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Effect of Municipal Solid Waste Compost, Rock Phosphate and Phosphate Solubilizing Bacteria on Nutrients Uptake and Yield in Wheat

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A B S T R A C T

Municipal solid waste compost (MSWC), rock phosphate (RP) and phosphate solubilizing bacteria (PSB) @ 20 ml pot^{-1} were applied as soil amendment to investigate its effect on soil, nutrients uptake and yield in wheat (*Triticum aestivum*, L.). Maximum up take of potassium (K) mg kg^{-1}, Phosphorous (P) mg kg^{-1} and Nitrogen (N) mg kg^{-1}, Iron (Fe) mg kg^{-1}, Copper (Cu) mg kg^{-1}, Manganese (Mn) mg kg^{-1} and Zinc (Zn) mg kg^{-1} was observed with the application of RP @ 1000 kg ha^{-1} + MSWC @ 20 t ha^{-1}. Significant increase in plant height, fresh weight plant^{-1}, grain weight plant^{-1}and spike length was found by the same treatment, Significant difference was also observed with application of PSB on soil nutrients, nutrients uptake and yield in wheat. It was also observed soil parts hydrogen (Ph) and electric conductivity (Ec) ds m^{-1}remained unaffected by all the treatments applied. Comparing all the treatments, it can be concluded that rock phosphate 1000 kg ha^{-1} + MSWC @ 120 ton ha^{-1} can affectively improve the soil nutrients (macro and micro) uptake with significant increase in yield attributes in wheat.1

Introduction

The application of municipal solid waste compost (MSWC), rock phosphate (RP) and phosphate solubilizing bacteria (PSB) as soil amendment is of economic and environmental interest to sustain natural resources like soil and water for increasing food production is a serious challenge to be addressed in 21st century. Long term food security requires a balance between crop production and soil health/ fertility. However, imbalanced application of chemical fertilizers or excessive nutrient supply not only affect on nutrient use efficiency (Aulakh, 2010), but also deteriorates the soil structure, atmosphere and quality of underground water (Aulakh *et al.*, 2009).

In developed countries municipal solid waste compost (MCWC) is considered as a new soil amendment to compensate other organic composts like farm yard manure and poultry manure (Cherif *et al.*, 2009). Solid waste management. SWMC can be used as a low grade manure and soil conditioner. MCWC is generally low in nutrition therefore less acceptable to the farmers, hence enrichment of

MSWC is necessary to improve nutrient status and quality of compost (Kavitha and Subramanian, 2007).

Phosphate solubilizing microorganisms (PSM) along with rock phosphate (RP) is a chaper source of phosphorous (P) fertilizer in crop production resulting in higher yield (Khan *et al.,* 2004). The effect of phosphate solubilizing bacteria was found significant on plant height, grain yield, straw yield and at nutrients uptake in wheat (Hossain *et al.,* 2004).

Considering the quality and nutritional significance of MSWC, the study was conducted to investigate best combination of MSWC, with phosphatic fertilizer, rock phosphate and phosphorous solubilizing bacteria on plants nutrient uptake and yield in wheat.

Materials and Methods

Treatments and Experimental Design

A pot experiment was conducted in two factorial completely randomized design with three replications to investigate the effects of rock phosphate application along with organic manures (municipal solid waste compost and rock phosphate) on soil and plants of wheat. Factor 1: mineral and organic phosphorous (P) source (rock phosphate) and Factor 2: P-solubilizing bacteria. Treatments were applied with and without phosphorous solubilizing bacteria (PSB) WPs-8 inoculated @ 20ml pot^{-1}. The detail of treatments is as under:-

Treatments detail

T_1 = control

T_2 = P fertilizer @ 90 kg ha^{-1}

T_3 = RP only @ 1000 kg ha^{-1}

T_4 = RP @ 1000 $kgha^{-1}$ + MSWC @ 10 ton ha^{-1}

T_5 = RP @ 1000 $kgha^{-1}$ + MSWC @ 20 ton ha^{-1}

Soil sample was taken before sowing and after harvesting wheat crop. Before sowing composite sample was taken from all pots and soil analysis was done showing in Table. 2…..Variety of wheat was chakwal-50 and 20 seeds per pots were sown and after germination only 8 plants per pot were selected.

