RESPONSE OF SUNFLOWER GROWN IN CALCAREOUS SOIL TO INOCULATION WITH "PHOSPHOREIN" AND NITROGEN FERTILIZATION

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Abstract

Two field experiments were conducted during summer seasons of 2005 & 2006 to evaluate response of sunflower plants (*Helianthus annus* L. cv. Sakha 53) grown in sandy calcareous soil to fertilization with mineral and organic nitrogen as well as inoculation with biofertilizer "Phosphorein" and to four N-fertilization treatments : 60 kg mineral N/fed, 60 kg organic N/fed, 30 kg mineral N/fed + 30 kg organic N/fed and 60 kg mineral N/fed + 30 kg organic N/fed.

Biofertilizer increased plant growth, nitrogen and phosphorus uptake significantly. An increase in seed yield (10.6%) and oil yield (11.1%) was recorded.

The treatment of 30 kg mineral N_2 + 30 kg organic N_2 / fed attained pronounced increase of plant growth, N and P uptake. Seeds and oil yields being 18.9 and 18.8% respectively in comparison with the control were determined.

INTRODUCTION

Calcareous soils naturally occur in arid and semi-arid regions because of relativity low leaching. They also occur in humid and semi arid zones if their parent materials are rich in $CaCO_3$ and when the parent material is relativity young and has undergone little weathering (Brody and Weil, 1999). In Egypt, the calcareous soils constitute about 25-30% of the total area (Abu-Elela, 2002).

The main problems of calcareous soils in agriculture are: crusting of soil surface, cemented condition of the subsoil layers, low availability of nutrients especially nitrogen, phosphorus and essential micronutrients.

Phosphorus (P), although is abundant in soils in both inorganic and organic forms, it is one of the most plant growth-limiting nutrient particularly in calcareous soils. Phosphate solubilizing bacteria (PSB) are ubiquitous in soils and could be play an important role for supplying P to plants in a more friendly environment and sustainable manner. "Phosphorein biofertilizer" (commercial biofertilizer contains strains of phosphate solubilizing bacteria, *Bacillus megatherium var. phosphaticum*) usually uses to improve plant growth and increase yield of many crops. The application of phosphate dissolving bacteria (PDB), or Arbuscular Mycorrhizal Fungi (AMF) were reported to increase P – availability and P-uptake by plants particularly those grown in calcareous and sandy soils. Phosphate dissolving bacteria could be reduced about 25 % of the P – fertilizer (El-Dosuky and Attia, 1999, Abo-Baker, 2003).

Abou Khadrah et al. (2002) and Bassal (2003) reported that sunflower seed inoculation with the biofertilizer "Phosphorein" increased seed and oil yields compared with the untreated plants.

Most of the newly reclaimed soils in Egypt are sandy and calcareous that suffers from low crops productivity, poor physico-chemical characteristics and water retension. The application of organic manures is well established for reclamation and fertilization of plants grown in sandy and calcareous soils, due to their beneficial effects on physico-chemical and biological characteristics of these soils (Attia and El-Dosuky, 1996, Mostafa, 2004).

Amara & Dahdoh (1995) and Kaur et al. (2005) reported that the application of organic manures, alone or in combination with chemical fertilizers, increased soil organic C, total N, P and K and stimulated population and activity of soil microorganisms.

The aim of the current investigation was to study stimulation of plant growth and increase yield of sunflower grown in calcareous sandy soil by using biofertilizer and organic manure.

MATERIALS AND METHODS

Two field experiments were conducted in sandy calcareous soil at the Experimental Farm of Arab El – Awammer Research Station, Agric. Res. Center (ARC)., Assiut Governorate, Egypt during summer seasons of 2005 & 2006 to evaluate response of sunflower plants (*Helianthus annus* L. cv. Sakha 53) to inoculation with "Phosphorein" and mineral N-fertilization. The Physical and chemical characteristics of the experimental soil used during the current study shown in Table (1).

Table 1. Some physical and chemical characteristics of the field experimental soil.

