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Evaluation of methods of EM application with different composts on the yield and phosphorus uptake of wheat crop

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Abstract

Due to high cost of P fertilizers, natural rock phosphate (RP) is considered a good alternative for P fertilizer. Phosphorus biofertilizers in the form of microorganisms enhance RP solubalization and increase its availability to the plant. An experiment was conducted to determine yield, yield components, phosphorus and nitrogen uptake of wheat crop as influenced by different methods of effective microbes application with composts at research farm of The University of Agriculture Peshawar, during rabi season 2013 – 2014. There were eleven treatments control, N and K as basal dose, organic waste compost (C-I), C-I + effective microbes soil application (EM-I), C-I + effective microbes foliar application (EM – II), C-I + Half EM–I + Half EM-II, Farm yard manure (C-II), C-II + EM-I, C-II + EM – II, C-II + Half EM–I + Half EM-II. Maximum grain yield of 5590 kg ha^{-1}, total dry matter yield of 13092 kg ha^{-1}, thousand grain weight of 51.17 g, soil N content of 3680 mg kg^{-1}, P content of 5.925 mg kg^{-1} were observed in the treatment of FYM compost with soil application of EM, which were statisticaly at par with SSP treatment. Plant N and P uptakes were significanly improved by the treatment of FYM compost with soil application of EM followed by SSP treatment. The constantly better performance of FYM compost with soil application of EM regarding wheat yield, yield components, N and P uptake suggested that it may be used as an alternative source of P fertilizer.

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Introduction

Soils of Pakistan are deficient in nitrogen (N) and phophorus (P). The P deficiency has been observed in about 80% soils to support good agriculture (Nasir *et al.,* 1990*).* Due to high Ca content in our soil, P is fixed in the form of dicalcium phosphate and is unavailable to the plant. Therefore, for better yield plants utilize only a small portion of P, while the remaining of P is fixed into insoluble forms (Rodríguez and Fraga, 1999).

Due to high cost of P fertilizers, natural rock phosphate (RP) has been found as a good alternative for P fertilizer. It is chemicaly tri-calcium phosphate with non-available P and is mainly used in phosphatic fertilizers. Pakistan has 6.9 million tons RP deposits only in Hazara, out of which, about 4.58 million tons are considered as obtainable.

Phosphorus biofertilizers in the form of microorganisms can solubilise the nonavailable soil phosphates and increase its availability to the plant. Microorganisms in biofertilizers can also promote plant growth by increasing the capability of BNF, increasing the availability of other micronutrients and by production of plant growth enhancing substances. In this way, biofertilization technology decrease cost of production and are also environment friendly (Galal *et al.*, 2001).

The technology of effective microorganisms (EM) of natural farming has been descrided by Higa and Wididanain (1991), which is based on using mixed microorgansims culture(lactic acid bacteria, photosynthetic bacteria, yeasts, actinomycete and fermenting fungi) found in natural environment. Effective microorganism increases soil fertility, enhances crop production and crop quality, helps to correct crop physiological and nutritional problems, reduces diseases, speed up the decomposition of organic matter, minimises diseases problem of continuous cropping by supressig Fusarium propagation and activities, improve soil physical properties, increases population of beneficial microorganisms in the soil (Arakawa, 1991). However Photosynthetic bacteria are the backbone of the EM, increase phosphorus availibility to plant by working synergistically with Vesicular arbuscular mycorrhiza.

For centuries composts have been used for improvement of soil condition. Farmer do know the importance of composts which is used to enhance crop production, to save money, to avoid the use of synthetic fertilisers and preserve natural resources. Composts provide a stable organic matter that enhance the biological, chemical and physical characteristics of soil, thereby improving soil qualities and crop yield. Compost has good effects on soil charateristics, thus providing favourable envirnment for root growth and consequently enhancing crop production and improving quality of crops. P solubility from RP has been increased by composting of dungs and other organic material with rock phosphate (Singh and Amberger, 1991) and this low-input technology is used widely to enhance the value of manure as fertiliser (Mahimairaja *et al.*, 1995). When the temperature of pits become equal to the air temperature in surrounding then composts look like dark soil, having constant ratio of carbon nitrogen and the materials do not identifiable, volume of compost becom reduce then it is ready to use.

