتروجينى المستخدم فى الدراسة هى يوريا 46% نيتروجين بمعدل 60 وحدة أزوت لكل فدان وتم إضافتها بثلاث طرق:

- الطريقة الأولى: هو إضافة السماد النيتروجينى دفعة واحدة عند الزراعة.
- الطريقة الثانية: هى إضافة السماد النيتروجينى على دفعتين متساويتين الأولى عند الزراعة عند التفريع.
- الطريقة الثالثة: هى إضافة السماد النيتروجينى على ثلاث دفعات بالتساوى ـ الأولى عند الزراعة الثانية عند التفريع الثالثة قبل طرد السنابل (عند الحمل).

كما تم دراسة تأثير فطر الميكوريزا (*Glomus fasciculatum*) على امتصاص النيتروجين والفوسفور والبوتاسيوم بواسطة صنفى القمح. جميع العمليات الزراعية أجريت حسب توصيات وزارة الزراعية ما عدا العوامل تحت الدراسة. وأوضحت النتائج تأثير جرعات السماد النيتروجينى المضاف مع فطر الميكوريزا وبدونه على محصول صنفى القمح سخا 69 وجيزه 155 وكذلك الامتصاص لبعض العناصر الغذائية (NPK)بواسطة نباتات القمح

وكانت أهم النتائج الآتى:

1- تأثير إضافة السماد النيتروجينى على دفعات ثلاث أدى ذلك إلى زيادة فى محصول الحبوب والقش للقمح حيث كان أعلى محصول من الحبوب هو 3.090 ، 2.853 طن/فدان ، بينما أعلى محصول من القش هو 4.305 ، 3.893 طن/فدان بواسطة صنفى القمح سخا 69 وجيزه 155 مع التلقيح بفطر الميكوريزا على التوالى.

2- تأثير إضافة السماد النيتروجينى على دفعات أدى إلى زيادة معنوية فى كمية النيتروجين الممتص بواسطة الحبوب والقش لمحصول القمح حيث كانت أعلى قيم من النيتروجين الممتص هى 43.49 ، 44.73 كيلو جرام نيتروجين لكل فدان بالنسبه لمحصول الحبوب أما بالنسبه لمحصول القش فكانت القيم هى 15.79 ، 14.01 كيلو جرام نيتروجين لكل فدان وذلك مع التلقيح بفطر الميكوريزا لصنفى سخا 69 وجيزه 155 على التوالى.

3- بالنسبه للفوسفور الممتص أوضحت النتائج أن أعلى قيمة من الفوسفور الممتص كانت بواسطة الحبوب وهى 12.01 ، 11.90 كيلو جرام خامس أكسيد الفوسفور P_2O_5 لكل فدان فى حالة إضافة السماد النيتروجينى على ثلاث دفعات متساوية. أما بالنسبه للقش فكانت أعلى قيمة هى 4.85 ، 4.21 كيلو جرام خامس أكسيد الفوسفور P_2O_5 لكل فدان وذلك مع التقليح لكلا الصنفين سخا 69 وجيزة 155 علىالترتيب.

4- بالنسبه للبوتاسيوم الممتص أوضحت النتائج أعلى قيمة من البوتاسيوم الممتص 55.79 ، 50.27 كيلو جرام من K_2O لكل فدان بواسطة محصول القش عند إضافة السماد النيتروجينى على ثلاث دفعات متساوية بواسطة صنفى القمح سخا 69 وجيزه 155 أما بالنسبه إلى كمية البوتاسيوم الممتص بواسطة حبوب القمح كانت 14.06 ، 11.41 كيلو جرام من K_2O لكل فدان بواسطة صنفى القمح سخا 69 وجيزه 155 مع فطر الميكوريزا.

5- كما اوضح التقليح بفطر الميكوريزا زيادة معنوية فى امتصاص النيتروجين والفوسفور والبوتاسيوم بواسطة الحبوب والقش لمحصول القمح.

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