Chemical Analysis

Samples were dried in hot air oven at 65 ^oC for 24 hours. Dried samples were grinded and stored in plastic bottles. Plant and compost samples were digested with H2SO4-salicylic acid mixture in block digester and heated to 400 ^oC. After digestion, distillation with 10 N NaOH and titration against 0.01 N H_2SO_4 will be carried out total nitrogen will be calculated with following formula (Buresh *et al.,* 1982)

Wet digestion was done according to (Issac and Johnson 1975). Digested filtrate was used to measure total phosphorus clorimetrically. Potassium was analyzed by using digested filtrate directly by flame photometer. Micronutrients (Fe, Cu, Mn, Zn) were analyzed using digested filtrate directly by flame photometer.

Macronutrients (N, P, K) and Micronutrients (Fe, Cu, Zn, Mn) in soil and rock phosphate were determined through AB-DTPA Method (Soltanpour and Workman, 1979) Electrical conductivity was determined using soil to distilled water ratio of 1:1 (Rhoades, 1982).

Soil pH was determined using soil to distilled water ratio of 1:1 by calibrated pH meter (Mclean, 1982).

Statistical Analysis

The data collected was analyzed by using appropriate statistical analysis tools (Steel *et al.*, 1997).

Results and Discussion

There were no significant differences ($p<0.05$) between the soil pH values of all the soil treatments with and without phosphorous solubilizing bacteria (Table. 3) similar results were obtained by Bouzaiane *et al.,* (2007). Data in (Table. 4) revealed that none of treatment has influence on fresh weight of plant, spike length plant^{-1} and number of tillers plant^{-1}. Grain weight plant^{-1} was maximum (3.46 g) and (3.5 g) with and without PSB by T_5. These results are in accordance with (Cherif *et al.,* 2009) who reported a noticeable increase in grain yield by MSWC and other organic fertilizers compared to control. Plant height showed significant difference with in treatments and where PSB was applied. Plant height was maximum (68.8 cm) by T_5 followed by (66.8cm) which was produced by the treatment T_4 with PSB. While the same treatments T_5 and T_4 showed maximum plant height (65.6 cm) and (63.38 cm) without PSB. The findings are in accordance with results of Afzal, *et al.,* (2005) and Ali *et al.,* (2003) who observed MSWC has positive effects on plant height. However Kumari *et al.,* (2002) reported a significant increase in sorghum plant height by inoculation of different bacterial strains.

Macro and micronutrient content in soil

Data in (Table.3) reveals that P content of soil after harvesting increased significantly among the treatments and a significant difference was noted where PSB applied and where PSB was not applied. These findings are in unity with results observed by Noor *et al.,* (2005) and Kavitha *et al.,* (2007) who reported that there was increase in p content in soil by applying phosphobacteria, rock phosphate and organic manure. Results in also shows that K and N content of soil after harvest also increased significantly among treatments but application of PSB made no significant difference in soil K. Maximum K (182 mg kg^{-1}), P (7.6 mg kg^{-1}) and N (14.7 mg kg^{-1}) was found in the samples collected from plots where RP @ 1000 kg ha^{-1} + MSWC @ 20 ton ha^{-1} was applied with PSB.

These findings are in agreements with results of Noor *et al.,* (2005). While data regarding nitrate-nitrogen of soil presented in table.3 reflects that there was significant difference present among the treatments but application of PSB had no significant effect on nitrate nitrogen content in soil. These findings relates with sharif *et al.,* (2011) who reported PSB had no significant effects on soil nitrogen content.