Wheat (*Triticum aestivum* L.) is a rabi, self-pollinated, summer days plant and belong to the Poaceae family. It is grown in winter season in Pakistan. In developing countries like Pakistan, wheat crop is preferred because of its high yield. During 2011-2012 the total production of wheat in Pakistan was 23473.4 thousand tons under total area of 8649.8 thousand hactare, with average production of 2714 kg ha^{-1}. In Khyber Pakhtunkhwa, the production of wheat was 842.7 thousand tons under the area of 729.3 thousand hactare and the average production was 1550 kg ha^{-1}during 2011-2012. (MINFAL, 2011–2012).

According to the significance of rock phosphate as a naturally occuring and more profitable phosphorus source and the role of EM and composts, this study will be conducted to determine the influence of methods of EM applications with composts of different organic materials and RP on the yield and plant P uptake of wheat.

Materials and methods

An experiment was carried out in field to evaluate wheat yield, yield components and phosphorus uptake influenced by soil and foliar application of Effective microorganisms (EM) with composts of different organic materials prepared with RP. This experiment was conducted at the research farm of The University of Agriculture Peshawar, during Rabi (2013-2014). Wheat variety, Seran @100 kg seed ha $^{-1}$ was grown in Randomized Complete Block Design (RCBD) with 3 replications. The numbers of treatments were 11, with 4×5 m^2 plot size. The crop was grown with a row to row distance of 25 cm. Recommended level of fertilizers were applied @ of 120-90-60 kg ha^{-1} N, P_2O_5 and K_2O, respectively. Three splits application of nitrogen was applied as urea and all phosphorus and potassium were applied at sowing time. Phosphorus was applied either in the form of SSP or composts already prepared by our research group from farm yard manure and organic wastes with RP on their P analysis basis. Source for K was potassium sulphate fertilizer. All cultured practices were strictly followed throughout growing period for optimum crop production. The treatments combinations are given in Table 3.

All the inputs were mixed properly in soil and applied before sowing. One liter of effective microbes were mixed in one liter of conc. solution of gure and then put 20 liters of water for dilution. Placed the EM solution for 3 days. It was done for EM activation. The pH was dropped to 3.6 afer 3 days which indicated that effective microbes are activated. EM was applied at the the time of sowing and as foliar spray at tillering stage at the rate of 20L ha^{-1} with the help of hand pump.

Collection of Soil and Plant Samples

Composite soil sample was collected at 0-15 cm depth from experimental field perior to sowing and fertilizer application and after crop harvest from each treatment, these samples were dried, grinded and sifted by a seive less than 2mm in diameter. These samples were laballed and stored properly for analysis. Ten wheat Plants were collected randomly from each treatment at maturity stage for the analysis of plant P and N concentrations and their uptakes by wheat plants. These plant samples were washed with distil water, oven dried at 90 ^oC, grinded, labelled and store properly.

Soil Analysis

Composite soil samples were collected from each treatment after crop harvest and were examined for different physico-chemical properties following standard procedures.Soil particles analysis was performed by hydrometer method (Barbers 1995) and the textural triangle was used to find soil texture (Koehler *et al*., 1984). Soil organic matter content was determined by oxidizing soil with $K_2Cr_2O_7$ and titrating against Fe_2SO_4 (Nelson and Sommer, 1982). Electrical conductivity was studied in 1:5 soils: water suspension by EC meter by the method of Rhoades (1982).AB-DTPA extractable P was determined by procedure as described in Soltanpour and Schwab (1977). Total N content in soil samples was determined by Kjeldahl method (Bremner, 1982).

Analysis of Plant Samples

P in plant samples was determined by diacid (nitric acid and perchloric acid) digestion. P was measured calorimetrically (Ryan *et al*., 2001) N was determined by Kjeldahl method (Bremner and Mulvaney, 1982). Nutrient uptake was calculated by multiplying biological yield with nutrient concentrations.

Agronomic Data

Agronomic Data on total dry matter yield, grain yield and1000 grain weight was also recorded. Biological yield (kg ha^{-1}) was determined by harvesting three central rows in each 20 m^2 plot.

The plants of harvested rows were dried in sun for a week. After seven days the harvested material was weighted and biological weight was converted in to (kg ha^{-1}) by using formula:

$$\text{Total dry matter yield } (kg\ ha^{-1}) = \frac{\text{Biological yield of 3 rows}}{\text{No. of rows harvested x row to row distance x row length}} \times 1000$$

The harvested three rows material of each 20 m² were threashed and the grain obtained for each 20 m² was weighed to obtain grain yield. For 1000 grain weight, thousand grains from each 20m² plot were counted and weighed on electronic top loader balance.

