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Effect of Organic N and Rock Phosphate on Yield and Nutrients Content of Pepper Plant Grown on Sandy Soil under Organic Farming Condition

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ABSTRACT

A field successive experiment was carried out employing sandy soil to evaluate the increase in yield productivity and nutrients content of pepper plant under organic farming condition as compared to conventional farming condition. Treatments were representing all the combinations of organic N (150 and 225 kg N fed^{-1}) and P fertilization rates (0, 60, 90 and 120 kg P_2O_5 fed^{-1}) in a randomized complete block design with three replicates.

Results showed that application of organic farming may lead to pepper yield (unmarketable and/or marketable) lower than yield under conventional farming. Most of yield components recorded high values under organic farming as compared to conventional farming. The most promising treatments for production of marketablepepper yield could be: Those of (225 kg organic N + 120 kg P_2O_5 fed^{-1}) which showed a decrement of (-7.85%) and (225 kg organic N + 90 kg P_2O_5 fed^{-1}) with a decrement of (- 10.2%). The treatments of (225 kg organic N + 120 kg P_2O_5 fed^{-1}) followed by (225 kg organic N + 90 kg P_2O_5 fed^{-1}) could be recommended for obtaining the highest rate of income from the marketable yield of pepper.

The multiple linear regression shows that there is a highly significant correlation (P=0.01) among marketable pepper yield (y) and stem dry weight, root P content, available N in soil and height plant (R^2= 90.8 %). The expected equation to predict the marketable pepper yield under organic farming was:

Marketable pepper yield = 2.23 – 0.223 stem dry weight – 34.8 root P content + 0.024 available N in soil – 0.056 plant height.

The path analyses reveals that the most closely variables related to marketable pepper yield is stem dry weight and root P content.

Most nutrients except N content of pepper plant organs increased under organic farming as compared to the recommended rates of mineral fertilization under conventional farming.

KEY WORD: Organic farming, compost, Rock phosphate, Pepper yield, Nutrients content.

INTRODUCTION

Over the last few decades, the world has witnessed a rapid development of the organic agriculture segment. Organic farming systems aim to produce safe food with the least harmful environmental impact by imposing severe restrictions on the use of synthetic agrochemicals **(Rodrigues *et al*., 2006)**. Organic farming is defined by an ecological production management system that promotes and enhances biological activity. It is based on minimal use of farm inputs and on management practices that restore, maintain and enhance ecological harmony. It differs among the alternative agriculture systems that allow only, the minimal use of pesticides, herbicides and chemical fertilizers inputs cause injury on ecological balance considered essential to maintain the long-term fertility of soil **(Stockdale *et al*., 2001)**. The management of organic farms excludes the use of synthetic fertilizers and pesticides, while increasing and maintaining soil fertility over the long-term **(IFOAM, 2000)**. To achieve this, organic farming enhances internal nutrient cycling by: incorporating crop residues, introducing crop rotations, using green manures (nitrogen fixing leys) and different types of organic fertilizers. The scarcity of organic fertilizers (manures and slurries) in many agricultural areas often results in highly negative nutrient balances in organically managed agricultural lands **(Alfoeldi *et al*., 2002)**.

Organic agriculture has been criticized as low-yieldingand less efficient than conventional agriculture in its use of land and resources **(Trewavas, 2004)**. Several yield trial comparisons between organic and conventional farming systems have shown significantly lower yields for organic systems **(Ryanet *et al*., 2004)**. **Kevin *et al*., (2007)** showed that consumer demand regarding the impacts of conventional agriculture on the environment and human health have spurred the growth of organic farming systems; however, organic agriculture is often criticized as low-yielding and unable to produce enough food to supply the world's population. Using wheat as a model crop species,

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we show that poorly adapted cultivars are partially responsible for the lower yields often found in organic farming systems when compared with conventional farming systems.