Macro and Micronutrients uptake in wheat

Data presented in (Table.5) demonstrates that P uptake in wheat was significant among treatments applied but PSB did not showed any significant effect on the uptake of P except where rock phosphate is applied with PSB. These findings are similar to Imran *et al.,* (2011) who studied the effect of DAP, RP, and RP enriched compost on maize crop and concluded that DAP showed the highest P uptake followed by RP enriched compost and RP. Potassium uptake by wheat plants revealed that there was significant increase in K uptake by the application of different treatments and higest concntration was occurred where compost was applied T_5 (1.75 %) and T_4 (1.59 %) with PSB. The findings are in confirmation with Han *et al.,* (2006) who conclude that there was boost in uptake of K in pepper by addition of RP with phosphorus solublising bacteria as compared to the treatments without phosphorus solublising bacteria.

Table.1 Analysis of rock phosphate and MSWC compost used

Treatments Detail	N	P	K	Fe	Cu	Zn	Mn
RP	21 ppm	190 ppm	43 ppm	28 ppm	6.8 ppm	4 ppm	8.4 ppm
MSWC	1.2%	.43%	1.1%	2281 ppm	22 ppm	310 ppm	312 ppm

Table.2 Physicochemical properties of experimental soil

Soil properties	Concentration
pH	7.75
Ec (dS/m)	0.42
Texture	sandy loam
NO_3-N (mg/ kg)	6.53
Available P (mg/ kg)	5.01
Potassium (mg /kg)	125
Fe (mg/kg)	8.2
Copper(mg/kg)	0.50
Zinc(mg /kg)	0.65
Mn(mg /kg)	12.5

Table.3 Macronutrients, EC, pH in soil

Treatments	K mg kg^{-1}		P mg kg^{-1}		NO3-N mg kg^{-1}		pH		Ec ds/m	
	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB
Control (NK)	125F	128EF	3.5E	3.6E	7.3E	7.2E	7.86ABC	7.77BC	0.45BC	0.43C
90 kg/ha P source(NK)	131DEF	128.6EF	8.4A	5.7CD	7.4CD	8.6DE	7.9AB	7.75C	0.44A	0.48C
RP 1000 kg/ha(NK)	144D	141DE	5.9CD	4.7DE	9DE	8.5DE	7.8A	7.79BC	0.43AB	0.42C
RP+MSCW 10 /ha(NK)	168BC	164C	7.2BC	4.8DE	13.6AB	11.5BC	7.92ABC	7.89ABC	0.47BC	0.43C
RP+MSCW 20t/ha(NK)	182A	178AB	7.6AB	5.1D	14.7A	13.6AB	7.95AB	7.89ABC	0.48BC	0.44C
LSD	13.04		1.35		2.18		0.14		0.05	

LSD= Least significant difference

Table.4 Physical parameters

Treatments	Heightplant[1]		Fresh wt/ plant		Spike length		Number of Tillers/ plant		Grain weight/ plant	
	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB
Control	53.00E	54.50 D	3.2 C	3.7 D	7.16 D	7.0 E	2.63 C	3A	3.0 E	2.85 D
90 kg/ha P source	65.00C	61.63 B	5.8 A	4.5 A	8.01 C	8.10 C	3.03 B	3.6A	4.87A	3.33 A
RP 1000 kg/ha	55.60 D	60.10 C	3.3 C	3.2 E	8.13 C	7.63 D	3.03 B	3.3A	3.1 D	2.83 D
RP+MSCW 10 t/ha	66.63 B	52.36 E	4.7 B	4.1 C	8.60 B	8.26 B	3.10 B	3.3A	3.26 C	3.06 C
RP+MSCW 20t/ha	68.40 A	65.70 A	5.3 A	4.3 A	9.0 A	8.56 A	3.33 A	3.6A	3.46 A	3.20 B
LSD	3.86		0.59		1.5		1.42		0.32	

