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EFFECT OF SOME NITROGENOUS AND PHOSPHATIC FERTILIZERS SOURCES AND VA-MYCORRHIZA INOCULUM ON GROWTH, PRODUCTIVITY AND STORABILITY OF GIRLIC (*Allium sativum* L.)

1-Vegetative growth and chemical constituents.

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ABSTRACT

Two field experiments were carried out at a private farm at El-Manial village, Talkha province, Dakahlia governrate during winter seasons of 2004/2005 and 2005/2006. The study aimed to investigate the effect of N-sources (calcium nitrate, ammonium sulphate, sulphur coated urea and bentonite coated urea), P-sources(super phosphate either powder and granules and rock phosphate) as well as vesicular arbuscular mycorrhiza (VAM) fungi and their interactions on the vegetative growth (plant height, number of leaves/plant, dry weight, leaf area/plant, chlorophyll content/plant, neck diameter, bulb diameter and bulbing ratio) and chemical constituents (N, P, K, NO_3 and NO_2) of garlic plants (Sids-40).

The obtained results showed that plant height, dry weight, leaf area/plant, total chlorophyll content, neck diameter and bulb diameter were significantly increased by application of ammonium sulphate, in both seasons, while, number of leaves/plant was not significantly affected by N-sources, in both seasons. Plant height, dry weight, leaf area, total chlorophyll and bulb diameter were significantly increased by application of powder super phosphate, in both seasons, while, number of leaves/plant, neck diameter and bulbing ratio were not significantly affected by P-sources, in both seasons. All measured parameters were significantly increased by inoculation of VAM fungi except of number of leaves/plant and bulbing ratio were not significantly affected by VAM fungi, in both seasons.

Application of sulphur coated urea significantly increased the percentage content of N, P and K and significantly reduced NO_3 and NO_2, in both seasons and the lowest values of NO_3 and NO_2 obtained by application of bentonite coated urea, in both seasons. Application of granules super phosphate significantly increased N % and K % and the concentration of NO_3 and NO_2 reduced by using rock phosphate followed by using powder super phosphate, in both seasons, while, P % was not significantly affected by P-sources. Inoculation of VAM fungi significantly increased the concentration of N %, P % and K % and this treatment significantly reduced the concentration of NO_3 and NO_2, in both seasons.

INTRODUCTION

Garlic (*Allium sativum* L .) as a member of the *Alliaceae* Family is one of the most important vegetable bulb crop . It is commonly used as a spice or for many medicinal purposes. In Egypt, it has been generally cultivated for both local consumption and export. Increasing garlic productivity and improving bulb quality are important aims. Growing desired genotypes and using suitable form of nitrogen could be good tools to accomplish these aims. Use of slow release nitrogenous fertilizers (SRNF) is one of the most important alternatives to rationalize the use of soluble nitrogenous fertilizers, besides to protect the environment from nitrogenous residues pollution, whether for soil or water or atmosphere. Where nitrogen element is released at a slow rate throughout one season or more , the plants are able to take up most of it without waste. SRNF also promotes steady and uniform growth for guarantees high N-efficient use and reduces N-losses either by volatilization or leaching (Abbady *et al*., 1997 and El-Mallah *et al*., 1998).

Phosphorus is one of the most important nutrients for garlic growth, productivity and storability in heavy soil. In Egypt the most important problem of phosphorus fertilization is that the amount available for plant is usually low since the phosphorus of the applied fertilizers could be converted to unavailable form for plant absorption by its reaction with the soil constituents (Kumar and Sharma, 2004).

Vesicular-Arbuscular Mycorrhiza (VAM) is the symbiotic association of a fungus and the roots of plant. This association alters the root structure and helps plants to obtain water and minerals, particularly phosphorus. In addition, mycorrhizal fungi (VAM) are extremely widespread in the most of plants grown in Egypt (El-Shaikh , 2005).

Application of ammonium sulfate as a source of nitrogen gave the maximum growth rate, photosynthetic pigments, fresh and dry weight, leaf area, chlorophyll content/plant and bulb diameter, followed by application of sulphur coated urea, El-Beheidi *et al.* (1985), Abdel-Hamed *et al.* (1996) and Gad El-Hak and Abd El-Mageed (2000). Sang *et al.* (2001) found that the slow release fertilizers, urea formaldehyde slightly increased the plant height, leaf sheath diameter and leaf number compared with conventional fertilizer treatment. Tartoura *et al.* (2003) showed that rock phosphate coated urea gave the significant increases in most of vegetative characters followed by bentonite coated urea.

Wani and Konde(1998) found that application of different P-sources with VAM fungi to garlic plants significantly increased plant height, number of leaves/plant and plant weight over the non-mycorrhizal treatment and Nagaraju *et al.*(2001) on onion.

Inoculation of VAM fungi to garlic plants significantly increased all measured parameters (vegetative growth and chemical constituents) and significantly reduced NO_3 and NO_2, in both seasons (Koch *et al.* 1997, Wani and Konde 1998, Lubraco *et al.* 2000 on garlic, Hammad and Abdel-Ati, 1998 on potato Nagaraju *et al.* 1999 on onion, Awad 2002 on potato and El-Morsy *et al*. 2002 on sweet potato.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons of 2004-2005 and 2005-2006 at EL-Manial village, Talkha province, Dakahlia governorate to study the effect of some nitrogenous and phosphatic fertilizers sources and Vesicular Arbuscular Mycorrhiza (VAM)

fungi inoculum on growth and chemical constituents of garlic. Physical properties for experiment soil
(texture class) was clay loam and pH = 8.1 and 7.9 in the first and second year, respectively.

