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GROWTH, YIELD AND QUALITY OF POTATO CROP AS AFFECTED BY THE INOCULATION WITH VESICULAR-ARBUSCULAR MYCORRHIZAL (VAM) FUNGI UNDER DIFFERENT LEVELS OF PHOSPHOROUS.

Awad, E. M.
Vegetable Res. Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Chemical fertilizers are commonly added to potato plants to produce high yield although, the use of biofertilizers is more economical and much saving than the use of inorganic fertilizers, which already raised the pollution of the environment.

Therefore, this study was conducted in two successive summer seasons of 2000 and 2001 on potato cv. Spunta at Baramoon Experimental Farm, Dakahlia Governorate, Egypt, to investigate the effect of vesicular-arbuscular mycorrhizal (VAM) fungi and four levels of chemical phosphorous i.e., 0, 25, 50 and 75 kg P_2O_5/fed. as well as to study the interaction on growth, tuber yield and their components of potato plant. Moreover, the contents of NPK in foliage, starch and nitrate in tubers.

The obtained results revealed that inoculation potato seed tubers with VAM fungi before planting markedly increased vegetative growth, i.e., plant height, foliage fresh weight/plant, number of main stems/plant, foliage dry weight, total tuber yield (ton/fed.), number of tubers/plant, tuber average weight, tuber dry matter/plant, NPK contents in foliage and starch content in tubers while, the concentration of nitrate decreased in tuber by using of VAM fungi during both seasons

Vegetative growth (plant height, foliage fresh weight/plant, number of main stems/plant) NPK and nitrate contents increased with increasing phosphorous fertilizer at level 75 kg P_2O_5/fed. while, higher value of foliage dry weight, total tuber yield and its component (tuber average weight, tuber dry matter/plant), NPK and nitrate contents in tuber treatment receiving 50 kg P_2O_5/fed.of P fertilizer.

The positive interaction between VAM fungi and phosphorous levels on plant height (in first season), total tuber yield and NP contents in foliage in the two seasons.

Generally, the results indicated that inoculation potato seed tubers with VAM fungi at the rate 12.5 kg/ton) before planting in addition to 50 kg P_2O_5/fed. gave higher total tuber yield/fed. and starch content in tuber.

Thus inoculation with VAM fungi before planting raised the efficiency of P fertilizer and would decrease the required rate to plants about by 25 %. Consequently increase the productivity and improving quality of tuber, in addition to produce the pollution of environment.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is important nutritionally because it can supply carbohydrates for energy, proteins, vitamins and minerals for growth and health (Burtan, 1966).

Phosphorus is one of the most important nutrients for potato growth, particularly in heavy soils. The inadequate supply of this element to the crop

retards growth of plants, particularly the terminal growth during the early stages and hasten maturation (Grewal, 1990).

In Egypt the most important problem of phosphate fertilization is 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 (Abdel-Nasser and Makawi, 1979 and El-Dahtory *et al.*, 1989). This could be explained that our soil needs a high amount of phosphorus to complete the plant requirements and consequently it may be increase the cost of potato production.

In this respect, El-Gamal (1985), Tukoki and Mohler (1990) and Shehata *et al.* (1994) reported that plant height, average number of main stems/plant and foliage fresh weight significantly increased with increasing phosphorous levels. El-Banna and Abd El-Salam (2000) indicated that average of potato tubers weight increased significantly by application of rock phosphate. El-Kader (2002); Awad (1997) and Arisha and Bardisi (1999) found significantly increases in vegetative growth and tuber yield by increasing phosphorus levels. Hossam *et al.* (1997); Freeman *et al.* (1998) and Ali (2002) declared that application of P increased stem number/m^2 and mean tuber weight and tuber yield. However, Shehata *et al.* (1994); Abdel-Ati (1998) and El-Kader (2002) indicated that increasing P to 62 kg P_2O_5/fed., increased plant height, number of branches/plant, number and weight of tubers/plant, total yield/fed., tuber dry matter (%) and N, P and K contents in leaves and tubers.

Therefore, it is essentially to use vesicular-arbuscular mycorrhiza (VAM) fungi as a biofertilizers to improve soil fertility and save a considerable amount of phosphorus requirement, as well as, decrease the pollution of environment (Mahmoud and Abdel-Hafez, 1982).

The improvement of phosphorous uptake and plant growth by arbuscular mycorrhizae (AM) has been well documented in many crop plants (Abbot and Roberson, 1984; Smith and Gianinazzi, 1988; Khalifa and Badr, 1992; Bonfante and Peratto, 1995 and Leadir *et al.*, 1998). They found that the vesicular-arbuscular mycorrhiza (VAM) inoculation of plants greatly increased the rate of photosynthesis compared with noninoculated plants and they attributed the increased growth of the mycorrhizal plants to the increased in photosynthesis.