Soil Properties	Values	Soil Properties	Values
		Organic matter %	0.24
Sand (%)	96.72	Total nitrogen (%)	0.003
Silt (%)	2.12	Available P (ppm)	8.30
Clay (%)	1.16		
Soil texture	Sandy	Available micronutrients (ppm):	
Total $CaCO_3$ %	35.18	Fe	1.85
EC dsm^{-1}(1:1 water extract)	0.35	Mn	1.59
pH		Zn	0.33
(1:1 water suspension)	8.65	Cu	0.38

In both experiments, the experimental design was split plot with four replications, where N-fertilization treatments (60 kg mineral N/fed, 60 kg organic N/fed, 30 kg mineral N/fed + 30 kg organic N/fed and 60 kg mineral N/fed + 30 kg organic N/fed) were laid in main plots, and the uninoculation treatment or inoculation with "Phosphorein" were placed in the sub plots. The size of each sub plot was 1/400 fed (3m × 3.5m =10.5m^2) containing five ridges each 3.5 meter long and 60 cm wide. The Farmyard manure and the granular super- phosphate (15.5% P_2O_5 applied at a 1evel of 150 kg /fed.) were surface spread and mixed with soil during ridging and plot preparation.

Sunflower seeds were inoculated with "Phosphorein" (peat - based inoculum obtained from Ministry of Agriculture, Giza, Egypt), before sowing by using seed coating technique. Seeds were dilled in hills 4-5 cm deep and 20 cm apart (3 - 5seeds/hill) on one side of the ridges, and after 17 days from sowing, seedlings were thinned to one plant /hill. Ammonium nitrate (33.5% N) was used as mineral N-fertilizer. Mineral N-fertilizer was added in three doses after 20, 30 and 41 days from sowing. Sunflower plants were foliar sprayed once, at rate of 0.5L /plot (200 L/fed) after 52 days from sowing with solution containing chelated Fe, Mn, Zn and boric acid at levels of 150, 150, 150, and 50 ppm, respectively. The chemical analyses of the used organic fertilizer (FYM) are shown in Table (2) .

Table 2. The chemical analyses of the used organic fertilizer (FYM)

Properties	Values	Properties	Values
Organic matter (%)	48.58	Total Fe (ppm)	6474
Organic carbon (%)	28.18	Total Mn (ppm)	164
Total N (%)	1.011	Total Zn (ppm)	54
C/ N ratio	27.87	Total Cu (ppm)	11
Total P (%)	0.403	pH (1:10 suspension)	7.65
Total K (%)	1.643		
Total Na (%)	1.070	EC (1:10 suspension) mmhos /cm	6.61

Samples, of random 3 plants, were taken from each plot 51 days after sowing, then, shoot and root fresh weights were immediately determined. Shoot and roots were washed with tap water followed with distilled water, then air dried and oven dried at

70° C to determine dry weights. Shoot contents of N and P were determined by using microkjeldahl procedure and stannous chloride phosphomolybdic sulfuric acid method, respectively as described in Jackson, 1973 and plant uptakes were calculated.

At harvest (after 82 days from sowing), ten random plants were taken from the five ridges of each experimental unit, where plant height (cm), stem diameter (cm), head diameter (cm), No. of seeds per head and 1000-seeds weight (g), were determined. The rest of plants in the experimental plots were harvested and used for estimating total straw and seed yields /fed. Seed samples from each plot were taken for chemical analysis and determination of oil content (AOAC, 1980). Also, composite soil samples were taken from the ridge surface layers (0- 30) of each plot and soil samples were extracted with 0.5 M $NaHCO_3$ at pH 8.5. Available P was measured colorimetrically by stannous chloride phosphomolybdic-sulfuric acid method (Jackson, 1973).

The MSTAT-C (version 2.10) computer program was used to perform all the analysis of variance to compare significant differences among treatment means, using the LSD at *p = 0.05* and *p = 0.01.* as outlined by Steel and Torrie (1982).

RESULTS AND DISCUSSION

The obtained results and statistical analysis of the two successive seasons (2005&2006) for plant growth parameters, yield and yield components of sunflower plants as affected by N-fertilization and Phosphorein application, are shown in Tables (3 & 4). Analysis of variance of the obtained data showed that there were no significant interactions between the two tested factors (N-fertilizer treatments and Phosphorein application) on any of the recorded parameters.