Statistical Analysis

The collected data was statistically analysed by using RCBD in 8 package statistix as described by Jandel Scientific (1991) and means separation among the treatments were done by using LSD at 0.5 level of significance.

Results and discussion

An experiment was conducted at the research farm of The University of Agriculture Peshawar, during Rabi (2013-2014) to evaluate the influence of EM application with composts.

Table 1. Treatment combination.

S.No	Treatments
1	Control (No fertilizers)
2	N and K as basal dose of fertilizer applied to all treatments except control.
3	Single Super Phosphate
4	Organic waste compost (C-I)
5	C-I + EM soil application (EM-I)
6	C-I + EM foliar application (EM-II)
7	C-I + Half EM-I + Half EM-II
8	Farm yard manure compost (C-II)
9	C-II + EM-I
10.	C-II + EM-II
11.	C-II + Half EM-I+ Half EM-II

Physical and chemical properties of soil under investigation are presented in Table. 2. Data in Table 2 showed that soil under observation was calcareous in nature, alkaline in reaction, silty clay loam in texture, low in SOM content, poor in available Phosphorus and total nitrogen contents.

Composts prepared with organic material, farm yard manure and organic wastes were analysed for their N and P concentrations and the data are presented in Table 3 revealed that total N concentration in FYM compost was 2 % and in compost of organic wastes as 1.20 %. The P_2O_5 content of FYM and organic wastes composts were as 3 %, and 2.5 %, respectively.

Wheat grain yield

Wheat grain yield as affected by different methods of EM applied with composts of FYM and OW prepared with RP is presented in Table 4. Data indicated that grain yield was significantly affected ($p < 0.0001$) by treatments combination of composts and effective microbes. Maximum yield of grains 5590 kg ha^{-1} was found with soil applied EM (EM-I) with FYM compost (C-II), which was 132% higher thancontrol, followed by the treatment of combined soil and foliar application of EM with FYM compost whereas yield produced by SSP is statistically at par from C-I + EM-I and CII + half EM-I + half EM-II. Lowest yield of grains 2411 kg ha^{-1} was found in control treatment. It may be due to effective microbes boost up mineralization process in FYM compost (C-II) more as compared to OW compost (C-I) and more nutrients availability to crops requirement for higher net dry matter production hence increases grain yield and total dry matter production over control and other treatments. Statistically, total dry matter production and yield components were highly significant by applying FYM, poultry manure with beneficial or effective microbes (Ortiz-Monasterio *et al.*, 1997; Shah and Ahmad, 2006; Shah *et al.*, 2010; Muhammad *et al.*, 2012), which supported this result.

Total dry matter yield

Table 4 showed mean data of wheat total dry matter yield as affected by different methods of EM applied with composts of FYM and OW prepared with rock phosphate. Highest total dry matter yield of 13092 kg ha^{-1} was produced with EM soil application (EM-I) with FYM compost, which was 129% increase over the control, followed by EM soil application (EM-I) with organic wastes compost, and SSP treatments which were statistically similar with each other. The lowest total dry matter yield of 5705 kg ha^{-1} was recorded in control treatment.

Table 2. Physico-chemical properties of soil under investigations.

Property	Unit	Value
Clay	%	33
Silt	″	53
Sand	″	14
Textural class	-----	Silty clay loam
EC (1: 5)	dS m^{-1}	0.24
pH (1:5)	-------	7.79
Organic matter	%	0.89
$CaCO_3$	″	15.5
Soil nitrogen content	″	0.16
AB-DTPA extractable Phosphorus	mg kg^{-1}	4.15

It may be due to effective microbes boost up mineralization process in FYM compost (C-II) as compared to OW compost (C-I) and more nutrients availability to crops requirement for higher net dry matter production hence increases grain yield and total dry matter production over control and other treatments. These results are in agreement with Ortiz-Monasterio *et al.* (1997), Shah and Ahmad (2006), Shah *et al.* (2010) and Muhammad *et al.* (2012) who found that total dry matter production, and yield components were highly significant by applying FYM, poultry manure with beneficial or effective microbes.

Table 3. Concentrations of N and P in farm yard manure and organic wastes composts under investigation.