MATERIALS AND METHODS

A field trial was conducted on a loamy sand soil at Ismailia Agricultural Research Station, by cultivating pepper (Capsicum annum L., cv Marrkony) at summer season 2015. Main and interaction effects of different rates of compost (as a source of organic N) and rock phosphate (as P source) on yield components and nutrients content of pepper plant were achieved. The experiment was carried out following the randomized complete block design, with three replicates for each experimental unit. The compost was added by through mixing with the surface soil layer at a rate of 10 ton fed^{-1} (150 kg organic N fed^{-1}) and 15 ton fed^{-1} (225 kg organic N fed^{-1}) for compost, which was combined with four P_2O_5rates of (0, 60, 90 and 120 kg P_2O_5 fed^{-1}) in the form of rock phosphate (12 % P_2O_5). One K fertilization rate (24 kg K_2O fed^{-1}) was added in the form of feldspar (8 % K_2O). The N, P and K fertilization was run entirely through preparing the soil before planting, at the recommended doses of mineral N, P and K fertilization to act as a control treatment which were compared to the other organic treatment.

The experimental plots were sampled initially before pepper planting to determine some physical and chemical properties according to the standard procedures outlined by **Cottenie (1980)**.

Chemical properties of the tested compost and rock phosphate were measured according to the standard methods described by **Cottenie (1980)** and are shown in (Table, 2). Plant samples were collected from mature pepper pants at harvest stage for analysis. Plant samples were dried at 65C° for 48 hrs, ground and wet digested using H_2SO_4: H_2O_2 method **(Cottenie, 1980)**. The digests samples were then subjected to measurement of N using Micro-Kjeldahle method; P was assayed using molybdenum blue method and determined by spectrophotometer and K was determined by Flame Photometer **(Chapman and Pratt, 1961)**.

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

Soil property	Value	Soil property	Value
Particle size distribution %		**pH (1:2.5 soil suspension)**	7.52
Coarse sand	69.9	**EC (dS m^{-1}), soil paste extract**	1.26
Fine sand	14.2	**Soluble ions (mmol L^{-1})**	
Silt	5.7	**Ca^{++}**	6.12
Clay	10.2	**Mg^{++}**	4.60
Texture	Loamy sand	**Na^{+}**	1.94
$CaCO_3$ %	2.50	**K^{+}**	0.12
Saturation percent %	23.30	**CO_3^{--}**	nd
Organic matter%	0.01	**HCO_3^{-}**	2.20
Available N (mg kg^{-1})	9.3	**Cl^{-}**	4.98
Available P (mg kg^{-1})	1.8	**SO_4^{--}**	5.60
Available K (mg kg^{-1})	67.5	**CEC (cmol kg^{-1})**	6.50

nd: not detected.

Table (2): Some Chemical properties of theusedcompost and rock phosphate.

	pH* (1:2.5)	**Organic Carbon**	**C/N ratio**	**N**	**P**	**K**
		%		**g kg^{-1}**		
Compost	6.65	33.8	16:1	2.11	1.36	2.27
Rock phosphate	7.60	nd	nd	0.42	12.0	0.11

* compost: water suspension.

RESULTS AND DISCUSSION

Results in (Table, 3) indicate that increasing P fertilization rate under both organic N rates significantly and or insignificantly increased for both yield and yield components. The mostly induced parameters, i.e., marketable, unmarketable yields (unmarketable yield was mean first and second packing), bell length and diameter, ascorbic acid content and root dry weight all of which under the highest rates of applied organic N (225 kg N fed^{-1}) as well as the highest P fertilization rate (120 kg P_2O_5 fed^{-1}). However, the highest values of stem and leaf dry weights were recorded under the highest organic N rate + 3rd P rate.