Vosatka and Gryndler (1999) found that inoculation of potato plants with VAM fungus increased the weight of the biggest tuber and the total weight of tubers.

Black and Tinker (1977) reported that inoculation of potato plant by VAM, led to seed tuber yield increased by 20%. On the other hand, Abdel-Naem *et al.* (1999) mentioned that potato tubers variety Alpha were inoculated with Azospirillum and /or vesicular-arbuscular mycorrhiza (VAM) gave higher levels of dry matter than the untreated plants. Hammad and Abdel-Ati (1998) reported that the total and marketable yield of potato tubers of Diamont variety were significantly higher in Azospirillum or VAM inoculated plants as compared to uninoculated.

Hammad and Abdel-Ati (1998); Abdel-Naem *et al.* (1999) mentioned that the potato tubers of plants inoculated with Azospirillum and / or VAM

fungus gave significant increases in the concentration of NP and uptake value. On the other hand, the same authors observed reduction of nitrate and nitrate contents of potato tubers via biofertilization with Azospirillum and VA-Mycorrhizal fungi.

El-Morsy *et al.* (2002) found that application of VAM fungi to sweet potato markedly increased most vegetative parameters, total yield and quality than untreated plants.

Kandasamy *et al.* (1988) indicated that inoculated of sweet potato cuttings with VAM fungus and /or *Azospirillum brasilense* resulted in significantly higher plants N and P contents, tuber weight and starch content than the uninoculated control.

The aim of this present study was to evaluate the effects of vesicular-arbuscular mycorrhiza (VAM) fungi inoculation, different phosphorus levels and their interaction on plant growth, tuber yield and some nutrient contents of potato plants as well as to investigate the possible in decreasing the inorganic phosphorus application and to avoid environment pollution.

MATERIALS AND METHODS

Two field experiments were conducted at Baramon Experimental Farm, Dakahlia Governorate during the two summer seasons of 2001 and 2002 on potato cv. Spunta. Seed tubers pieces were planted on 14 and 18 January in the 1st and 2nd season, respectively, with an average weight of about 50 g for each planted on rows of 75 and 25 cm within row.

Some physical and chemical properties of the soil at depth of 0.- 30 cm are shown in Table (1)

Table (1):Some physical and chemical properties of the soil.

Sand (%)	Silt (%)	Clay (%)	Texture	O.M. (%)	$CaCO_3$ %	pH	Available nutrients (ppm)		
							N	P	K
26.0	25.8	43.0	Clayey	1.9	3.7	7.8	20.3	15.4	295

Vesicular-arbuscular mycorrhizal fungi (VAM) was obtained from Fungus Control Res. Dept., Plant Pathology Res. Inst., Agric. Res. Center, Giza.

Potato tuber seeds were mixed with inoculated Mycorrhizal fungi as biofertilizer at rate 12.5 kg/ton. Multi VA- Mycorrhiza fungi (*Glomus spp.* & *Gigaspora spp.*). The spores count was found to be 145 spore/1g soil, added to the soil immediately before planting.

Nitrogen (180 kg/fed.) in the form of ammonium nitrate (33.5 % N) was added at three equal portions at 3, 5 and 7 weeks from planting, while potassium sulphate (48 % K_2O) was added once after 7 weeks from planting date at the rate of 96 K_2O/fed.

The experimental treatments and design:

The experimental design was split plot design with three replicates. Inorganic phosphorous with four levels (0, 25, 50 and 75 kg P_2O_5/fed.) was

randomly distributed in the main plots, while sub-plots were assigned to treated and untreated with vesicular-arbuscular mycorrhizal fungi (VAM). The sub-plot area was 11.25 m^2 which contained 3 ridges, with 5 m length and 0.75 m width. Inorganic phosphorus was added in the form of calcium superphosphate (15.5 % P_2O_5) once before planting. Other field practices were recommended by the Ministry of Agriculture.

Studied characters

Vegetative growth characters:

At 70 days after planting (DAP), a random sample (5 plants) from each plot was taken and the following data were recorded: plant height, number of main stem/plant, foliage fresh/plant and foliage dry weight (%).

Yield and its components:

At harvest time (105 DAP) tuber yield (ton/fed.), average of number tubers/plant, average of tubers weight and dry matter of tubers (%) were estimated.

Tuber quality:

Dry matter (%) and starch content (%) in tubers were evaluated according to A.O.A.C (1990) method.