The results in Tables (3 & 4) reflected great differences in response of sunflower to N-fertilization. It could be noted that rate of N-fertilization was equal (60 kg N/fed) in three of the tested treatments (No. 1, 2 and 3), nevertheless the response of sunflower came different depending on the form of N applied. The best response, highest value of plant growth and yields (seeds and straw) as well as high oil yield (307 kg/fed), were obtained with the treatment of 30 kg mineral N + 30 kg organic N/fed. In other words, the best significant results were obtained when half of the given-N was in mineral-form and the other half in organic-form. The extra application of mineral-N (treatment No. 4:

60 kg mineral N + 30 kg organic-N) did not induce significant increases in plant growth or yields over those of the above treatment (No. 3). Whereas, the lowest value of plant growth and yields were obtained with treatment No. 2. These results indicated that the optimum N-fertilization treatment for sunflower growth and yield was 30 kg mineral-N + 30 kg organic N. This treatment scored 18.9 % increase in seeds yield of sunflower and 18.8 % increase in oil yield compared with control treatment. These results could be attributed to the rapid need for available mineral-N to supply the fast growth of sunflower, and later on, to the mineralized nitrogen from degradation of added organic-form (FYM).

Similar results were reported on sunflower by El-Amin et al., 2007 and wheat (Attia and El-Dosuky, 1996), which indicated the beneficial effect of using both organic and inorganic sources of nutrient to fast- growing crops.

Response of sunflower, grown in calcareous soil, to phosphorein application was highly significant for plant growth and N&P uptakes (Table 3) as well as yield and yield components (Table 4). Increases in seed and oil yields due to Phosphorein inoculation were 10.6% and 11.1% respectively. The recorded increases, either in plant growth or yields obtained by phosphorein inoculation could be attributed to the increase in amounts of available P by phosphate-solubilizing bacteria *(Bacillus megatherium*). This significant effect was quite obvious from the data of soil available P, determined at harvest (Table 5). The application of nitrogen in organic-form, either alone or combined with mineral-N, significantly increased soil available P. The promotive effect of added organic matter (FYM) could be attributed to organic carbon necessary for growth and multiplication of the heterotrophic phosphate solubilizing bacteria (Alexander, 1982, Amara and Dahdoh, 1995, Kaur et al., 2005.)

Table 3. Influence of N-fertilization and Phosphorein application on growth of sunflower plants (combined analysis of two successive sessions).

Tested factors	Treatments	Root dry Weight (g/plant)	Shoot Wt. (g/plant)		Shoot content (%)		Uptake (mg/plant)		Plant height (cm)	Stem diameter (cm)	
			Fresh	Dry	N	P	N	P			
N- fertilization	60 kg M.N./ fed	3.46	151.8	29.55	2.17	0.411	638	122	83.8	0.98	20.0
	60 kg O.N./ fed	3.14	127.3	26.10	1.96	0.396	511	103	83.5	0.89	19.6
	30 kg M.N.+30 kg O.N./fed	3.84	175.3	35.13	2.21	0.425	780	148	90.6	1.06	22.5
	60 kg M.N.+30 kg O.N./fed	4.07	190.1	37.02	2.25	0.441	836	162	91.9	1.09	22.3
L.S.D $_{0.05}$		0.45	17.91	2.79	0.123	n.s	66.6	14.8	3.8	0.10	1.35
L.S.D $_{0.01}$		0.62	24.54	3.82	0.168	-	91.2	20.2	5.2	0.14	1.85
Phosphorein application	P_0 (Control)	3.36	154.6	30.73	2.13	0.405	658	125	86.4	0.98	20.6
	P_1 (Phosphorein)	3.90	167.6	33.16	2.17	0.432	724	143	88.5	1.03	21.5
L.S.D $_{0.05}$		0.21	8.41	1.58	n.s	0.018	35.0	6.0	1.6	0.03	0.48
L.S.D $_{0.01}$		0.28	11.4	2.15	-	0.025	47.4	8.2	n.s	0.04	0.65

* After 51 days from sowing.