The experimental design and treatments:-

The experiment was carried out in a split split- plots design with three replicates. The four nitrogen fertilizers sources occupied the main plots which were subdivided to three sub plots each contained one of the phosphatic fertilizers sources while the VA- Mycorrhiza fungi treatments were assigned to the sub-sub plots. The sub-sub plots area was 10.5 m^2 which contained five rows, 3.5 m long and 0.6 m wide. The full dose of recommended chemical fertilizers rates (120 kg N + 75 kg P_2O_5 + 72 kg K_2O \ fed.) the experiment includes 24 treatments, which were the combination of 4 nitrogen sources x 3 phosphorus sources x 2 VAM fungi. Four sources of chemical nitrogenous fertilizers were used, soluble as: Calcium nitrate (15.5 % N), ammonium sulfate (20.5 % N) and slow release N fertilizers as: Sulphur coated urea (37.8 % N) and bentonite coated urea (37.8 % N) which were taken from Egyptian Fertilizers Development Center (EFDC). Also three sources from phosphatic chemical fertilizers were used, soluble as:- calcium super phosphate powder (15.5 % P_2O_5), calcium super phosphate granules (15.5 % P_2O_5) and insoluble rock phosphate (28 % P_2O_5) which was taken from Abo-Tartor, Suez governorate. The soluble N fertilizers were applied as 50 % at 30 days after planting and 50 % one month later while the slow release N fertilizers were applied as one dose at 30 days after planting. The soluble and insoluble phosphatic fertilizers were applied as one dose at 30 days after planting. VAM fungi are the most widespread associations between fungi and plant. Three species of indomycorrhizal fungi (*Glomus fasciculatum, Glomus mosseae* and *Glomus monosporum*) were supplied by Botany Department, Faculty of Science, Mansoura University, Egypt. A fifty grams of VAM inoculum were added to the root absorption zone of each plant at 21days after planting before irrigation. The planting was carried out during the first week of October for both seasons of study. Uniformed cloves were hand planted on both sides of the ridges at 10 cm apart. All field plots were fertilized with 72 kg k_2o/fed. as potassium sulfate(48 % k_2O) equally divided and added after 30 and 60 days after planting. The other cultural practices for garlic commercial production were used according to the instruction laid down by the Ministry of Agriculture, Egypt. The harvesting was done 180 days after planting for both seasons.

Data recorded and statistical analysis

Vegetative growth characteristics:-

At 120 days after planting, a random of 5 guarded plants were taken from each plot to estimate traits of plant vegetative growth as follow:-

a-Plant height: It was measured in cm starting from tip of the longest leaf blade to the base of bulb.

b-Number of leaves per plant:-All visible leaves of chosen plants were counted (dry and undifferentiated leaves were excluded).

c- Leaf area per plant:The leaves of chosen plants were cleaned from dust and given 10 disks (1.54 cm diameter) from the leaves of each plant were taken, dried and weighted up to 0.1 mg. Plant leaf area was calculated according to the method described by Kollar (1972) using following formula:

$$\text{Leaf area in } m^2 = \frac{\text{Leaves dry weight}}{\text{Disks dry weight}} \ (\text{No. of disks x disk area})$$

d-Dry weight of whole plant: The chosen plants of each treatment were cleaned from the dust, and dried at 70 °C till constant weight.

e-Total chlorophyll: Chlorophyll contents were determined by A Minolta SPAD chlorophyll Meter (Yadava, 1986). Chlorophyll meter reading were taken on 6th leaf of plant. A Minolta SPAD chlorophyll meter uses light sources and detectors to

measure the light transmitted by a plant leaf at two different wavelengths (one in the red and one in the infrared region of the spectrum). The ratio of the light transmittance at these wavelengths, in addition to the ratio determined with no sample, is processed by the instrument to produce a reading shown on a digital display. This reading is in SPAD units, which are values, defined by Minolta to indicate the relative amount of chlorophyll contained in plant leaves (Piekielek and Fox, 1992).

f- Bulbing ratio: It is measured as reported by Mann(1952**).**

$$\text{Bulbing ratio} = \frac{\text{Neck diameter (cm)}}{\text{Bulb diameter (cm)}}$$

Diameters of both plant neck and bulbs were determined by using caliper.

Chemical constituents:-

Sample (100 gm) of dried cloves of each treatment was ground and wet digested as described by Hesse (1971) to determined:-

a- Total nitrogen % determined according to the method described by **Chapman and Partt(1961).**

b- Phosphorus (%) determined as reported by John (1970).

c- Potassium (%) determined by the method of Brown and Lilleland (1946)

d- Concentrations of No_3- and No_2- (ppm) were determined by the modified method of Singh (1988).

Data statistical analysis:-All obtained data were subjected to statistical analysis of variance and the least significant difference (L.S.D.)was calculated as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth characteristics :

1- Effect of N – sources :

Data presented in Table(1) show that plant height, dry weight, total chlorophyll content/plant, neck diameter and bulb diameter were generally significantly increased, in both seasons with application of ammonium sulphate fertilizer, followed by sulphur coated urea, in both seasons, while number of leaves significantly not affected by N – sources, in both seasons, and bulbing ratio was significantly reduced by application of calcium nitrate followed by ammonium sulphate and sulphur coated urea, in the first season.

Leaf area was significantly increased by application of sulphur coated urea, in both seasons. These increases occurred on plant vegetative growth characteristics as a result of application ammonium sulphate and sulphur coated urea fertilizers could be attributed to that two fertilizers contain N – element plus S – element, whereas calcium nitrate and bentonite coated urea are not have. N and S elements are presented in the molecule of most amino acids, whereas, Ca present very less in the minority of the amino acids, this in turn, stimulating division and elongation of cells and hence plant growth. Further more, nitrogen is an essential component of many organic compounds in plant, such as proteins, enzymes, chlorophyll, vitamins, carotenoids, hormones and nuclic acids (Russell, 1950). These compounds may be play an important role in cell formation and plant development. The obtained data are in harmony with those of EL- Beheidi *et al*. (1985), Abdel-Hamed *et al.* (1996), Gad El-Hak and Abdel-Mageed(2000) and Sang *et al.* (2001).

2 – Effect of P – sources :-

Data presented in Table (1) show that there were significantly increases on plant height, dry weight, total chlorophyll content/plant and bulb diameter by application of super phosphate powder followed by super phosphate granules and rock phosphate at the last. Leaf area/plant was significantly increased by application of super phosphate granules, in both seasons. While, number of leaves / plant, neck diameter and bulbing ratio were not significantly affected by the P – sources . These increases due to that super phosphate powder fertilizer has the best solubility, it makes better uptake by the plant roots and the beneficial effect of P – element on the activation of photosynthesis and metabolic processes of organic compounds in plant and hence increasing plant growth whereas, super phosphate granules has the best guard from contact with the soil particles, so, it was away from fixation. These results are in agreement with those of Nagaraju *et al.* (2001) on onion , Kumar and Sharma (2004) on cabbage and Shabana (2004) on tomato.