In other words the dual synergistic effect probably was mutual for N and P. However, the average values of yield and yield parameters increased significantly under higher organic N compared with the lower N one. **Dibb *et al.*, (1990)** attributed the role 0f N and P in crop fertilization leading to increased absorption of both nutrients to that in turn increased top growth, particularly as a result of N absorption. **Alabi and Odubena (2001)** reported that pepper production enjoys maximum benefit of organic manure from household refuse for soil fertility maintenance. Organic manure contains large amounts of all the mineral nutrients needed by plant. Increasing the rate of both P and organic fertilizer treatments significantly enhanced fresh fruit yield per plant when compared with the control treatment. This also enhanced significantly the yield per hectare and yield components such as the fruit length and diameter **(Alabi, 2006)**.

Results in Table (4) indicate drastic decrements in both marketable and unmarketable yield of pepper under all treatments of organic farming. The rate of reduction was partially compensated by increasing the added organic N rate from 150 to 225 kg N $fed^{-1}$and adding higher P rates consistently.

The reduction in marketable and unmarketable yield amounted to (-44.3 % and -70.9 %), respectively, under 150 kg organic N and without adding P corresponding to (-40.8 % and -67.4 %) for 225 kg organic N and zero P, respectively. Increasing P rate gradually diminished these reduction percentage to (-11.3 % and -30.4 %) for marketable and unmarketable versus (-7.85 % and -30.2 %) for both types of yield under 225 g organic N + 120 kgP_2O_5 fed^{-1}.

Finally, the most promising treatments could be: treatments of (225 kg organic N + 120 kg P_2O_5 fed^{-1}) which showed a decrement of (-7.85%) and (225 kg organic N + 90 kg P_2O_5 fed^{-1}) with a decrement of (- 10.2%). Translating these values into net income by taking into considerations the price of added fertilizer and expected price of marketable yield, the calculations reveal thatthe net income for the both organic treatments could be higher than of conventional farming treatments by 4673 and 5541 Egyptian pound, respectively.

Table (3): Interaction effect between organic N and P fertilization rates on yield and yield components of pepper plant.

Organic N Kg fed^{-1}	Rock P_2O_5 kg fed^{-1}									
	0	60	90	120	Mean	0	60	90	120	Mean
	Marketable yield ton fed^{-1}					Unmarketable yield ton fed^{-1}				
150	5.823	7.507	7.747	9.270	7.587	0.497	0.667	1.080	1.190	0.859
225	6.187	8.660	9.380	9.630	8.464	0.557	0.833	1.163	1.193	0.937
Mean	6.005	8.083	8.563	9.450		0.527	0.750	1.121	1.191	
L.S.D.$_{0.5}$ N=0.234 P= 0.242 NP= 0.342 Mineral fertilization = 10.45						L.S.D.$_{0.5}$ N= 0.058 P= 0.039 NP= 0.056 Mineral fertilization = 1.710				
	Bell length (cm)					Bell diameter (cm)				
150	9.660	11.21	12.35	12.45	11.42	8.143	8.710	8.967	9.017	8.709
225	11.45	12.47	13.70	14.50	13.03	8.680	8.757	9.017	9.230	8.921
Mean	10.55	11.84	13.02	13.47		8.411	8.733	8.992	9.123	
L.S.D. $_{0.5}$ N=0.284 P= 0.504 NP= 0.713 Mineral fertilization = 10.44						L.S.D.$_{0.5}$ N=0.112 P= 0.232 NP= 0.328 Mineral fertilization = 8.620				
	Ascorbic acid content (%)					Root dry weight (g $plant^{-1}$)				
150	52.19	54.93	61.38	63.24	57.94	1.643	1.813	2.903	2.927	2.322
225	52.85	61.60	63.04	63.97	60.37	1.720	2.257	2.957	2.963	2.474
Mean	52.52	58.26	62.21	63.60		1.681	2.035	2.930	2.945	
L.S.D.$_{0.5}$ N= 2.147 P= 1.229 NP= 1.738 Mineral fertilization = 56.28						L.S.D. $_{0.5}$ N= 0.039 P= 0.068 NP= 0.097 Mineral fertilization = 3.340				
	Stem dry weight (g $plant^{-1}$)					Leaf dry weight (g $plant^{-1}$)				
150	2.777	4.740	4.850	5.220	4.397	2.023	2.513	3.193	3.823	2.888
225	2.979	5.010	5.620	5.547	4.789	2.127	2.400	4.537	4.400	3.366
Mean	2.878	4.875	5.235	5.383		2.075	2.456	3.865	4.111	
L.S.D.$_{0.5}$ N=0.152 P= 0.248 NP= 0.351 Mineral fertilization = 10.84						L.S.D. $_{0.5}$ N=0.114 P= 0.260 NP= 0.368 Mineral fertilization = 9.530				