Chemical composition:

At 70 days after planting the mineral contents N, P and K (%) were estimated in dry matter of leaves samples. Nitrogen was determined by micro-kjeldahl method. Phosphorous was determined calorimetrically as described by Jackson (1967). Potassium was determined by using a flame photometer (Jackson, 1967).

Nitrate concentration ppm estimated was measured as described by Singh (1988).

Data were statistically analyzed and means were compared by using L.S.D test as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Vegetative growth parameters

a- Effect of VA- Mycorrhizal fungi:

Data presented in Table (2) indicate that inoculation potato seed tuber with VAM led to a significant increases in the vegetative growth parameters, i.e. plant height, number of main stems/plant, foliage fresh weight/plant and foliage dry weight (%) as compared with uninoculated treatments in the two growing seasons. The superior effect of VAM could be explained in the light of the great role played via mycorrhizal mycelia means that they are more effective than plant root hairs at absorbing nutrient elements including phosphorous, nitrogen, potassium, calcium and some micro-nutrients, rate of photosynthesis and phytohormones such as gibberellins, auxins and cytokinins significantly promote plant growth. Similar results were reported by

Trent *et al* (1989), Thampson (1990), Verma and Jamaluddin (1994), Verma and Arya (1998) and Leadir *et al.* (1998)

b- Effect of phosphorous levels:

Data in Table (2) reveal that vegetative growth of potato plants, i.e. plant height, number of main stems/plant, foliage fresh weight/plant and foliage dry weight (%) were significantly increased with increasing P fertilizer levels in both growing seasons. The simulative effect of P on growth parameters may be due to that phosphorous activated photosynthesis and metabolic process of organic compounds in plants, the energy transfer compounds consequently increasing plant growth. These results are similar to those of Gardener *et al.* (1985), Arisha and Bardisi (1999). Also, Tukoki and Mohler (1990), Shehata *et al.* (1994) and Abdel Ati (1998) reported that plant height, average number of main stems/plant and foliage fresh weight significantly increased with increasing phosphorous levels.

c- The interactions between VAM and phosphorous levels

Data in Table (2) clear also, that the interactions between the applied phosphorous levels and VAM exert its promoting effect on vegetative growth. On the other hand, it is observed that, treatments were, generally, insignificant.

Table (2): Vegetative growth parameters as affected by inoculation with VA-Mycorrhizal fungi (VAM), phosphorous and their interactions during the two summer seasons 2000 and 20001.

Characters / Treatments	Plant height (cm)		No. of main stems /plant		Foliage fresh weight /plant (g)		Foliage dry weight (%)	
	2000	2001	2000	2001	2000	2001	2000	2001
VAM fungi								
With	39.83	41.25	2.76	2.75	296.2	303.4	12.24	12.32
Without	31.75	35.75	1.96	2.23	269.1	276.3	11.72	11.74
F-test	*	*	*	*	*	*	*	*
P_2O_5 levels kg/fed.								
0	28.00	30.67	1.50	1.60	240.0	241.0	10.35	10.42
25	33.17	33.83	2.13	2.28	263.0	271.0	11.68	11.75
50	37 83	40.83	2.75	2.88	300.8	312.5	13.19	13.28
75	44.17	48.67	3.05	3.20	326.2	335.0	12.69	12.68
L.S.D at 5 %	1.72	2.70	0.28	0.25	10.50	9.37	0.16	0.17
Interactions								
With VAM fungi								
0	30.67	33.00	1.80	1.73	254.7	251.7	10.61	10.67
25	38.33	35.67	2.63	2.67	276.3	286.7	11.99	12.06
50	41.67	43.67	3.20	3.20	311.0	325.3	13.44	13.57
75	48.67	52.67	3.40	3.40	342.7	350.0	12.90	12.99
Without VAM fungi								
0	25.33	28.33	1.20	1.47	225.3	330.3	10.08	10.16
25	28.00	32.00	1.63	1.90	250.7	355.3	11.37	11.44
50	34.00	38.00	2.30	2.57	290.7	299.7	12.94	12.99
75	39.67	44.67	2.70	3.00	309.7	320.0	12.49	12.37
L.S.D at 5 %	2.43	NS	NS	NS	NS	NS	NS	NS

2- Yield parameters:

a- Effect of VA- Mycorrhizal fungi:

Data recorded in Table (3) clear that inoculation potato seed tuber with VAM significantly increased total tuber yield, tuber average weight and tuber dry weight while number of tubers/plant increased insignificantly in the two seasons compared with untreated ones. The percentage of increment in total tuber yield/fed. due to inoculation with VAM were 20.79 and 15.43 % in the 1st and 2nd season, respectively. The increases occurred in total tuber yield and its components due to VAM application could be attributed to the great effect of stimulated plant root, nutrients uptake and photosynthesis process which led to produce vigorous plants thereby increased total yield and its components. These results are in agreement with those obtained by Koch *et al.* (1997), Hammad and Abdel Ati (1998), Verma and Arya (1998), Abdel-Naem *et al.* (1999) and Vosatka and Grynodler (1999) who found that inoculation with VAM increased the weight of the biggest tuber and the total weight of tubers. Also, Black and Tinker (1977) reported that inoculation with VAM increased total yield by 20 %.

b- Effect of phosphorous levels:

Data presented in Table (3) indicate that total tuber yield, tuber average weight and tuber dry matter in the both seasons as well as number of tubers/plant in the second season were significantly increased with increasing phosphorous levels up to 50 kg P_2O_5 fed. whereas a further increase in phosphorous level up to 75 kg P_2O_5 fed. caused insignificant effect. The maximum total tuber yield were obtained from treatment received 50 kg P_2O_5 fed. in both seasons. This increase may be due to the important role of phosphorous in certain essential such as higher photosynthesis and release of energy during cellular metabolism. Moreover, it is a component of organic compounds in plants. Similar results were obtained by Awad (1997), Freeman *et al.* (1998) Hossam *et al.* (1997), Arisha and Bardisi (1999), El-Kader (2002) and Ali (2002). Who they found that application of P significantly increased yield.

c- The interactions between VAM and phosphorous levels

Data in Table (3) show the interaction effect of phosphorous levels with VAM on total tuber yield and its components. It is obvious from such data that total tuber yield had significantly influenced in both seasons, while number of tubers/plant, tuber average weight/plant and tuber dry weight not significant in the both season. In general, the maximum tuber yield obtained when potato plant fertilized with 50 kg P_2O_5 fed. in the presence of VAM inoculum where as the lowest value was obtained as a result of untreated tubers and without phosphorous application. Similar results were concerted with. Abbot and Robson (1984), Khalifa and Badr (1992), Hammad and Abdel-Ati (1998) who declared that total and marketable yield increased. This may be due to high efficiency of the applied VAM inoculum in supplying the grown plants with the required P and other nutrients.

Table (3): Total tuber yield and its components as affected by inoculation with VA- Mycorrhizal fungi (VAM), phosphorous and their interactions during the two summer seasons 2000 and 20001.

Characters / Treatments	Total yield (ton/fed.)		No. of tubers /plant		Aver. Tuber weight (g)		Dry weight of tubers (%)	
	2000	2001	2000	2001	2000	2001	2000	2001
VAM fungi								
With	10.69	10.77	3.53	3.73	83.05	84.63	19.46	19.59
Without	8.85	9.33	3.30	3.40	79.24	81.09	17.89	17.97
F-test	*	*	NS	NS	*	*	*	*
P_2O_5 levels kg/fed.								
0	6.88	7.01	2.40	2.47	70.62	72.74	16.74	16.88
25	8.86	9.24	3.15	3.27	78.63	80.24	17.92	18.07
50	11.76	11.99	4.30	4.53	92.54	93.76	20.71	20.92
75	11.59	11.95	3.82	4.00	82.80	84.66	19.34	19.25
L.S.D at 5 %	0.52	0.36	0.41	NS	2.76	2.75	0.47	0.64
Interactions								
With VAM fungi								
0	7.77	7.83	2.53	2.63	72.54	73.75	17.17	17.23
25	9.76	9.82	3.30	3.50	80.33	82.09	18.68	18.85
50	13.12	13.22	4.30	4.60	94.81	96.01	21.69	21.75
75	12.10	12.20	4.00	4.20	84.51	86.65	20.31	20.52
Without VAM fungi								
0	5.98	6.19	2.27	2.30	68.70	71.73	16.30	16.52
25	7.95	8.66	3.00	3.03	76.94	78.38	17.17	16.51
50	10.40	10.77	4.30	4.47	90.27	91.52	19.72	17.29
75	11.09	11.71	3.63	3.80	81.09	82.72	18.37	20.08
L.S.D at 5 %	0.73	0.52	NS	NS	NS	NS	NS	NS

3- NPK content

a- Effect of VA- Mycorrhizal fungi:

Data in Table (4) show that using VAM fungi inoculum resulted in a significant increases in of N, P and K content in foliage in the both growing seasons. It is well known that VAM fungi is capable to contribute for supply plant root hairs to absorb nutrient elements including phosphorus, nitrogen and potassium (Saber, 1995, Verma and Arya, 1998 and Chen *et al.*, 1999), similar results were reported by Hammad and Abdel-Ati (1998) and Abdel-Naem *et al.* (1999) who they showed that potato tubers of plants inoculated with Azospirillum and/or VAM fungus had significant increases in the contents of NP and uptake value.