3 – Effect of VAM fungi : -

Data presented in Table (1) reveal that inoculation of garlic plants by VAM fungi led to significant increases in plant height, dry weight, leaf area/ plant, total chlorophyll content/plant, neck diameter and bulb diameter in both seasons, while, number of leaves / plant and bulbing ratio were significantly not affected by inoculation of VAM fungi, in both seasons.

The superiority effect of VAM fungi could explained based on their role in supplying the growing plants with available phosphorus needs, some micronutrients and phytohormones, such as gibberllins, auxins and cytokinins which promoted plant growth, in addition to root development and thereby enhanced nutrient uptake (Marschner 1995), Obtained results go well with those of Koch *et al.* (1997), Wani and Konde (1998) on garlic and El – Morsy *et al.* 2002) on sweet potato.

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4-Interaction effect between N-sources and P-sources :

The effect of interaction of N – sources with P – sources on plant vegetative growth parameters of garlic plants at 120 DAP, data in Table (2) show that there were significantly differences among the studied treatments plant height, dry weight, bulb diameter were significantly increased by application of ammonium sulphate with powder super phosphate, followed by application of ammonium sulphate with granules super phosphate, in both seasons. Leaf area/plant significantly increased by application of sulphur coated urea with powder super phosphate, in both seasons. Total chlorophyll content/plant was significantly increased by application of ammonium sulphate with powder super phosphate, in the second season only, while, number of leaves/plant, neck diameter and bulbing ratio were not significantly affected by the interaction, in both seasons and total chlorophyll significantly not affected by the interaction, in the first season. The interaction had a positive effects on the most studied parameters. These results are in agreement with those of Maksoud *et al.* (1983 &1984), Oh *et al*. (1991), Ashok *et al.* (1996), El – Gamal and Salim (2005) and Sardi and Timar (2005) on garlic, Rizk (1997) on onion and Awad (2005) on potato.

5-Interaction effect between N-sources and VAM fungi :

Data in Table (3) show that there were significantly increases at most of measured parameters, i.e., plant height and number of leaves/plant in the first season only were significantly increased by application of sulphur coated urea with inoculation of VAM fungi, dry weight and bulb diameter were significantly increased by application of ammonium sulphate with VAM fungi, in both seasons and neck diameter and bulbing ratio, in the second season were significantly reduced by using calcium nitrate without VAM fungi. While, plant height in the second season, number of leaves/plant in the second season, leaf area/plant and total chlorophyll content/plant, in both seasons, neck diameter and bulbing ratio, in the first season were not significantly affected by the interaction. These increases might be ascribed to the beneficial effect of VAM fungi and N – element on absorption and efficiency of plant nutrition. These results are in agreement with that of Baath and Spokes(1989) who suggested that supplying chives plants by combined N and P fertilization in the presence of VAM fungi stimulated plant growth.

6-Interaction effect between P-sources and VAM fungi :

Data in Table (3) show that there were significantly increases at most of measured parameters, i.e., dry weight, in both seasons by application of powder super phosphate with VAM fungi, leaf area/plant, in both seasons by application of granules super phosphate with VAM fungi and neck diameter and bulb diameter, in both seasons were significantly increased by application of granules super phosphate with VAM fungi. While, plant height, number of leaves/plant and bulbing ratio, in both seasons and total chlorophyll content/plant in the second season were not significantly affected by the interaction. These results are in agreement with those of Sari *et al.* (2002) on garlic, Awad (2002) on potato and El – Morsy *et al.* (2002) on sweet potato.

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7-Interaction effect between N-sources, P-sources and VAM fungi

As for the interaction effect of the three studied factors, data in Table (4) reveal that dry weight significantly influenced by the interaction, in both seasons. However, plant height and number of leaves / plant were not significantly affected by the interaction (N – sources x P – sources x VAM fungi) in both seasons . It meaning that the parameters of dry weight / plant have a positive response to the interaction (N – sources x P – sources x VAM fungi). Generally, plants received combination of ammonium sulphate and super phosphate powder in the presence of VAM fungi resulted in the highest vegetative growth. The leaf area was significantly increased, in both seasons by application of sulphur coated urea with powder super phosphate with VAM fungi and total chlorophyll content/plant, neck diameter, bulb diameter and bulbing ratio significantly increased in the first season only while, these parameters were not significantly affected by the interaction, in the second season. The obtained results are in harmony with that obtained by Baath and Spokes (1989) on chives and Hammad and Abdel – Ati (1998) on potato.

Chemical constituents

1-Effect of N-sources :

Data presented in Table (5) show that there were significantly increases in N %, P % and K %, in both seasons. The application of sulphur coated urea as a source of nitrogen significantly increased the concentration percentage of N %, P % and K %, and this treatment exerted the highest values, in both seasons, followed by bentonite coated urea, followed by ammonium sulphate and calcium nitrate came in the last. This treatment significantly reduced the concentration of NO_3 and NO_2 in the garlic bulb, in both seasons. The lowest values of NO_3 and NO_2 obtained by applying bentonite coated urea, in both seasons. These increment may be due to that sulphur coated urea has big value of sulphur, this converts by bacteria and other organisms to sulphuric acid in the soil, in turn, decrease the soil pH to the optimum level for the majority of micronutrients to be absorbed by plant root. These results were similar to that reported by Govind *et al.* (1976) who showed that the effect of sulphur coated urea on nitrate accumulation was minimal on cabbage and tomato. Similar results were reported by Abdel - Fattah *et al.* (2001) who found that $Ca(NO_3)_2$ fertilizer application exerted significantly increases on NO_3 and NO_2 concentration. These results were similar with those of El-Saei and Tartoura(2006) on cabbage, and Hussien *et al.* (2007) on Jerusalem artichoke.

2-Effect of P-sources :

Data in Table (5) clarified that the concentration percentage of macronutrients, i.e., N % and K % were significantly increased, in both seasons, while the concentration percentage of P % was not significantly affected by application of any of P – sources. The highest values obtained by application super phosphate powder or granules on N % (no significant between the two values) and super phosphate granules on K %, compared with the other sources, in both seasons. The concentration of NO_3 and NO_2 were significantly reduced by application of powder super phosphate and the lowest values of NO_3 and NO_2 by applying rock phosphate. Several investigators reported that P is the main constituent of many organic compounds in plants. Moreover, it plays an important role in certain essential steps, such as photophosphorylation and release of energy during cellular metabolism (Russel 1950, Mengel and kirkby 1987 and Marschner 1995). These obtained data are in harmony with those of Sanderson *et al*. (2002) on potato and Shabana (2004) on tomato.