Manures	N (%)	P_2O_5 (%)
Farm yard manure compost (C-I)	2.0	3.00
Organic waste compost (C-II)	1.20	2.50

Straw yield

Tabl. 4 showed mean data of wheat total dry matter yield as affected by different methods of EM applied with composts of FYM and OW prepared with RP. Highest straw yield of 7629 kg ha^{-1} was produced with SSP treatment, which ws statistically similar to EM soil application (EM-I) with FYM compost and EM soil application (EM-I) with organic wastes compost, which was 132% more than control followed by treatment of both soil and foliar application of EM with FYM composts. The lowest straw yield of 3295 kg ha^{-1} was observed in control treatment. It may be due to effective microbes boost up mineralization process in FYM compost (C-II) as compared to OW compost (C-I) and more nutrients availability to crops requirement for higher net dry matter production hence increases grain yield and total dry matter production over control and other treatments.

Table 4. Wheat grains, dry matter yield, straw yield and 1000 grains weight of wheat as influence by different methods of EM application with composts.

Treatments	Wheat grains yield (kg ha⁻¹)	Total dry matter yield (kg ha⁻¹)	Straw yield (kg ha⁻¹)	1000 grains weight (g)
Control	2411 g*	5705 g*	3295 f*	37.93 e*
N and k (basel dose)	3933 f	9959 f	6026 de	41.43 d
Single Super Phosphate	5254 ab	12883 a	7629 a	50.27 ab
Organic waste compost (C-I)	4326 e	10038 f	5712 e	41.33 d
C-I+EM soil application (EM-I)	5107 b	12316 b	7209 ab	48.47 bc
C-I+EM foliar application (EM-II)	4300 e	10512 e	6212 cde	41.97 d
C-I+Half EM-I+ Half EM-II	4552 de	10620 e	6068 cde	43.30 d
Farm yard manure compost (C-II)	4745 cd	11254 d	6509 cd	42.87 d
C-II+EM-I	5590 a	13092 a	7501a	51.17 a
C-II+EM-II	4972 bc	11320 cd	6348 cd	43.20 d
C-II+half EM-I + half EM-II	5107 b	11746 c	6638 bc	46.73 c
LSD P ≤ 0.05	353.73	425.93	605,74	2.52

*Mean with different letter(s) in columns are significantly different at P ≤ 0.05.

These results are in line with several researchers (Ortiz-Monasterio *et al.*, 1997; Shah and Ahmad, 2006; Shah *et al.*, 2010; Muhammad *et al.*, 2012) who found that total dry matter production, and yield components were highly significant by applying of FYM, poultry manure with beneficial or effective microbes.

Table 5. The influenced by different methods of EM appliction with composts on post-harvest soil pH, EC, and organic matter content.

Treatments	pH	Ece(dSm⁻¹)	SOM (%)
Control	7.69	0.23	0.78 e*
N and k (basel dose)	7.61	0.23	0.88 d
Single Super Phosphate	7.61	0.25	0.91 d
Organic waste compost (C-I)	7.57	0.24	1.36 c
C-I+EM soil application (EM-I)	7.34	0.30	1.58 a
C-I+EM foliar application (EM-II)	7.51	0.26	1.41 bc
C-I+Half EM-I+ Half EM-II	7.46	0.27	1.51 ab
Farm yard manure compost (C-II)	7.58	0.26	1.36 c
C-II+EM-I	7.40	0.27	1.55 a
C-II+EM-II	7.56	0.25	1.39 c
C-II+half EM-I + half EM-II	7.50	0.26	1.49 a
LSD P ≤ 0.05	NS	NS	0.077

*Mean with different letter(s) in columns are significantly different at P ≤ 0.05.

Thousand grains weight

Wheat thousand grains weight as affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 4. Thousand grains weight was significantly affected ($p < 0.0001$) by treatment combinations. Highest thousand grains weight of 51.17 g was noted with soil application of EM (EM-I) with FYM compost which was 34% increased over the control and was staticsally at par with SSP treatment, followed by soil application of

EM (EM-I) with organic wastes compost, The lowest thousand grains weight of 37.93 g was observed in control treatment. It may be due to effective microbes increased mineralization process in FYM compost (C-II) as compared to OW compost (C-I) and more nutrients availability to crops requirement for higher net dry matter production hence increases thousand grains weight and total dry matter production over control and other treatments. These results are in agreement with Awaad *et al.* (2009) findings.