Table (4): Surplus (+) or deficit (-) values for yield relating the different organic fertilization treatments over or under those obtained by the mineral fertilization treatment.

Treatments (kg fed^{-1})		Yield (ton fed^{-1})	
Organic N	**P_2O_5**	**Marketable (%)**	**Unmarketable (%)**
150	0	-44.3	-70.9
	60	-28.3	-61.0
	90	-25.9	-36.8
	120	-11.3	-30.4
225	0	-40.8	-67.4
	60	-17.1	-51.3
	90	-10.2	-32.0
	120	-7.85	-30.2

The treatments of (225 kg organic N + 120 kg P_2O_5 fed^{-1}) followed by (225 kg organic N + 90 kg P_2O_5 fed^{-1}) could be recommended for obtaining the highest rate of income from the marketable yield of pepper.

With regard to marketable pepper yield under organic farming, correlation coefficient (r) between the marketable pepper yield (Y) and each of stem dry weight at harvest stage, root P content, available N in soil and plant height was positively significant.

Meanwhile, the multiple linear regression shows that there is a highly significant correlation (P = 0.01) relating marketable pepper yield (Y) to stem dry weight, root P content, available N in soil and plant height (R^2= 90.8). The expected equation to predict the marketable pepper yield was:

Marketable pepper yield = 2.23 – 0.223 stem dry weight – 34.8 root P content + 0.024 available N in soil – 0.056 plant height.

Results in (Table, 5) show that under both lower and higher organic N rate, values of N content in root, stem, leaf and fruit were increased by increasing P fertilization rate. The N content values in pepper root, stem, leaf and fruit steadily increased as the rate of applied P increased showing average percentages of 1.228, 0.952, 1.806 and 2.339, respectively, under higher organic N rate as compared with lower applied organic N rate. The maximum N content of root, stem, leaf and fruit (1.483, 1.163, 2.373 and 2.603%, respectively) occurred under the higher organic N rate (225 kg N fed^{-1}) + the highest P fertilization rate (120 kg P_2O_5 fed^{-1}). **Alabi (2006)** found that increasing the rates of applied P increased significantly the nutrient elements (N, P and K) of pepper plant with increasing the rates of applied poultry dropping.

Under both the lower and higher organic N rates, significant increases in P content of root, stem, leaf and fruit occurred under increasing P fertilization rate applied. P content values in pepper root, stem, leaf and fruit increased steadily as the rate of applied P increased showing average percentages of 0.194, 0.227, 0.274 and 0.272, respectively, under higher organic N rate as compared with lower applied organic N rate.

The maximum P content of root, stem, leaf and fruit (0.245, 0.278, 0.364 and 0.305 %, respectively) occurred under the higher organic N rate (225 kg N fed^{-1}) and highest P fertilization rate (120 kg P_2O_5 fed^{-1}). **Pazhanivelan *et al.*, (2006)** added that increasing P uptake when compost was enriched by rock phosphate due to inducing the solubility of P and thereby it availability to crop.

Under both the lower and higher organic N rates, significant increases in K content of root, stem, leaf and fruit took place under increasing P fertilization rate. K content values in pepper root, stem, leaf and fruit increased steadily as the rate of applied P increased showing average percentages of 2.820, 3.114, 3.854 and 2.334 respectively, under higher organic N rate as compared with lower applied organic N rate. The maximum K content of root, stem, leaf and fruit (2.995, 3.850, 4.187 and 2.667 %, respectively) occurred under the higher organic N rate (225 kg N fed^{-1}) and highest P fertilization rate (120 kg P_2O_5 fed^{-1}). **Alabi (2006)** found that increasing the rates of applied P and poultry droppings increased significantly the nutrient elements (N, P and K) of pepper plant.