LSD= Least significant difference

Table.5 Macronutrient uptake by wheat

Treatments	K%		P%		N%	
	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB
Control	0.66 D	0.62 D	0.41 A	0.47 B	1.8 B	1.7 C
90 kg/ha P source	1.27 C	0.86 C	0.73 A	0.61 A	1.7 B	1.87 B
RP 1000 kg/ha	0.28 E	0.54 E	0.83 A	0.47 B	1.8 B	1.5 C
RP+MSCW 10 t/ha	1.46 B	1.3 B	0.50 A	0.37 D	2.4 A	1.86 B
RP+MSCW 20t/ha	1.71 A	1.50 A	0.63A	0.40 C	2.5 A	2.32 A
LSD	0.17		0.28		0.31	

LSD= Least significant difference

Table.6 Micronutrient uptake by wheat

Treatments	Fe mg kg^{-1}		Cu mg kg^{-1}		Mn mg kg^{-1}		Zn mg kg^{-1}	
	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB	With PSB	Without PSB
Control	78.3 E	76.9 E	16.8 B	14.6 E	26.7 E	23.4 E	17.4 E	15.6 E
90 kg/ha P source	94.47 C	79.7 C	21.6 B	19.1 D	42.4 C	32.1 D	21.6 D	19.4 D
RP 1000 kg/ha	83.6 D	74.4 E	28.7 AB	25.3 C	34.4 D	32.9 C	27.3 C	23.6 C
RP+MSCW 10 t/ha	98.9 B	83.9 B	39.1 A	33.1 B	48.4 B	42.7 B	42.8 B	39.0 B
RP+MSCW 20t/ha	105.2 A	93.4 A	40.2 A	43.6 A	56.4 A	53.6 A	49.9 A	43.4 A
LSD	7.86		4.44		7.43		6.28	

LSD= Least significant difference

Total nitrogen of the plant samples ranged from 1.7% to 2.5% in Table.5. The results showed non-significant differences among different treatments applied. There was no significant effect of PSB was showen on uptake of nitrogen. These observations are at par with those of Minja *et al.*, (2008) who found that green manure along RP was more effective than other treatments.

Data in (Table.6) regarding micronutrients (Fe. Cu, Mn, Zn) in soil shows significant increase in micro nutrients uptake among treatments. These findings are in conformity with Roghanian *et al.*, (2012) who observed increase in availability and uptake of iron (Fe), manganese (Mn), Zinc (Zn) and Nickle (Ni) with the application of municipal waste compost leachate. Application of PSB did not have any effect on the concentration of micronutrients (Fe, Cu, Mn) but significant difference was noted in case of zinc (Zn) with in soil. These results supported kumari *et al.*, (2002) who reported that compost treated plot enhanced micronutrient up take.

These studies provide an insight in understatnding, how municipal solid waste compost (MSWC) and rock phosphate (RP) in addition of phosphorous solublizing bacteria (PSB) result in agronomically pheasible, envoronmentally sound and economically viable sustainable production system by maintaining and enhancing soil ferlitilty status, reducing nutrient losses and improving nutrients uptake in plants resulting in improved crop production. From the above study it is suggested that MSWC and RP with PSB can be effective soil treatment to improve soil fertility status and increased economical yield in wheat.

References

Afzal, A., M. A. Saeed, A. Asad and M. Farooq. 2005. Effect of phosphate solubilizing microorganisms on phosphorous uptake, yield and yield traits of wheat (*Triticum aestivum* L.) in Rainfed area. Int. J. Agri. Biol., 2: 207-209.

Ali, H. I., M. R. Ismail, M. M. Manan and H. M. Saud. 2003. Rice straw compost used as a soil less media for organic tomato transplant production. Asian J. Microbial. Biotechnol. Environ. Sci. 5:31-36.

Aulakh, M. S. 2010. Integrated nutrient management for sustainable crop production, improving crop quality and soil health, and minimizing environmental pollution. World Congress of Soil Sci. 1-6 August, Brisbane, Australia.

Aulakh, M. S., M.P. S. Khurana and D. Singh. 2009. Water pollution related to agricultural, industrial and urban activities, and its effects on food chain; Case studies from Punjab. J. New Seeds. 10: 112-137.