Table 6. Effect of methods of EM application with composts on post harvest soil total N and AB-DTPA extractable P contents.

Treatments	Total soil N(mg kg^{-1})	AB-DTPA Extractable P(mg kg^{-1})
Control	1577d*	2.05 e*
N and k (basel dose)	2969abc	3.250 d
Single Super Phosphate	2733bc	5.039 ab
Organic waste compost (C-I)	2290cd	3.406 d
C-I+EM soil application (EM-I)	3100abc	4.567 bc
C-I+EM foliar application (EM-II)	2498bc	3.365 d
C-I+Half EM-I+ Half EM-II	2853abc	4.10 bcd
Farm yard manure compost (C-II)	2367cd	3.608 cd
C-II+EM-I	3680 a	5.925 a
C-II+EM-II	2757bc	3.850 cd
C-II+half EM-I + half EM-II	3300ab	3.193 cd
LSD $P \leq 0.05$	0.851	1.4033

*Mean with different letter(s) in columns are significantly different at $P \leq 0.05$.

Soil pH Values

pH values recorded after crop harvest were non significantly ($p = 0.0944$) affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 5. pH value rang from 7.34 to 7.69. Its might be due to H^+ ion concentration was equal in all treatments except control due to the inorganic fertilizer also releases H^+ion whereas pH decreases with increasing of organic matter to the soil with different ratios, results are in contrast with Muhammad *et al.* (2012) who stated that pH decreases significantly with organic fertilizer with effective or beneficial microbes. pH of soil were influenced by integration of organic and inorganic fertilizers (Rautaray *et al.* 2003 and Zelalem, 2013).

Soil Electric Conductivity

EC recorded after crop harvest were non significantly ($p = 0.0672$) affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 5. Its might be due to the EC of soil depends upon total soluble salts in treatments total soluble concentration are statically similar with each other and have EC varies little. The results are in contrast with Sarwar *et al.*, (2008); Selvakumari *et al.* (2000) and Rautaray *et al.* (2003) and Zelalem, (2013) whose reported that EC was significantly affected by organic and inorganic fertilizer with supplementation of beneficial microbes.

Soil Organic Matter Content

Soil organic matter content recorded after crop harvest was significantly ($p < 0.0001$) affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 5. Soil organic matter relatively of 1.58, 1.55 and 1.49 % were observed with EM soil application (EM-I) with organic wastes compost, soil application of EM (EM-I) with FYM compost and combined soil and foliar application of EM with FYM compost which are statistically similar with each other.

Table 7. Plant Nitrogen and Phosphorus concentrations of wheat plant as infuenced by the methods of EM application with composts.

Treatments	Total plant N (%)	Plant P (%)
Control	0.88 g*	0.08 g*
N and k (basel dose)	1.03 fg	0.09fg
Single Super Phosphate	1.54 b	0.22 b
Organic waste compost (C-I)	1.16ef	0.11ef
C-I+EM soil application (EM-I)	1.52 b	0.20bc
C-I+EM foliar application (EM-II)	1.26 de	0.13 e
C-I+Half EM-I+ Half EM-II	1.30 de	0.17 cd
Farm yard manure compost (C-II)	1.24 de	0.12 e
C-II+EM-I	1.79 a	0.29 a
C-II+EM-II	1.35 cd	0.17 cd
C-II+half EM-I + half EM-II	1.49bc	0.19 cd
LSD P ≤ 0.05	0.1677	0.0298

*Mean with different letter(s) in columns are significantly different at P ≤ 0.05.

The lowest organic matter of 0.78 % was observed in control plot.Its might be due to incorporation of organic manurewhich enhanced soil organic matter.The same results were obtained by Drinkwater *et al.* (1995) found that developed organic matter improved with FYM application. Similarly Korsaeth *et al.* (2002) reported that organic fertilizer linearly escalation soil organic matter. Combination of organic fertilizer suggestively enhanced organic matter (Rautaray *et al.* 2003 and Zelalem, 2013).

Organic basesenhanced soil nutrient,soil organic matter and soil organic carbon (Anatoliy and Thelen, 2007). These support our results.

Table 8. Plant N and P uptake of wheat plant as infuenced by methods of EM application with composts.