Regarding the comparison between organic and conventional farming on nutrient content of pepper plant, obtained data (Table, 5) show that N content of root, stem, leaf and fruit increased under conventional farming compared to organic farming condition. On the other hand the P contents in root, stem and leaf pepper was highest underorganic farming than conventional farming, but P content.

Table (5): Interaction effect between organic N and P fertilization rate on nutrients content of root, stem, leaf and fruit of pepper plant at maturity stage.

Organic N kg fed^{-1}	Rock P_2O_5 kg fed^{-1} (P)														
	0	60	90	120	Mean	0	60	90	120	Mean	0	60	90	120	Mean
	Root														
	N					P					K				
150	0.957	1.140	1.183	1.450	1.183	0.141	0.152	0.168	0.200	0.165	2.527	2.660	2.773	2.950	2.728
225	1.010	1.140	1.277	1.483	1.228	0.143	0.178	0.211	0.245	0.194	2.707	2.777	2.800	2.995	2.820
Mean	0.983	1.140	1.230	1.466		0.142	0.165	0.189	0.225		2.617	2.718	2.786	2.972	
L.S.D. $_{0.5}$ N=0.045 P=0.056 NP=0.112 Mineral fertilization = 2.590						L.S.D. $_{0.5}$ N=0.012 P=0.012 NP=0.017 Mineral fertilization =0.150					L.S.D. $_{0.5}$ N=0.0.116P=0.0.088NP=0.102 Mineral fertilization = 2.590				
	Stem														
	N					P					K				
150	0.683	0.833	1.007	1.027	0.687	0.166	0.180	0.201	0.262	0.202	2.707	2.840	2.923	3.697	3.042
225	0.860	1.097	1.163	0.952	0.952	0.171	0.194	0.264	0.278	0.227	2.763	2.910	2.933	3.850	3.114
Mean	0.771	0.965	1.085	0.989		0.168	0.187	0.232	0.270		2.735	2.875	2.928	3.775	
L.S.D. $_{0.5}$ N=0.048 P=0.068 NP=0.079 Mineral fertilization = 1.257						L.S.D. $_{0.5}$ N=0.009 P=0.012NP=0.017 Mineral fertilization = 0.174					L.S.D. $_{0.5}$ N=0.008 P=0.079 NP=0.125 Mineral fertilization = 2.513				
	Leaf														
	N					P					K				
150	0.957	1.277	1.800	2.343	1.594	0.076	0.226	0.264	0.303	0.217	3.400	3.530	3.807	4.107	3.711
225	1.140	1.450	2.260	2.373	1.806	0.205	0.236	0.291	0.364	0.274	3.580	3.770	3.877	4.187	3.654
Mean	1.048	1.363	2.030	2.358		0.140	0.231	0.277	0.333		3.490	3.650	3.842	4.147	
L.S.D. $_{0.5}$ N=0.008 P=0.079 NP=0.112 Mineral fertilization = 2.640						L.S.D. $_{0.5}$ N=0.003 P=0.012 NP=0.017 Mineral fertilization = 0.245					L.S.D. $_{0.5}$ N=0.075 P=0.143 NP=0.202 Mineral fertilization = 3.097				
	Fruit														
	N					P					K				
150	1.890	2.043	2.110	2.233	2.069	0.207	0.279	0.284	0.303	0.268	1.840	1.903	2.080	2.423	2.062
225	2.070	2.093	2.590	2.603	2.339	0.213	0.270	0.300	0.305	0.272	1.857	2.280	2.560	2.677	2.344
Mean	1.980	2.068	2.350	2.418		0.210	0.274	0.292	0.304		1.848	2.091	2.320	2.550	
L.S.D. $_{0.5}$ N=0.131 P=0.097 NP=0.137 Mineral fertilization = 3.230						L.S.D. $_{0.5}$ N=0.015 P=0.012 NP=0.017 Mineral fertilization = 0.309					L.S.D. $_{0.5}$ N=0.088 P=0.131 NP=0.186 Mineral fertilization = 2.233				

in fruit was highest value under conventional farming than organic farming. K content of root, stem, leaf and fruit was highest value under organic farming than conventional farming.