3-Effect of VAM fungi :

As for the effect of VAM fungi inoculation on chemical constituents of garlic bulb, data in Table (5) show that macronutrients uptake percentage, i.e., N %, P % and K % were significantly increased by inoculation with VAM fungi and significantly reduced the concentration of NO_3 and NO_2 of garlic bulb, as compared with the uninoculated ones. The VAM inoculation being significantly the most effective, in both seasons of the study, the increased concentration percentage with VAM inoculation better than without by 11.29, 11.82, 47.80, 40.37 and 9.21, 9.21 % on N, P and K, in both seasons, respectively. The superiority effect of VAM fungi may be due to the small diameter and large size of their hyphe and the accumulation of polyphosphate in their vacuoles. Polyphosphate was involved in transport of P in hyphe to infect root where it is hydrolyzed in the arbuscules and most likely transported as inorganic phosphate across the plasma membrane of the host root cell. Moreover, K ions and basic amino acids may be taken up internally by absorption to polyphosphate granules (Smith and Person, 1988). These results were similar with those of Awad (2002) on potato and El-Morsy *et al*. (2002) on sweet potato, found that N , P and K concentrations markedly increased in foliage and tubers of plants inoculated with VAM fungi.

4-Interaction effect between N-sources and P-sources :

As for the effect of interaction between N-sources with P-sources on the chemical constituents of garlic bulb, data in Table (6) show that the interaction had a significant effect on the concentration of N % , in the first season and K % , in both seasons. However, P % concentration of garlic bulbs did not reflect any significant increases, in both seasons and N % concentration, in the second season of the study. The highest values obtained by application of sulphur coated urea with super phosphate powder on N %, in the first season and super phosphate granules on K %, in both seasons. The lowest values of nitrate and nitrite accumulation of garlic bulb cloves obtained by application of bentonite coated urea with super phosphate powder, in both seasons. These results are in harmony with those of Shobahalan and Arumugam (1991) and El-Gamal and Selim (2005) on garlic and Fayed (1998) on onion.

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Table 6: N %, P %, K %, NO_3 and NO_2 accumulation (ppm) of of garlic at 120 days after planting as affected by the interaction between nitrogen and phosphorus fertilizer sources during 2004/2005 and 2005/2006 seasons.

Treatments	Characters	N %		P %		K %		NO_3 (ppm)		NO_2 (ppm)	
		2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
Calcium nitrate	Super phosphate powder	2.89	2.92	0.490	0.487	1.41	1.41	280.3	282.1	3.65	3.67
	Rock phosphate	2.70	2.73	0.482	0.468	1.37	1.38	271.1	275.8	3.46	3.52
	Super phosphate granules	2.90	2.91	0.532	0.522	1.47	1.46	283.6	282.6	3.71	3.73
Ammonium sulphate	Super phosphate powder	3.29	3.32	0.623	0.598	1.50	1.53	241.6	244.3	3.31	3.36
	Rock phosphate	3.21	3.28	0.653	0.622	1.48	1.49	233.0	233.1	3.17	3.22
	Super phosphate granules	3.26	3.33	0.632	0.627	1.55	1.54	247.1	250.6	3.35	3.36
Sulphur coated urea	Super phosphate powder	3.68	3.68	0.672	0.667	1.83	1.81	192.5	195.1	2.80	2.83
	Rock phosphate	3.59	3.56	0.638	0.640	1.78	1.77	187.1	188.5	2.73	2.73
	Super phosphate granules	3.60	3.67	0.635	0.627	1.89	1.85	193.1	197.1	2.84	2.83
Bentonite coated urea	Super phosphate powder	3.37	3.45	0.597	0.580	1.60	1.60	191.3	191.3	2.78	2.79
	Rock phosphate	3.37	3.42	0.593	0.565	1.57	1.57	181.8	179.6	2.68	2.70
	Super phosphate granules	3.44	3.49	0.577	0.568	1.65	1.63	191.3	194.5	2.81	2.79
L.S.D. at 5 %		0.08	N.S.	N.S.	N.S.	0.01	0.01	3.0	3.6	0.01	0.03

6-Interaction effect between P-sources and VAM fungi :

Concerning the interaction effect of P-sources with VAM fungi on mineral composition of garlic bulbs, data in Table (7) indicate that there were significantly increases on P % , in the first season and K %, in both seasons. While, N % concentration was not significantly affected by the interaction, in both seasons and P % concentration, in the second season of the study. The highest values obtained by application of rock phosphate with VAM fungi on P %, in the first season, and by application super phosphate granules and inoculated with VAM fungi in case of K % concentration of garlic bulb, in both seasons. Nitrate accumulation was significantly reduced, in the first season only by rock phosphate with VAM fungi, while, in the second season was not significantly affected by the interaction. the lowest records of NO_2 accumulation, in both seasons obtained by rock phosphate with VAM fungi. The obtained results are nearly with the results obtained by Hammad and Abdel-Ati(1998) on potato and Mengistu and Singh (1999) on onion.

Table 7: N %, P %, K %, NO_3 and NO_2 accumulation (ppm) of of garlic at 120 days after planting as affected by the interaction between nitrogen fertilizer sources and VAM fungi as well as phosphorus fertilizer sources and VAM fungi during 2004/2005 and 2005/2006 seasons.