Bouzaiane, O., H. Cherif, F. Ayari, N. Jedidi and A. Hassen. 2007. Municipal solid waste compost does effects on soil microbial biomass determined by chloroform fumigation-extraction and DNA methods. Annals of Microbioloy. 57: 681-686.

Buresh, R. J., P. C. Austin and E. T. Craswell. 1982. Analytical methods in N-15 research. Fert. Res., 3: 37-62.

Cherif, H., F. Ayari, H. Ouzari, M. Marzorati, L. Brusetti, N. Jedidi, A. Haseen and D. Daffonchio. 2009. Effects of municipal waste compost, farmyard manure and chemical fertilizers on wheat growth, soil composition and soil bacteria characteristics under Tunisian arid climate. European J. Soil Biol. 45: 138-145.

Han, H., S. Supanjan and K. D. Lee. 2006. Effect of co-inoculation with phosphate and potassium solublizing bacteria on mineral uptake and growth of pepper and cocummber. Plant Soil Env., 3: 130-136.

Hossain, M. B., M. A. Sattar and M. Z. Islam. 2004. Characterization and effect of phosphate solubilizing bacteria in wheat. J. Agric. Res. 42: 3-4.

Imran, M. 2011. Effect of recycled and value added organic waste on solubilization of rockphosphate in soil and its influence on maize growth. Int. J. Agri. and Biol., 36: 138-156.

Issac, R. A and W. C. Johnson. 1975. Collaboration study of wet and dry ashing techniques for elemental analysis of plant tissue by atomic absorption spectrophotometer. J. Assoc. Annal. Chem., 58: 436-440.

Kavitha, R. and P. Subramanian. 2007. Effect of enriched municipal waste compost application on growth, plant nutrient uptake and yield of rice. J. Agronomy. 6: 586-592.

Khan, M. S., A. Zahid and M. Aamil. 2004. Bioassociative effect of rhizospheric microorganisms on growth, yield and nutrient uptake of greengram. L. Plant Nutri., 27: 599610.

Kumari, M. S and K. Ushakumari. 2002. Effect of vermicompost enriched with rock phosphate on yield and uptake of nutrients in cowpea. J. Tropical Agri. 40: 27-30.

Mclean, K. S. 2005. Soil and fertilizer Phosphorous. In: Soil Science. A. Rashid and K. S. Memon. Edited by E. Bashir and R. Bantel. Roohani Art Press Isb.

Minja, R. R., A. P. Maerere, C. L. Rweyemamu and G. G. Kimbi. 2008. Effects of amending compost and green

manure with phosphate rock on quality of amaranth. Afr. J. Hort. Sci., 1: 70-71.

Noor, A. 2005. The role of rock phosphate and farm yard manure compibed phosphate solubilizing bacteria in increasing nutrient uptake and soybean yield. J. Land and Environ. 7: 41-47.

Rhoades, J. D. 1982. Soluble salts (Electrical conductivity), R. H. Miller and O. R. keeneys (eds), Methods of soil analysis part 2. ASA. No. 9. Madison, Wiconsin, USA, pp.172-173.

Roghanian, S., H. M. Hosseini, G. Savaghebi, L. Halajian, M. Jamei and H. Ethseami. 2012. Effects of composted municipal waste and its leachate on some soil chemical properties and corm plant response. Intern. J. Agri,: Res and Rev. 2: 801-814.

Sharif, M. 2011. Response of dung compost with rock phosphate on yield and phosphorous and nitrogen uptake of maize crop. Afri. J. Biotech. 10: 12595-12601.

Soltanpour, P. N. and S. Workman. 1979. Modification of the $NAHCO_3$DTPA soil test to omit carbon black. Commun. Soil Sci. Plant Anal., 10:1411-1420.

Steel, R. G. D., J. H. Torrie and M. A. Boston. 1997. Principles and procedures of statistics: A biometrical approach, ed. McGraw Hill Book company Inc. New York, pp. 633.

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