Treatments	N uptake(kgha⁻¹)	P uptake(kgha⁻¹)
Control	50 h*	4.4 g*
N and k (basel dose)	103g	8.9 f
Single Super Phosphate	199 b	28.6 b
Organic waste compost (C-I)	116 fg	11.2ef
C-I+EM soil application (EM-I)	187 bc	24.9 c
C-I+EM foliar application (EM-II)	132ef	13.3 e
C-I+Half EM-I+ Half EM-II	138de	18.5 d
Farm yard manure compost (C-II)	139de	13.7 e
C-II+EM-I	234 a	38.4 a
C-II+EM-II	153d	19.1 d
C-II+half EM-I + half EM-II	175c	22.0 cd
LSD P ≤ 0.05	27.64	3.55

*Mean with different letter(s) in columns are significantly different at P ≤ 0.05.

Post Harvest Soil Total N Content

Post harvest soil total N content was significantly ($p < 0.0001$) affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 6. Highest total soil N content of 3680 mg kg^{-1} was noted with soil application of EM (EM-I) with FYM compost followed by SSP treatment. The lowest total soil N content of 1577 mg kg^{-1} was noted in control treatment. The same results were reported by Anatoliy and Thelen (2007) who concluded that it may be due to slow decomposition of organic fertilizers by effective microbes so that slow releases of nutrients leads more soil N. The same results were reported by Kumar and Goh (2002) who concluded that Soil nitrogen increased (22.4 %) due to FYM with effective microbes.

Post-Harvest Soil P Content

Post-harvest soil AB-DTPA extractable P content as affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table 6. Soil P content was significantly ($p < 0.0001$) affected by treatments combination. High soil P content of 5.5252 mg kg^{-1} was recorded with application of C-II+EM-I, followed by SSP treatment.

The lowest soil P content of 2.05 mg kg^{-1} was recorded in control treatment. The same result was obtained by Anatoliy and Thelen (2007) who found that it may be due to slow decomposition of organic fertilizers by effective microbes so that slow releases of nutrients leads more soil P. Similarly Kumar and Goh (2002) found that soil phosphorus increases with application of organic fertilizer with effective microbes.

Table 9. Economics analysis of fertilizers used in the experiment.

Treatments	Yield (Kg ha^{-1})	YieldIncrease (Kg ha^{-1})	Increasedyield value (Rs. ha^{-1})	Cost ofFertilizers (Rs. ha^{-1})	NetReturn* (Rs. ha^{-1})	VCR**
Control	2411					
N and k (basel dose)	3933	1522	50226	19250	30976	2.6:1
Single Super Phosphate	5254	2843	93819	27750	66069	3.3:1
Organic waste compost (C-I)	4326	1915	63195	16525	46670	3.8:1
C-I+EM soil application (EM-I)	5107	2696	88968	16706	72262	5.3:1
C-I+EM foliar application (EM-II)	4300	1889	62337	16706	45631	3.7:1
C-I+Half EM-I+ Half EM-II	4552	2141	70653	16706	53947	4.2:1
Farm yard manure compost (C-II)	4745	2334	77022	15650	61372	4.9:1
C-II+EM-I	5590	3179	104907	15851	89056	6.6:1
C-II+EM-II	4972	2561	84513	15851	68662	5.3:1
C-II+half EM-I + half EM-II	5107	2696	88968	15851	73117	5.6:1

Price of wheat = Rs. 33kg^{-1}, FYM = Rs. 2 kg^{-1} O.W= Rs. 1.50 kg^{-1} and SSP =Rs. 17kg^{-1}, SOP= Rs. 80kg^{-1}, and Urea= Rs. 35 kg^{-1}, EM Rs. 180L^{-1}

*Net Return= increased yield Value – fertilizer Cost

**VCR = increased yieldValue / fertilizer Cost.

Plant N Concentration

Wheat plant N concentration as affected by different methods of EM applied with composts of FYM and OW prepared with RP is presented in Table. 7. Plant N concentration was significantly ($p < 0.0001$) affected by treatments combination. Highest plant N concentration of 1.79% was observed with soil application of EM (EM-I) with FYM compost followed by SSP treatment. The lowest plant N concentration of 0.88% was observed in control treatment. This result is in agreement with Agbede *et al.* (2010) who reported that might be due to effective microbes increases decomposition and mineralization process in organic fertilizer which lead to more nutrients availability to crops. Selvakumari *et al.* (2000), Sarwar *et al.* 2003 and Dixit and Gupta (2000) reported that N, P and K concentration by plant were ominously inclined by organic manures. Singh *et al.* (2002), Yaduvanshi (2001), and Tabassam *et al.* (2002) founded that accumulation of natural manuresand compost to soil was enhanced concentrations of N, P and K in plant.