Treatments \ Characters		N %		P %		K %		NO_3 (ppm)		NO_2 (ppm)	
		2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
Interaction between nitrogen fertilizer sources and VAM fungi											
Calcium nitrate	**Without**	2.71	2.73	0.424	0.417	1.36	1.36	288.2	291.7	3.78	3.81
	With	2.95	2.97	0.578	0.568	1.47	1.48	268.5	268.6	3.43	3.47
Ammonium sulphate	**Without**	3.04	3.09	0.529	0.536	1.44	1.44	252.2	256.2	3.43	3.46
	With	3.46	3.53	0.743	0.696	1.58	1.60	229.0	229.2	3.12	3.16
Sulphur coated urea	**Without**	3.37	3.38	0.504	0.524	1.75	1.73	199.6	204.1	2.90	2.91
	With	3.87	3.90	0.792	0.764	1.91	1.89	182.2	183.1	2.68	2.68
Bentonite coated urea	**Without**	3.26	3.30	0.459	0.457	1.55	1.54	198.3	198.8	2.87	2.86
	With	3.52	3.61	0.719	0.686	1.66	1.67	178.0	178.1	2.64	2.65
L.S.D. at 5 %		0.07	0.09	0.039	0.032	0.01	0.01	1.3	2.2	0.02	0.02
Interaction between phosphorus fertilizer sources and VAM fungi											
Super phosphate powder	**Without**	3.15	3.17	0.500	0.496	1.52	1.51	236.9	240.1	3.29	3.31
	With	3.47	3.52	0.691	0.670	1.64	1.66	216.0	216.3	2.98	3.02
Rock phosphate	**Without**	3.02	3.04	0.449	0.466	1.49	1.48	229.3	231.0	3.17	3.19
	With	3.42	3.46	0.734	0.682	1.62	1.62	207.2	207.5	2.85	2.89
Super phosphate granules	**Without**	3.13	3.17	0.488	0.488	1.56	1.56	237.5	242.0	3.28	3.29
	With	3.47	3.53	0.699	0.683	1.71	1.69	220.0	220.5	3.07	3.07
L.S.D. at 5 %		N.S.	N.S.	0.034	N.S.	0.01	0.01	1.1	N.S.	0.01	0.02

7-Interaction effect between N-sources, P-sources and VAM fungi :

Data presented in Table (8) show the interaction effect among N-sources, P-sources and VAM fungi on macronutrients uptake, i.e., N %, P %, K %, NO_3 and NO_2 concentration of garlic bulbs. Obtained results revealed significant increases in K % content, in both seasons. While N % and P % were not significantly affected by the above mentioned interaction, in both seasons. The best records of K % content of garlic bulbs obtained by application of sulphur coated urea with super phosphate granules in the presence of VAM fungi. The lowest values of NO_3 and NO_2 concentration obtained by application of bentonite coated urea with rock phosphate with VAM fungi, in both seasons followed by results obtained by applying of sulphur coated urea with rock phosphate with VAM fungi, in both seasons. Similar results were obtained by Hammad and Abdel-Ati (1998) on potato and Mingistu and Singh (1999) on onion and Awad(2002) on potato.

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تأثير بعض مصادر الأسمدة الأزوتية والفوسفاتية والتلقيح بالميكورهيزا على نمو وانتاجية وتخزين الثوم

1- النمو الخضرى و المحتوى الكيماوى.

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أجريت هذه الدراسة على محصول الثوم(سدس – ٤٠) خلال موسمى الدراسة ٢٠٠٤ – ٢٠٠٥ ، ٢٠٠٥ – ٢٠٠٦ بهدف دراسة تأثير بعض مصادرالأسمدة الأزوتية مثل نترات الكالسيوم ،سلفات الأمونيوم ، اليوريا المغلفة بالكبريت واليوريا المغلفة بالبنتونايت وبعض مصادر الأسمدة الفوسفاتية مثل سوبر فوسفات الكالسيوم كل من الناعم والمحبب وصخر الفوسفات وكذلك التلقيح بفطر الميكورهيزا والتفاعل بين هذه العوامل على النمو الخضرى والمكونات الكيماوية لأبصال الثوم. وتشير النتائج المتحصل عليها الى أن طول النبات والوزن الجاف والمساحة الورقية للنبات ومحتوى الكلوروفيل الكلى وقطر العنق وقطر البصلة زادت معنويا باضافة سماد سلفات الامونيوم كمصدر للنتروجين فى كلا موسمى الدراسة. كما أدت اضافة سماد السوبر فوسفات الناعم الى حدوث زيادة معنوية فى كل من طول النبات والوزن الجاف والمساحة الورقية للنبات ومحتوى الكلوروفيل الكلى وقطر البصلة فى كلا موسمى الدراسة، بينما عدد الأوراق وقطر العنق ونسبة التبصيل لم تتأثر معنويا بأى من مصادر الفوسفور فى موسمى الدراسة. أدى التلقيح بفطر الميكورهيزا الى نباتات الثوم الى حدوث زيادة معنوية فى معظم الصفات المدروسة ما عدا عدد الأوراق وقطر العنق ونسبة التبصيل لم تتأثر معنويا بأى من مصادر الفوسفور فى كلا موسمى الدراسة.

زادت النسبة المئوية لمحتوى كل من النتروجين والفوسفور والبوتاسيوم باضافة سماد اليوريا المغلفة بالكبريت كما أن هذه المعاملة قللت تركيز النترات والنتريت فى أبصال الثوم ولكن التركيز الأقل حدث باضافة اليوريا المغلفة بالبنتونايت، كما لم تتأثر النسبة المئوية لمحتوى الفوسفور بأى من مصادر الفوسفور. وكان التلقيح بفطر الميكورهيزا أعطى زيادات معنوية فى النسبة المئوية لمحتوى كل من النتروجين والفوسفور و البوتاسيوم وقللت جدا من تركيز النترات والنتريت فى أبصال الثوم فى كلا موسمى الدراسة.

Table 1: Plant height, number of leaves/plant, dry weight /plant, leaf area/plant, total chlorophyll content/plant SPAD unit, neck diameter/plant, bulb diameter and bulbing ratio of garlic at 120 days after planting as affected by some nitrogen and phosphorus fertilizer sources as well as VAM fungi during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	Plant height (cm)		Number of leaves /plant		Dry weight /plant (g)		Leaf area/ plant (m^2)		Total Chlorophyll content/plant SPAD unit		Neck diameter/plant (cm)		bulb diameter (cm)		bulbing ratio	
	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
A- Nitrogen fertilizer sources																
Calcium nitrate	78.41	79.34	10.04	9.64	12.48	12.95	0.149	0.157	100.42	99.39	1.08	1.11	3.50	3.42	0.309	0.326
Ammonium sulphate	82.07	82.69	10.28	10.22	13.91	13.95	0.170	0.176	101.86	101.22	1.37	1.35	4.13	4.11	0.334	0.332
Sulphur coated urea	80.44	81.27	10.32	10.35	13.06	13.95	0.173	0.176	100.35	99.54	1.30	1.35	3.85	3.94	0.337	0.343
Bentonite coated urea	79.85	80.64	10.46	10.46	12.70	12.67	0.164	0.167	99.08	98.32	1.32	1.29	3.59	3.73	0.368	0.346
L.S.D. at 5 %	0.38	0.39	N.S.	N.S.	0.07	0.15	0.005	0.005	0.17	0.52	0.06	0.06	0.13	0.05	0.017	N.S.
B- Phosphorus fertilizer sources																
Super phosphate powder	80.71	81.44	10.21	9.89	13.56	13.73	0.166	0.170	101.82	100.68	1.30	1.26	3.86	3.85	0.337	0.328
Rock phosphate	79.34	80.13	10.41	10.24	12.58	13.06	0.159	0.164	99.24	98.60	1.24	1.27	3.62	3.71	0.343	0.345
Super phosphate granules	80.53	81.38	10.20	10.37	12.98	13.35	0.167	0.174	100.22	99.58	1.27	1.29	3.83	3.84	0.331	0.337
L.S.D. at 5 %	0.18	0.22	N.S.	N.S.	0.11	0.10	0.004	0.004	0.22	0.19	N.S.	N.S.	0.09	0.08	N.S.	N.S.
C- VAM fungi																
Without	79.14	80.06	10.32	10.15	11.27	11.53	0.138	0.141	99.17	98.53	1.104	1.11	3.31	3.27	0.333	0.340
With	81.25	81.91	10.23	10.18	14.81	15.23	0.190	0.197	101.69	100.70	1.441	1.44	4.23	4.33	0.341	0.334
F. test	*	*	N.S.	N.S.	*	*	*	*	*	*	*	*	*	*	N.S.	N.S.