b- Effect of phosphorous levels:

Data recorded in Table (4) reveal that the addition of phosphorous levels resulted significant increases in the N, P and K content in foliage in the both seasons. These results may be due to the effect of phosphorous on plant growth and consequently to the efficiency of the root in absorbing

various nutrients. The present results are in agreement with those reported by Abdel Ati (1998), Shehata *et al.* (1994) who reported that higher levels of phosphourous was associated with an increase in N and P contents in potato plants.

c- The interactions between VAM and phosphorous levels

Data in Table (4) also, show that the interaction of VAM fungi inoculum and phosphorous levels had significant effect on the N and P contents of foliage in the both seasons. Similar results were obtained by Chen *et al.* (1999) and Verma and Arya (1998), on the other hand, the effect of interaction on potassium content in the foliage was not significantly in the both seasons.

Table (4): N, P and K percentage in foliage at 75 days after planting as affected by inoculation with VA- Mycorrhizal fungi (VAM), phosphorous and their interactions during the two summer seasons 2000 and 20001.

Characters	N (%)		P (%)		K (%)	
Treatments	2000	2001	2000	2001	2000	2001
VAM fungi						
With	2.70	2.78	0.55	0.53	2.59	2.65
Without	2.41	2.50	0.47	0.46	2.35	2.38
F-test	*	*	*	*	*	*
P_2O_5 levels kg/fed.						
0	1.99	2.06	0.39	0.73	2.05	2.11
25	2.35	2.43	0.49	0.47	2.37	2.39
50	2.81	2.91	0.55	0.54	2.58	2.62
75	3.08	3.20	0.62	0.61	2.88	2.95
L.S.D at 5 %	0.12	0.13	0.04	0.04	0.14	0.13
Interactions						
With VAM fungi						
0	2.07	2.10	0.43	0.39	2.20	2.26
25	2.61	2.69	0.55	0.51	2.49	2.52
50	2.88	2.97	0.60	0.58	2.71	2.77
75	3.22	3.36	0.66	0.64	2.95	3.05
Without VAM fungi						
0	1.91	1.93	0.35	0.36	1.90	1.94
25	2.08	2.16	0.45	0.43	2.26	2.25
50	2.74	2.85	0.51	0.49	2.44	2.47
75	2.93	3.04	0.58	0.58	2.80	2.84
L.S.D at 5 %	0.17	0.18	0.02	0.02	NS	NS

5- Tuber quality (Starch and nitrate content)

a- Effect of VA- Mycorrhizal fungi:

Data presented in Table (5) indicated that the effect of VAM fungi on starch content in tubers was significant with inoculum VAM fungi in both seasons. These results are in line with El-Morsy *et al.* (2002), Kandasmy *et al.* (1988) who stated that inoculation cutting with VAM fungus and/or

Azospirillium brasilense resulted in significantly increase in starch content than the uninoculated control.

Nitrate ion is well known environmental pollutant because of its potential role in infant methemoglobinemia associated with consumption of nitrate-rich water or vegetable, in the meantime, nitrate may cause direct toxicity by the formation of carcinogenic N-nitrose compound by the reaction with amino compounds (Hill, 1991).

On the other hand, application with VAM inoculum as a biofertilizer gave a significant decrease in the concentration of nitrate (ppm) in tubers compared with uninoculated control by VAM fungi. These results are in accordance with those obtained by Hammad and Abdel-Ati (1998), Abdel-Naem *et al.* (1999). They observed reduction of nitrate and nitrate contents of potato tubers via biofertilization with Azospirillum and VAM fungi.

Table (5): Starch (%) and nitrate content as affected by inoculation with VA-Mycorrhizal fungi (VAM), phosphorous and their interactions during the two summer seasons 2000 and 20001.

Characters	Starch (%)		NO_3 (ppm)	
Treatments	2000	2001	2000	2001
VAM fungi				
With	12.46	12.58	94.73	97.05
Without	11.79	11.86	112.14	113.40
F-test	*	*	*	*
P_2O_5 levels kg/fed.				
0	10.86	10.97	89.88	93.25
25	11.94	12.03	101.45	104.38
50	13.50	13.63	105.35	108.40
75	12.20	12.25	117.05	114.82
L.S.D at 5 %	0.31	0.33	3.92	3.18
Interactions				
With VAM fungi				
0	12.27	11.38	79.13	84.97
25	12.14	12.24	92.35	96.29
50	14.00	14.15	95.97	100.77
75	12.43	12.54	111.47	106.19
Without VAM fungi				
0	10.44	10.56	100.63	101.53
25	11.75	11.81	110.56	112.47
50	13.01	13.11	114.73	116.06
75	11.97	11.95	122.63	123.45
L.S.D at 5 %	NS	NS	NS	NS

b- Effect of phosphorous levels:

Data in Table (5) show that starch (%) and nitrate (ppm) content in tuber were significantly increased with application of phosphorous in the two growing seasons. The highest value of starch was obtained at 50 kg P_2O_5/fed. while the highest level of nitrate (117.0 and 114.82 ppm) was recorded in the

potato tuber by using 75 kg P_2O_5/fed. in both seasons, respectively. This result may be due to close correlation between higher of phosphorous was associated with an increase in N content in potato plant and accumulation of nitrate. These results are in agreement with this inoculated by Shehata *et al.* (1994).

c- The interactions between VAM and phosphorous levels

The results in Table (5) show also, that the interactions between VAM fungi and phosphorous levels had insignificant effect on starch (%) and nitrate (ppm) content in potato tubers in the both seasons.

CONCLUSION

In general obtained results in the present study show that the inoculation of potato seed tubers with VAM fungi inoculum at rate of 12.5 kg/ton seed tubers before planting, in combination with 50 kg P_2O_5/fed. gave higher tuber yield and its components as well as improving quality (starch content) in tuber. Therefore the application of VAM fungi inoculum reduced the required of chemical phosphorous fertilizer by about 25 %, thereby decreasing cost and pollution of environment.

REFERENCES

Abbot and Roberson, (1984). The effect of VA-mycorrhiza on plant growth.3 Ed. CRC press. Cleveland. OH.

Abdel-Ati, Y.Y. (1998). Yield and quality of potato as affected by phosphorus, chicken manure and seed tuber size. Assiut J. Agricultural Sci., 29 (5): 129-147.

Abdel-Naem, G. F., H. A. Ismail, A. M. Zaki and E. A. El-Morsi. (1999). Effect of fertilization on chemical constituents, nitrates, nitrites, ascorbic acid and some ant-nutritional factor levels in potato tubers (*Solanum tuberosum* L.). J. Agric. Sci. Mansoura Univ., 24 (2): 873-889.

Abdel-Nasser, M. and A.A. Makawi (1979). Occurrence of certain physiological groups of soil micro-organisms in rhizosphere and rhizophone of watermelon, cucumber and cowpea. Zbi. Bakt., 11 (134): 310-318.

Ali, M.N. (2002). Studies on potatoes. M.Sc. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Arisha, H. M. and A. Bardisi. (1999). Effect of mineral and organic fertilizers on growth, yield and tuber quality of potato under sandy soil conditions. Zagazig J. Agric. Res., 26(2): 391-409.

Awad, E. M. (1997). Studies on potato nutrition ((*Solanum tuberosum* L). Ph. D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

A.O.A.C (Association of Official Analytical Chemists). (1990). Official methods of analysis, 15th Ed., Washington, D.C., USA.

Black, R.L. B. and P.B. Tinker (1977). Interaction between effects of vesicular-arbuscular mycorriza and fertilizer phosphorous on yields of potatoes in the field. Nature, 267: 510-511.

Bonfante, P. and S. Peratto (1995). Strategies of arbuscular mycorrhizal fungi when infection host plants. New Phytol., 130:3-21.

Burtan, W.C. (1966). The Potato. 2nd Ed.Veenman, Wageningen Netherlands, pp 165-169.

Chen, A.,S.M.Chambers and J.W.G. Cairney (1999).Utilization of organic nitrogen and phosphorous sources by mycorrhizal endophytes of woollsia pungens (cav) F. Muell (Epacridaceae) Mycorrhiza, 8: 181-187.

El-Banna, E.N. and H.Z. Abd El-Salam (2000). Effect of rock phosphate and super phosphate application with organic manures on growth, yield and quality of potato (*Solanum tuberosum* L.). J. Agric. Sci. Mansoura Univ., 25(7):4531-4540.

El-Dahtory, T., M. Abdel-Nasser, A. R. AbdAllah and M. A. El-Mohandes. (1989). Studies on phosphate solubilizing bacteria under different soil amendments. Minia J. Agric. Res. & Dev., 11 (2): 935-950.

El-Gamal, A.M. (1985). Effect of phosphorous levels and source on potato yield and quality. J. Agric. Sci. Mansoura Univ., 10 (4): 1468-1472.

El-Kader, A.M. (2002). Effect of some organic and mineral fertilizers on some potato cultivars. M.Sc., Thesis, Fac. Agric., Mansoura Univ., Egypt.