REFERENCES

Alabi, D.A., 2006. Effects of fertilizer phosphorus and poultry dropping treatments on yield and quality of sweet pepper (capsicum annuum L.). African J. biotech., 5: 671-677.

Alabi, D.A. and Y. Odubena, **2001.** A preliminary study of the effects of two organic wastes and NPK (15:15:15) on the growth and yield of cowpea (*Vignaunguiculata (L) Wasp*). NigeriaJ. Hort. Sci. 5:19-27.

Alfoeldi, T.; A. Fliessbach, V. Geier, L. Kilcher, V. N iggli, L. Pfiffner, M. Stolze and H. Willer, 2002. Organic agriculture and the environment. In: El-Hage Scialabba N.; C. Hattam (Eds), Organic Agriculture, Environment and Food Security Environment and Natural Resources Series 4.AO (Chapter 2).

Chapman, H.D. and R.E. Pratt, 1961. Methods of analysis for Soil, Plants and Water. Dept. of Soil, Plant Nutrition, Univ. of California.U.S.A.

Clark, M. S.; W. R. Horwath, C. Shenan; K. M. Scow, W.T. Lantni and H. Ferries, 1999. Nitrogen, weeds and water as yield limiting factorsinconventional, low-input, and organictomato systems. Agric. Ecsyst. Environ., 73:257-270.

Conner, D.J., 2008. Organic agriculture can not feed the world. Field Crops Res., 106: 187-190.

Cottenie, A., 1980. Soil and plant testing as a basis of fertilizer recommendation. F.A.O. Soil Bull.

Dibb, D.W.; P. E. Fixen and Murphy, 1990. Balanced fertilization with particular reference to phosphorus interaction of phosphorus with other inputs and management practices Fert. Res., 26: 29-52.

Kevin, M. M., K.G. Campbell, S. R. Lyon and S. S. Jones, 2007. Evidence of varietal adaptation to organic farming systems. Field Crops Res. 102: 172-177.

International Federation of Organic Agriculture Movements (IFOAM), 2000. Basic Standards for organic Production and Processing. Decided by the IFOAM General Assembly in Basal, Switzerland, September (2000), Tholey-Theley.

Pazhanivelan, S.; **M. Mohamed, K. Vaiyapuri, C. Sharmila, K. Sathyamoorthi and A. Alagesan, 2006.** Effect of rockphosphate incubated with FYM on nutrient uptake and yield of lowland rice. Research Journal of Agriculture and Biological Sciences, 2:365-368.

Rodrigues M.A.; A. Pereira, J.E. Cabanas, L. Diasl, J.Pires and M.Arrobas (2006). Crops use-efficiency of nitrogen from manure permitted in organic farming. Europ. J. Agronomy, 25:328-335.

Ryanet M.H.; J.W. Derrick and P.R. Dann, 2004. Grain mineral concentrations and yield of wheat grown under organic and conventional management. J. Sci. Food Agric., 84:207-216.

Stockdale E.A.; N.H. Lampkin, M. Hovi, R. Keatinge, E.K. Lennarstson, D.W. Macdonald, S. Padel, F.H. Tatterall, M. S. walfe and C.A. Watson, 2001. Agronomic and environmental implications of organic farming systems, Adv. Agron., 70: 291-327.

Trewavas, A., 2004. Acritical assessment of organic farming-and- food assertions with particular respect to the UK and the potential environmental benefits of no-till agriculture. Crop Prot., 23:757-781.