Table 2: Plant height, number of leaves/plant, dry weight /plant, leaf area/plant, total chlorophyll content/plant SPAD unit, neck diameter/plant, bulb diameter and bulbing ratio of garlic at 120 days after planting as affected by the interaction between nitrogen and phosphorus fertilizer sources during 2004/2005 and 2005/2006 seasons.

Treatments	Characters	Plant height (cm)		Number of leaves/plant		Dry weight /plant (g)		Leaf area/ plant (m^2)		Total Chlorophyll content/plant SPAD unit		Neck diameter/plant (cm)		bulb diameter (cm)		bulbing ratio	
		2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005 /2006	2004 2005	2005/ 2006
Calcium nitrate	**Super phosphate powder**	77.93	78.82	10.00	8.73	13.09	13.43	0.141	0.144	**101.82**	**99.98**	1.05	1.11	3.58	3.35	0.293	0.335
	Rock phosphate	77.67	78.99	10.40	10.10	12.49	12.95	0.149	0.159	**99.54**	**98.99**	1.04	1.06	3.26	3.27	0.318	0.326
	Super phosphate granules	79.63	80.21	9.73	10.10	11.87	12.47	0.158	0.169	**99.90**	**99.21**	1.15	1.15	3.67	3.65	0.315	0.318
Ammonium sulphate	**Super phosphate powder**	83.86	84.34	10.16	10.20	14.20	14.64	0.176	0.180	**103.29**	**102.70**	1.40	1.38	4.30	4.30	0.326	0.322
	Rock phosphate	80.85	81.11	10.33	10.06	13.33	13.26	0.161	0.169	**100.64**	**100.15**	1.35	1.34	4.02	4.06	0.339	0.338
	Super phosphate granules	81.52	82.60	10.36	10.40	14.20	13.97	0.171	0.177	**101.64**	**100.82**	1.37	1.33	4.09	3.99	0.337	0.336
Sulphur coated urea	**Super phosphate powder**	80.89	81.82	10.33	10.16	13.57	14.00	0.179	0.185	**101.70**	**100.74**	1.41	1.33	4.00	4.05	0.353	0.329
	Rock phosphate	79.83	80.61	10.30	10.30	12.39	13.73	0.162	0.165	**99.11**	**98.25**	1.25	1.36	3.70	3.82	0.339	0.356
	Super phosphate granules	80.60	81.38	10.33	10.60	13.23	14.13	0.178	0.178	**100.26**	**99.64**	1.24	1.35	3.87	3.95	0.319	0.345
Bentonite coated urea	**Super phosphate powder**	80.16	80.79	10.36	10.46	13.37	12.85	0.166	0.169	**100.49**	**99.30**	1.33	1.22	3.56	3.72	0.376	0.327
	Rock phosphate	79.02	79.82	10.63	10.50	12.12	12.31	0.164	0.162	**97.66**	**97.02**	1.32	1.33	3.51	3.70	0.375	0.361
	Super phosphate granules	80.37	81.32	10.40	10.41	12.63	12.85	0.162	0.170	**99.09**	**98.64**	1.31	1.32	3.70	3.77	0.354	0.349
L.S.D. at 5 %		0.37	0.43	N.S.	N.S.	0.22	0.20	0.007	0.007	N.S.	0.38	N.S.	N.S.	0.17	0.15	N.S.	N.S.

Table 3: Plant height, number of leaves/plant, dry weight /plant, leaf area/plant, total chlorophyll content/plant SPAD unit, neck diameter/plant, bulb diameter and bulbing ratio of garlic at 120 days after planting as affected by the interaction between nitrogen fertilizer sources and VAM fungi as well as phosphorus fertilizer sources and VAM fungi during 2004/2005 and 2005/2006 seasons.