Plant P Concentration

Wheat plant P concentration as affected by different methods of EM applied with composts of FYM and

OW prepared with RP is present in Table 7. Plant P concentration was significantly ($p < 0.0001$) affected by treatments combination. Highest plant P concentration of 0.29% was noted with soil application of EM (EM-I) with FYM compost followed by SSP treatmen. The lowest plant P concentration of 0.08% was observed in control treatment. This result is in agreement with Agbede *et al.* (2010) who reported that might be due to effective microbes increases decomposition and mineralization process in organic fertilizer which lead to more nutrients availability to crops. Dixit and Gupta (2000), Selvakumari *et al.* (2000), and Sarwar *et al.* 2003 reported that N, P and K concentration by plant were ominously inclined by organic manures. Yaduvanshi (2001), Singh *et al.* (2002) and Tabassam *et al.* (2002) founded that accumulation of natural manuresand compost to soil was enhanced concentrations of N, P and K in plant.

Plant N uptake

Wheat plant N uptake as affected by different methods of EM applied with composts of FYM and OW prepared with RP is present in Table. 8. Plant N concentration was significantly ($p < 0.0001$) affected by treatments combination. Highest plant N uptake of 234 was noted with soil application of EM (EM-I) with FYM, which was 368% increased over the control, followed by soil application of SSP and EM (EM-I) with organic wastes compost treatments. The lowest plant nitrogen uptake of 50 kg ha^{-1} was found in control treatment.

This result is in agreement with Agbede *et al.* (2010) who reported that its might be due to effective microbes increases decomposition and mineralization process in organic fertilizer which lead to more nutrients availability to crops. Dixit and Gupta (2000), Selvakumari *et al.* (2000), and Sarwar *et al.* (2003) reported that N, P and K concentration by plant were ominously inclined by organic manures. Yaduvanshi (2001), Singh *et al.* (2002) and Tabassam *et al.* (2002) founded that accumulation of natural manuresand compost to soil was enhanced concentrations of N, P and K in plant.

Plant P uptake

Table 8 showed mean data of wheat plant P uptake as affected by different methods of EM applied with composts of FYM and OW prepared with RP. Plant P concentration was significantly ($p < 0.0001$) affected by treatments combination. Highest plant P uptake of 38.4 kg ha^{-1} was noted with soil application of EM (EM-I) with FYM compost, which was 600% increased over the control, followed by soil application of EM (EM-I) with organic wastes compost and SSP treatments which was statistically similar with each other. The lowest plant P uptake of 4.4 kg ha^{-1} was observed in control treatment. This result is similar to Agbede *et al.* (2010) who stated that its might be due to effective microbes increases decomposition and mineralization process in organic fertilizer which lead to more nutrients availability to crops. Selvakumari *et al.* (2000), Dixit and Gupta (2000) and Sarwar *et al.* (2003) reported that N, P and K concentration by plant were ominously inclined by organic manures. Yaduvanshi (2001), Singh *et al.* (2002) and Tabassam *et al.* (2002) founded that accumulation of natural manures and compost to soil enhanced the Nitrogen, Phosphorus and potassium concentrations in plant.

Economics Analysis of fertilizer application

The economics analysis of fertilizers used in the experiment is presented in Table 9.The treatment of FYM compost with soil applied EM gave maximum net return of 89056 rupees per hectare and VCR of 6.6, followed by FYM compost with half dose of soil and foliar application with a net return of 73117 rupees per hectare and VCR of 5.6, signifying profitable yield of wheat.

Conclusion

It can be concluded that FYM compost with soil application of EM significantly increased wheat total dry matter yield, straw yield, thousand grain weight. Post-harvest soil organic matter, Nitrogen and phosphorus contents were also significantly improved with both composts applied in combination with EM. Phosphorus and Nitrogen uptakes were also improved significantly by FYM compost with soil application of EM. FYM compost with soil application of EM proved the most economical treatment with net return of Rs. 89056 $ha^{-1}$and VCR value of 6.6:1 under given conditions. Based on these conclusions it is suggested that composting of organic materials and their application with EM has potential to enhance P solubility from RP and crop yield. Further studies are suggested to investigate the effect of composts and EM with different combination of chemical fertilizers under different agro-ecological conditions.

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