M.N., mineral nitrogen; O.N., organic nitrogen.

Table 4. Influence of N-fertilization and Phosphorein application on yield and yield components of sunflower plants (combined analysis of two successive sessions).

Tested factors	Treatments	Plant height (cm)	Stem diameter (cm)	Head diameter (cm)	No. of seeds/ head	Wt. of 1000 seeds(g)	Seed yield (kg/fed)	Straw yield (kg/fed)	% Oil in seeds	Oil yield (kg/fed)
N- fertilization	60 kg M.N. / fed	88.2	1.04	11.6	565	44.02	645.4	982	40.02	258.5
	60 kg O.N. / fed	89.7	1.05	11.0	489	41.46	521.2	898	39.39	205.1
	30 kg M.N.+30 kg O.N./fed	97.3	1.18	12.8	658	45.07	767.3	1197	40.11	307.1
	60 kg M.N.+30 kg O.N./fed	96.0	1.16	12.6	626	44.25	718	1127	40.26	289.4
L.S.D $_{0.05}$		3.7	0.086	0.56	n.s	n.s	56.52	102.3	n.s	23.72
L.S.D $_{0.01}$		5.1	0.118	0.76	-	-	77.43	140.1	-	32.49
Phosphorein application	P_0 (Control)	91.1	1.07	11.6	576	42.19	629.7	974	39.82	251.1
	P_1 (Phosphorein)	94.4	1.14	12.4	593	45.21	696.2	1127	40.07	279.0
L.S.D $_{0.05}$		1.9	0.031	0.24	23	1.31	22.75	55.9	n.s	9.69
L.S.D $_{0.01}$		2.6	0.042	0.32	31	1.77	30.83	75.7	-	13.13

Table 5. Combined analysis (2005&2006) of available P in soil at harvest as affected by N-fertilization and Phosphorein application.

Tested factors	Treatments	Ava. P at harvest
N- fertilization treatments	60 kg M.N. / fed	9.06
	60 kg O.N. / fed	10.35
	30 kg M.N.+30 kg O.N./fed	9.82
	60 kg M.N.+30 kg O.N./fed	9.72
$L.S.D_{0.05}$		0.74
Phosphorein Application	P_0 (Control)	9.25
	P_1 (Phosphorein)	10.22
$L.S.D_{0.01}$		0.48

In general, the obtained results of the current investigation are in accordance with those reported by Abou Khadrah et al., 2002, Bassal, 2003, where they of confirmed the improvement of sunflower growth, and yield by "Phosphorein" application, especially under low level of P-fertilizer.

Many reports have been estimated that application of biofertilizers containing phosphate solubilizing bacteria usually increase the uptake and available-P in calcareous soils and could be replace about 25% of the applied chemical P-fertilizer (El-Dosuky and Attia, 1999, Abo Baker, 2003).

REFERENCES

1. Abo-Baker, A. A. 2003. Studies on mixed and single microbial inoculation of cultivated plants for improvement of growth and yield. Ph. D., Thesis, Fac, Agric., Assiut University.
2. Abou Khadrah, S. H., A. A. E. Mohamed, N. R. Gerges and Z. M. Diab. 2002. Response of four sunflower hybrids to low nitrogen fertilizer levels and phosphorien biofertilizer. J. Agric. Res., Tanta Univ., 28(1): 105 - 118.
3. Abu-Elela, E. G. Y. 2002. The dynamic changes in chemical and mineralogical characteristics of calcids soils as affected by natural soil amendments. Ph. D. Thesis, Fac. Agric., Ain Shams Univ., Egypt.
4. Alexander, M. 1982. Introduction to Soil Microbiology. 2nd ed., John Wiley & Sons Inc, New York.
5. Amara, Mervat A.T. and M.S.A. Dahdoh. 1995. Effect of inoculation with plant growth promoting rhizobacteria (PGPR) on yield and uptake of nutrients by wheat grown on sandy soil. Fifth National Congress on Bio - Agriculture Relation to Environment., Nov., 20-21. Cairo, Egypt.