Treatments \ Characters		Plant height (cm)		Number of leaves/plant		Dry weight /plant (g)		Leaf area/ plant (m^2)		Total Chlorophyll content/plant SPAD unit		Neck diameter/plant (cm)		bulb diameter (cm)		bulbing ratio	
		2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
Interaction between nitrogen fertilizer sources and VAM fungi																	
Calcium nitrate	**Without**	77.29	78.51	10.20	10.13	10.73	11.28	0.124	0.128	**99.27**	**98.51**	0.96	1.01	3.14	2.99	0.308	0.338
	With	79.54	80.17	9.88	9.15	14.23	14.61	0.174	0.186	**101.57**	**100.27**	1.20	1.21	3.87	3.86	0.310	0.314
Ammonium sulphate	**Without**	80.80	81.60	10.08	10.00	11.88	11.99	0.141	0.147	**100.51**	**100.00**	1.19	1.18	3.55	3.43	0.337	0.348
	With	83.34	83.77	10.48	10.44	15.94	15.92	0.198	0.204	**103.20**	**102.44**	1.56	1.52	4.71	4.80	0.331	0.317
Sulphur coated urea	**Without**	79.38	80.30	10.42	10.24	11.28	11.88	0.147	0.150	**99.05**	**98.47**	1.11	1.16	3.39	3.43	0.330	0.338
	With	81.50	82.25	10.22	10.46	14.85	16.03	0.199	0.202	**101.66**	**100.62**	1.48	1.54	4.32	4.44	0.344	0.348
Bentonite coated urea	**Without**	79.08	79.84	10.57	10.24	11.17	10.99	0.140	0.139	**97.83**	**97.15**	1.13	1.08	3.17	3.24	0.359	0.335
	With	80.62	81.45	10.35	10.67	14.24	14.35	0.188	0.195	**100.33**	**99.49**	1.51	1.50	4.01	4.21	0.377	0.356
L.S.D. at 5 %		0.36	N.S.	0.36	N.S.	0.13	0.14	N.S.	N.S.	N.S.	N.S.	N.S.	0.05	0.13	0.14	N.S.	0.020
Interaction between phosphorus fertilizer sources and VAM fungi																	
Super phosphate powder	**Without**	79.70	80.61	10.21	10.10	11.81	11.71	0.142	0.144	**100.64**	**99.56**	1.14	1.09	3.48	3.41	0.328	0.323
	With	81.72	82.28	10.21	9.68	15.30	15.75	0.189	0.195	**103.01**	**101.79**	1.46	1.43	4.24	4.30	0.346	0.333
Rock phosphate	**Without**	78.31	79.17	10.56	10.16	10.34	10.99	0.129	0.131	**97.76**	**97.44**	1.03	1.08	3.05	3.07	0.338	0.352
	With	80.37	81.09	10.26	10.31	14.83	15.13	0.188	0.196	**100.71**	**99.77**	1.45	1.47	4.20	4.36	0.347	0.338
Super phosphate granules	**Without**	79.40	80.40	10.18	10.20	11.65	11.90	0.143	0.148	**99.10**	**98.59**	1.13	1.15	3.41	3.35	0.334	0.344
	With	81.65	82.36	10.23	10.55	14.31	14.81	0.192	0.200	**101.34**	**100.56**	1.40	1.43	4.26	4.33	0.329	0.330
L.S.D. at 5 %		N.S.	N.S.	N.S.	N.S.	0.11	0.12	0.006	0.004	0.29	N.S.	0.08	0.05	0.11	0.12	N.S.	N.S.

Table 4: Plant height, number of leaves/plant, dry weight /plant, leaf area/plant, total chlorophyll content/plant SPAD unit, neck diameter/plant, bulb diameter and bulbing ratio of garlic at 120 days after planting as affected by the interaction among nitrogen and phosphorus fertilizer sources as well as VAM fungi during 2004/2005 and 2005/2006 seasons.

Treatments		Characters	Plant height (cm)		Number of leaves/plant		Dry weight /plant (g)		Leaf area/ plant (m^2)		Total Chlorophyll content/plant SPAD unit		Neck diameter/plant (cm)		bulb diameter (cm)		bulbing ratio	
			2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
Calcium nitrate	Super phosphate powder	Without	76.82	78.00	10.06	10.33	11.14	11.41	0.127	0.129	100.89	99.45	0.93	1.01	3.36	2.98	0.277	0.342
		With	79.04	79.65	9.93	7.13	15.04	15.45	0.155	0.160	102.75	100.52	1.18	1.22	3.80	3.72	0.310	0.328
	Rock phosphate	Without	76.63	78.18	10.60	10.26	10.25	11.09	0.114	0.122	98.19	97.90	0.84	0.93	2.74	2.77	0.308	0.337
		With	78.72	79.80	10.20	9.93	14.74	14.81	0.183	0.196	100.89	100.07	1.24	1.19	3.79	3.77	0.327	0.315
	Super phosphate granules	Without	78.41	79.35	9.93	9.80	10.82	11.34	0.131	0.135	98.73	98.19	1.12	1.08	3.32	3.22	0.338	0.337
		With	80.85	81.08	9.53	10.40	12.92	13.59	0.185	0.203	101.07	100.23	1.17	1.22	4.03	4.09	0.292	0.300
Ammonium sulphate	Super phosphate powder	Without	82.80	83.53	10.06	10.00	11.95	12.43	0.149	0.154	101.70	101.18	1.20	1.18	3.86	3.71	0.311	0.320
		With	84.92	85.15	10.26	10.40	16.46	16.85	0.203	0.207	104.88	104.22	1.61	1.58	4.74	4.88	0.342	0.324
	Rock phosphate	Without	79.57	80.01	10.33	9.93	10.51	11.29	0.128	0.132	99.27	98.87	1.10	1.15	3.19	3.14	0.345	0.368
		With	82.12	82.22	10.33	10.20	16.15	15.23	0.193	0.205	102.02	101.42	1.60	1.53	4.84	4.98	0.332	0.308
	Super phosphate granules	Without	80.05	81.27	9.86	10.06	13.20	12.26	0.147	0.155	100.57	99.96	1.28	1.22	3.62	3.44	0.354	0.355
		With	82.99	83.94	10.86	10.73	15.20	15.68	0.196	0.199	102.71	101.68	1.46	1.44	4.56	4.54	0.320	0.318
Sulphur coated urea	Super phosphate powder	Without	79.71	80.75	10.33	9.93	11.97	11.80	0.150	0.155	100.41	99.61	1.22	1.15	3.61	3.61	0.338	0.319
		With	82.06	82.90	10.33	10.40	15.18	16.20	0.209	0.215	102.99	101.87	1.61	1.51	4.39	4.48	0.368	0.338
	Rock phosphate	Without	78.94	79.67	10.46	10.13	10.55	11.15	0.138	0.139	97.45	97.14	1.10	1.11	3.16	3.21	0.347	0.348
		With	80.72	81.54	10.13	10.46	14.24	16.32	0.185	0.191	100.76	99.37	1.40	1.61	4.24	4.43	0.330	0.365
	Super phosphate granules	Without	79.48	80.47	10.46	10.66	11.33	12.68	0.153	0.156	99.30	98.66	1.03	1.21	3.39	3.49	0.304	0.348
		With	81.71	82.30	10.20	10.53	15.13	15.58	0.203	0.201	101.23	100.62	1.44	1.50	4.34	4.41	0.334	0.341
Bentonite coated urea	Super phosphate powder	Without	79.47	80.16	10.40	10.13	12.19	11.21	0.143	0.139	99.56	98.02	1.20	1.04	3.11	3.33	0.388	0.312
		With	80.86	81.42	10.33	10.80	14.55	14.50	0.190	0.199	101.42	100.58	1.46	1.41	4.01	4.11	0.364	0.343
	Rock phosphate	Without	78.11	78.81	10.86	10.33	10.05	10.45	0.137	0.132	96.13	95.85	1.09	1.12	3.10	3.15	0.352	0.358
		With	79.94	80.83	10.40	10.66	14.19	14.17	0.191	0.192	99.19	98.20	1.56	1.55	3.92	4.25	0.398	0.364
	Super phosphate granules	Without	79.67	80.54	10.46	10.26	11.27	11.32	0.141	0.145	97.81	97.58	1.11	1.09	3.30	3.26	0.339	0.336
		With	81.06	82.11	10.33	10.56	13.99	14.38	0.183	0.195	100.37	99.70	1.52	1.55	4.11	4.28	0.370	0.362
L.S.D. at 5 %			N.S.	N.S.	N.S.	N.S.	0.22	0.24	0.011	0.008	0.58	N.S.	0.15	N.S.	0.22	N.S.	0.045	N.S.