El-Morsy, A.H.A., A.E. Abdel-Fattah and Z.S.A. El-Shal (2002). Effect of phosphorus fertilizer and VA-Mycorrhizal inoculation on Growth, tuber yield and quality of sweet potato. Proc. Minia 1st Conf. for Agric. Enuiron. Sci., Minia Egypt, March 25-28, pp 1815-1827.

Freeman, K.L., P.R. Franz, R.W. De Jong, and R.W. Jong-De (1998). Effect of phosphorous on yield, quality and retailer phosphorus concentration of potatoes (cv. Russet Burbank and Kennebec) grown in the krasnozem and duplex soils of Victoria. Australian J. Exp. Agric, 38 (1): 83-93.

Gardener, F.D., R.B. Pearce and R.L. Mitchell (1985). Physiology of Crop Plants. The Lowa Stat Univ. Press, pp:327.

Gomez, K.A, and A.A. Gomez (1984). Statistical Procedures for the Agricultural Research. Jhon Wiley and Sons, Inc., New York.

Grewal, J.S. (1990). Fertilizer use in potato crop in North-Western hills of India-present status and future strategies. J. India Potato Assoc., 17 (1&2): 12-112.

Hammad, A. M. M. and Y. Y. Abdel-Ati. (1998). Reducing of nitrate and nitrite contents of potato tubers via biofertilization with Azospirillum and VA-Mycorrhizal fungi. J. Agric. Sci. Mansoura Univ., 23 (6): 2597-2610.

Hill, M.J. (1991). "Nitrates and Nitrites in Foods and Water". Published by Ells Horwood Limited Chichester, West Sussex, Po 191 EB, England.

Hossam, M.T., M.S. Islam, M.Ilias, M.A. Hoque and M.A. Bari (1997). Phosphorous fertilization of cut shoot potato crop. Tropical Science, 37 (1): 35-38.

Jackson, M. L. (1967). Soil Chemical Analysis. Prentice-Hall of India, Private limited, New Delhi, pp. 111-204.

Kandasamy, D., D. Palanisamy and G. Oblisami (1988). Screening of germplasm of sweet potato for Va-mycorrhizal fungal occurrence and response of the crop inoculation of VAM fungi and *Azospirillium*. J. Root Crops, 14(1): 37-42.

Khalifa, M.R. and M.M. Badr, (1992). Inoculation with mycorrhizal fungi and/or Rhizobium leguminosarum under different levels of NPK fertilization. Egypt. J. Appl. Sci., 12: 851.

Koch, M., Z. Tanami, H. Bodani, S. Wininger and Y. Kapulik (1997). Field application of vesicular-arbuscular mycorrhizal fungi improved garlic yield in disinfected soil. Mycorrhiza, 7: 47-50.

Leadir, L.M.F., S. P. Raymond, G.R. Safir and J.Kamunski (1998). Phosphorous effect on phosphatase activity in endomycorrhizal maize. Physiol. Plantarum, 103: 162-171.

Mahmoud, S.A.Z. and A.M. Abdel-Hafez (1982). The role of phosphate mobilizing bacteria in plant nutrition. The 1st OAU/STRC Inter. African Conf. on Biofertilizers, Cairo, Egypt, 22-26 March.

Saber, M.S.M. (1995). Microorganisms Mobilizing plant Nutrients. Proceeding of the training Course Bio-Organic Farming Systems for Sustainable Agric. (Nov. 26 to Dec. Cairo, Egypt).

Shehata, S.A., E.M., Agwah and A.A. Fayed (1994). Effect of time and level of phosphorus application on growth, yield and chemical composition of potato plants. Bull. Fac. Agric. Univ. Cairo, 45: 483-496.

Singh, J. P. (1988). A rapid method for determination of nitrate in soil and plant extracts. Plant and Soil, 110: 137-139.

Smith, G.S. and P. Gianiozzi (1988). Physiological interactions between symbionts in vesicular-arbuscular mycorrhizal plants. Annu. Rev. Plant Physiol. Plant Mol. Biol., 39: 221-224.

Thampson, J.P. (1990). Soil sterilization methods to show VA-Mycorrhizae and P and Zn nutrition of wheat in vertisols. Soil Biol. Biochem., 22:229-240.

Trent, J.D., T.J. Suejcar, S. Christiansen (1989). Effects of fumigation on growth, photosynthesis, water relations and mycorrhizal development of winter wheat in the field. Can. J. Plant Sci., 69: 535-540.