6. AOAC. 1980. Official Methods of Analysis ((Association of Official Analytical Chemists)) 13th, ed Washington, D. C.
7. Attia , K.K. and M.M. El – Dosuky. 1996. Effect of elemental sulfur and inoculation with Thiobacillus, organic manure and nitrogen fertilization on wheat. Assiut, J. Agric. Sci., 27 (4): 191 – 206.
8. Bassal, S. A. A. 2003. Impact of tillage systems, hill spacings, bio and chemical phosphatic fertilization regimes on yield and its components of sunflower (Helianthus annus L.). Zagazig J. Agric. Res., 30 (3):619 – 634.
9. Brody, N.C. and R.R. Weil. 1999. The Nature and Properties of Soils. 12th Edition. Prentice Hall, Upper Saddle River, New Jersey.
10. El-Amin, E. A., S. I. Ibrahim., A. M. Eltilib and F. H. Ibrahim. 2007. Interactive effect of animal manure and chemical amendments on the growth attributes and yield of sunflower grown on a calcareous soil. Annals. Agric. Sci., Ain Shams Univ., Cario. 52(2): 543-549.
11. El-Dosuky, M. M. and K. K. Attia. 1999. Effect of inoculation with phosphate solubilizing bacteria, organic manure and phosphate fertilization on peanuts grown on sandy calcareous soil. Assiut, J. Agric. Sci., 30 (5): 177 – 188.
12. Jackson, M. L. 1973. Soil Chemical Analysis. Prentice-Hall, Inc. Englewood Cliffs, N.J. New Delhi, India.
13. Kaur, K., K. K. Kapoor, P. A. and A. Gupta. 2005. Impact of organic manures with and without mineral fertilizers on soil chemical and biological properties under tropical conditions. J. Plant Nutrition, Soil Sci., 168(1):117-122.
14. Mostafa, H.M. 2004. Response of wheat plants grown in sandy, calcareous and clayey soils to integrated application of organic manures and biofertilization . J. Agric. Sci. Mansoura Univ., 29 (3): 1473- 1485.
15. Steel, R. G. D. and J. H. Torrie. 1982. Principals and Procedures of Statistics. A Biometrical Approach. Mc Graw Hill Book Company, New York. USA.

استجابة نباتات عباد الشمس الناميه فى الأرض الرمليه الجيريه للتلقيح بالفوسفورين ومعاملات التسميد النيتروجينى

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تم أجراء تجربتين فى الموسم الصيفي لعامي ٢٠٠٥ و ٢٠٠٦ لدراسة استجابة نباتات عباد الشمس (صنف سخا ٥٣) الناميه فى الأرض الرمليه الجيريه فى محطة التجارب الزراعيه بمنطقة عرب العوامر، بمحافظة أسيوط ، جمهورية مصر العربيه، للتلقيح بالفوسفورين ولأربعة معاملات مختلفة من التسميد النيتروجينى على النحو التالي (٦٠ كجم نيتروجين معدني/فدان - ٦٠ كجم نيتروجين عضوي/فدان – ٣٠ كجم نيتروجين معدني + ٣٠ كجم نيتروجين عضوي/فدان - ٦٠ كجم نيتروجين معدني + ٣٠ كجم نيتروجين عضوي/فدان).

أدت معاملة البذور قبل الزراعة بالفوسفورين إلى تنشيط وزيادة معنوية جدا في نمو النبات، النيتروجين والفوسفور الممتص، والى زيادات معنويه فى محصول الحبوب (١٠,٦%) ومحصول الزيت (١١,١%).

اعطت المعاملة السماديه ٣٠ كجم نيتروجين معدنى + ٣٠ كجم نيتروجين عضوي/ الفدان أفضل نمو نباتى، وأفضل محتوى نيتروجين وفوسفور في النبات، كما أدت إلى زيادات معنوية جدا في محصول البذور ومحصول الزيت بلغت ١٨,٩% في محصول البذور و ١٨,٨% في محصول الزيت مقارنة بالمعاملة السماديه ٦٠ كجم نيتروجين معدني/ الفدان.