Table 5: N %, P %, K %, NO_3 and NO_2 accumulation (ppm) of garlic as affected by some nitrogen and phosphorus fertilizer sources as well as VAM fungi during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	N %		P %		K %		NO_3 (ppm)		NO_2 (ppm)	
	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
A- Nitrogen fertilizer sources										
Calcium nitrate	2.83	2.85	0.501	0.492	1.42	1.42	278.3	280.2	3.61	3.64
Ammonium sulphate	3.25	3.31	0.636	0.616	1.51	1.52	240.6	242.7	3.28	3.31
Sulphur coated urea	3.62	3.64	0.648	0.644	1.83	1.81	190.9	193.6	2.79	2.80
Bentonite coated urea	3.39	3.45	0.589	0.571	1.60	1.60	188.1	188.5	2.75	2.76
L.S.D. at 5 %	0.09	0.06	0.024	0.027	0.01	0.01	1.5	1.8	0.01	0.01
B- Phosphorus fertilizer sources										
Super phosphate powder	3.31	3.34	0.595	0.583	1.58	1.59	226.4	228.2	3.13	3.16
Rock phosphate	3.22	3.25	0.592	0.574	1.55	1.55	218.2	219.2	3.01	3.04
Super phosphate granules	3.30	3.35	0.594	0.586	1.64	1.62	228.8	228.2	3.18	3.18
L.S.D. at 5 %	0.04	0.04	N.S.	N.S.	0.01	0.01	1.5	1.8	0.01	0.01
C- VAM fungi										
Without	3.10	3.13	0.479	0.483	1.52	1.52	234.6	237.7	3.25	3.26
With	3.45	3.50	0.708	0.678	1.66	1.66	214.4	214.7	2.97	2.99
F. test	*	*	*	*	*	*	*	*	*	*

Table 8: N %, P %, K %, NO_3 and NO_2 accumulation (ppm) of of garlic at 120 days after planting as affected by the interaction among nitrogen and phosphorus fertilizer sources as well as VAM fungi during 2004/2005 and 2005/2006 seasons.

Treatments		Characters	N %		P %		K %		NO_3 (ppm)		NO_2 (ppm)	
			2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006	2004/ 2005	2005/ 2006
Calcium nitrate	Super phosphate powder	Without	2.83	2.85	0.427	0.417	1.37	1.36	290.6	297.0	3.85	3.86
		With	2.96	2.99	0.553	0.557	1.46	1.47	270.0	267.3	3.46	3.49
	Rock phosphate	Without	2.52	2.54	0.383	0.380	1.32	1.33	281.3	286.0	3.71	3.75
		With	2.89	2.92	0.580	0.557	1.43	1.43	261.0	265.6	3.22	3.29
	Super phosphate granules	Without	2.79	2.81	0.463	0.453	1.40	1.40	292.6	292.3	3.80	3.83
		With	3.02	3.01	0.600	0.590	1.54	1.53	274.6	273.0	3.62	3.64
Ammonium sulphate	Super phosphate powder	Without	3.05	3.11	0.557	0.547	1.44	1.44	253.3	257.3	3.47	3.51
		With	3.53	3.53	0.690	0.650	1.57	1.62	230.0	231.3	3.16	3.21
	Rock phosphate	Without	3.03	3.07	0.507	0.517	1.41	1.41	245.0	246.3	3.32	3.36
		With	3.39	3.50	0.800	0.727	1.56	1.57	221.0	220.0	3.01	3.07
	Super phosphate granules	Without	3.06	3.10	0.523	0.543	1.48	1.48	258.3	265.0	3.50	3.51
		With	3.47	3.57	0.740	0.710	1.62	1.61	236.0	236.3	3.20	3.21
Sulphur coated urea	Super phosphate powder	Without	3.44	3.44	0.543	0.543	1.75	1.72	201.0	204.0	2.93	2.96
		With	3.92	3.93	0.800	0.790	1.91	1.90	184.0	186.3	2.67	2.71
	Rock phosphate	Without	3.31	3.29	0.467	0.523	1.71	1.68	197.6	200.0	2.85	2.85
		With	3.86	3.83	0.810	0.757	1.86	1.86	176.6	177.0	2.62	2.61
	Super phosphate granules	Without	3.36	3.41	0.503	0.507	1.81	1.79	200.3	208.3	2.94	2.93
		With	3.83	3.93	0.767	0.747	1.97	1.92	186.0	186.0	2.75	2.74
Bentonite coated urea	Super phosphate powder	Without	3.27	3.27	0.473	0.477	1.55	1.54	202.6	202.3	2.91	2.93
		With	3.47	3.62	0.720	0.683	1.65	1.67	180.0	180.3	2.65	2.66
	Rock phosphate	Without	3.21	3.25	0.440	0.443	1.52	1.51	193.3	192.0	2.81	2.79
		With	3.53	3.59	0.747	0.687	1.63	1.64	170.3	167.3	2.56	2.61
	Super phosphate granules	Without	3.31	3.38	0.463	0.450	1.58	1.57	199.0	202.3	2.90	2.88
		With	3.56	3.60	0.690	0.687	1.71	1.70	183.6	186.6	2.72	2.70
L.S.D. at 5 %			N.S.	N.S.	N.S.	N.S.	0.02	0.02	2.2	3.9	0.03	0.03