Tukoki, J.L. and R.L. Mohler (1990). Evaluation of nutrient solution phosphorus concentration on potato plant tuber production under greenhouse. J. Plant Nutrition, 13 (1): 149-168.

Verma, R.K. and I.D. Arya (1998). Effect of arbuscular mycorrhizal fungal isolates and organic manure on growth and mycorrhization of micro propagated. Mycorrhiza, 8: 113-116.

Verma, R.K. and Jamaluddin (1994). Effect of VAM fungi on growth of same bamboos in the nursery. Indian J. Trop. Biodim, 2: 377-379.

Vosatka, M. and M. Gryndler (1999). Treatment with culture fractions from *Pseudomonas putida* modifies the development of *Glomus fistulosum* mycorrhiza and the response of potato and maize plants to inoculation. Soil ecology, 11(2-3): 245-251 (C.F. CAB International Abstracts, Computer Research).

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تأثير التلقيح بفطر الميكوريزا مع مستويات مختلفة من الفوسفـــــــور المعدنى على نمـــو ومحصـــــول وجودة درنـــات البطاطـــس.

السيد محمد محمد عوض
قسم بحوث الخضر، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزة, مصر.

على الرغم من ان التسميد المعدنى لنباتات البطـــاطس يعطـــى محصـــولا اعلـــى الا ان استعمال المخصب الحيوى يكون اكثر اقتصادية واكثر امنا من الاسمدة المعدنية التى تســـاهم فـــى تلوث البيئة بشكل ملحوظ.

وبذلك تم اجراء تجربتان فى موسمين صيفيـــن متتـــاليين ٢٠٠٠، ٢٠٠١ علـــى نبـــات البطاطس صنف اسبونتا فى مزرعة بحوث البساتين بالبرامون بمحافظة الدقهلية لتقييم تاثير التلقيـح بفطر الميكوريزا واربع مستويات مختلفة من الفوسفور المعدنى (صفـــر , ٢٥ , ٥٠ , ٧٥ كجـم فو٢ا٥/فدان) بالاضافة لتفاعلاتهما على النمو الخضرى ومحصول البطاطس ومكوناته علاوة علـــى محتوى النيتروجين والفوسفور والبوتاسيوم فى العرش والنشا والنترات فى الدرنات.

واوضحت النتائج المتحصل عليها ما يلى:

ادى تلقيح تقاوى البطاطس بفطر الميكوريزا قبل الزراعة الى زيادة معنوية فـــى النمـــو الخضرى (طول النبات وعدد السيقان الرئيسية بالنبات والوزن الطازج والجاف للنبات) ومحصـــول الدرنات الكلى وعدد الدرنات فى النبات ومتوسط وزن الدرنة والمادة الجافـــة بالدرنـــة ومحتـــوى النيتروجين والفوسفور والبوتاسيوم فى العرش والنشا فى الدرنات بينما تركيز النترات فى الدرنـات انخفض مع التلقيح بفطر الميكوريزا خلال موسمى الزراعة.

ازداد النمو الخضرى (طول النبات وعدد السيقان الرئيســـية والـــوزن الطـــازج للنبـــات ومحتوى النيتروجين والفوسفور والبوتاسيوم والنترات مع زيادة الفوسفور المعدنى عند معـــدل ٧٥ كجم فو٢ا٥/فدان) بينما كان اعلى معدل للوزن الجاف والمحصول الكلى ومكوناته (متوســـط وزن الدرنة والمادة الجافة للنبات) ومحتوى النيتروجين والفوسفور والبوتاسوم والنترات فى الدرنات عند اضافة ٥٠ كجم من التسميد الفوسفورى.

كانت التفاعلات موجبة بين التلقيح بفطر الميكوريزا ومستويات الفوسفور علـــى طـــول النبات فى الموسم الاول والمحصول الكلى ومحتوى النيتروجين والفوسفوروالبوتاسيوم فـــى كـــلا موسمى الزراعة.

بصفة عامة اوضحت النتائج ان تلقيح تقاوى البطاطس بفطر الميكوريـــزا بمعـــدل ١٢,٥ كجم /طن تقاوى قبل الزراعة بالاضافة الى التسميد بـــ ٥٠ كجم/ فو٢ا٥/فدان قد اعطت محصـــولا عاليا من الدرنات/فدان وزيادة فى محتوى النشا للدرنات ومحتوى اقل من النترات.

وبناءا علية فان التلقيح بفطر الميكوريزا قبل الزراعة يزيد من فعالية التسميد الفوســـفاتى مع انخفاض معدله المطلوب بنسبة ٢٥ % وبالتالى زيادة فى الانتاج وتحســـين صفـــات الجـــودة للدرنات مع قلة تلوث البيئة.