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GROWTH AND PHOSPHORUS UPTAKE OF SORGHUM PLANTS IN SALT AFFECTED SOIL AS AFFECTED BY ORGANIC MATERIALS COMPOSTED WITH ROCK PHOSPHATE

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Abstract

A field experiment was conducted to determine the influence of different organic materials, Farm yard manure (FYM), Humic acid (HA) and Press mud (PM) and their composts prepared with rock phosphate on the growth and phosphorus (P) uptake of sorghum (*Sorghum bicolor* L.). The experiment was conducted in Randomized Complete Block design with three replication in salt affected soil at research farm of botanical garden Azakhel Nowshera during kharif 2012. Fertilizers were applied at the rate of 120- 90-60 kg ha^{-1} N, P and K, respectively. The source of N was urea and organic materials in composted and non composted form. Single super phosphate, rock phosphate, organic materials and their composts were used as P source, while sulphate of potash was used as source of K. The organic materials were applied before crop sowing at recommended level on the basis of their P content. The maximum and significantly ($p \leq 0.05$) increased sorghum total dry matter yield of 23733 kg ha^{-1}, emergence m^{-2} of 142 and plant height of 147 cm were observed in the treatment where composts of FYM, HA and PM were applied in combination. Increase in soil organic matter content was recorded by the application of composts of different organic materials, while decreasing trend was found in the values of soil electrical conductivity (ECe) and sodium adsorption ratio (SAR**).** Maximum plant N uptake of 159 kg ha^{-1}, P uptake of 62.5 kg ha^{-1} and K uptake of 557 kg ha^{-1} were noted in the treatment where a combination of composts of FYM, HA and PM were added. Results suggest that the use of composts of different organic materials and RP are environment friendly and have the potential to improve sorghum growth, plants nutrient uptake and ameliorate salt affected soils

Introduction

Phosphorus (P) is an element that is found naturally everywhere. Earth's crust, water, rocks, minerals and all living organisms contain phosphorus. The nutrient P together with N and K is widely distributed in environment, play a vital role in plant and animal life (Donahue *et al*., 1990). Plant growth and development is greatly affected by the presence of P as it plays a variety of functions in plant metabolism. In macromolecules such as nucleic acids, it has functions of structural nature. Sufficient supply of P greatly affects many physiological processes like metabolic respiration, photosynthesis, cell division, early flowering, seed maturity and plant roots system. Most of the enzymatic activities and metabolic pathways are controlled by P. It has been reported that the level of P supply during reproductive stages regulates the partitioning of photosynthates between the source leaves and the reproductive organs, this effect being essential for N-fixing legumes (Marschner, 1993). Healthy animals and human beings also require adequate amounts of P in their food for normal metabolic processes (Anon., 1984, 1995). This nutrient is absorbed by plants from the soil solution as monovalent (H_2PO_4) and divalent (HPO_4) orthophosphate anions, each representing 50 percent of total P at a nearly neutral pH (pH 6-7). At pH 4-6, H_2PO_4 is about 100% of total P in solution. At pH 8, H_2PO_4 represents 20% and HPO_4 80% of total P (Black, 1965). Type of soil, crops, water, Pfertilizer, management practices and climatic conditions of an area are important factors to be considered when attempting to formulate sound P-fertilizer source and application for adequate crops yield response (Amanullah *et al*., 2010).

Rock phosphate is a non-detrital sedimentary rock which contains high amounts of phosphate bearing minerals. Phosphorite or rock phosphate contain 15 to 20% P but is in unavailable form (Blatt *et al*., 1996). These rocks are extensively used in fertilizer industry for the production of phosphorus fertilizers. It is also used in industrial chemicals and animal feed supplement products (Khasawneh & Doll, 1978). Elemental P is produced by mining and smelting of rock Phosphate. Approximately 90% of rock phosphate reserves are used in fertilizer industries and animal feed supplements products (Anon., 1989). In Pakistan, the raw material for phosphate fertilizer industries are hazara phosphorite deposits which are located in the north-western part of the country. These deposits are estimated at 6.9 million tons of which 4.58 million tons are considered as recoverable (Matiullah & Sharif, 2012).

Composting organic materials with rock phosphate (RP) has been shown to enhance the solubility of P from RP (Mishra & Bangar, 1986; Singh & Amberger, 1991) and is practiced widely as a low-input technology to improve the fertilizer value of manures (Ibrahim *et al*., 2008). Composts application improves soil physico-chemical characteristics, soil salinity and increases beneficial microbes (Munir *et al*., 2012). Efficient crop production can be achieved by composts as it improves water infiltration rate, water holding capacity, soil aeration, conserve soil moisture, porosity and decrease soil bulk density and stimulate micro-organisms in the soil that make plant nutrients readily available (Choudhary & Bailey, 1994; Lal, 1997; Sharif *et al*., 2013).

Salinity is a worldwide problem, with more than 3% of the world total land mass affected by salinity and over half the world's countries having at least some quantity of land affected. The impact on rural livelihoods is significant. Globally, there are over 4,000,000 square kilometers area affected by salinity (Anon., 1995). Soil salinity is a severe environmental hazard, causes land degradation and reduction of crops yield and plants nutrients accumulation in both dry and irrigated areas (Metternicht & Zinck, 2003). In Pakistan, 6.30 million hectare area is salt affected of which 1.89 hectare is saline, 1.85 million hectare is permeable saline-sodic, 1.02 million hectare is impermeable saline-sodic and 0.028 million hectare is sodic in nature. It is estimated that out of 1.89 million hectares saline patches, 0.45 million hectares present in Punjab, 0.94 million hectares in Sindh and 0.5 million hectares in Khber Pakhtunkhwa PK. About 1.4 million hectares of all agricultural land has now been abandoned. Approximately 3.1 million ha of salt affected land lie in canal irrigated areas of wheat belt (Choudhary & Bailey, 1994).

Sorghum (*Sorghum vulgare* L.) belongs to a worldwide family Graminae (poaceae). On the world production basis, sorghum ranked fourth among the major cereals after wheat, rice and maize. Sorghum is extremely well adapted to growing in the semi arid regions and is one of the principal crops of these areas provided they have long and warm summer. Sorghum was cultivated on a total of 262.7 thousand ha and its total production was 164.5 thousand tones for the year 2008-09. Its average per hectare yield for the same year was 626 kg ha^{-1} (Agric. Stat. Pak. 2008-09). In the province of Khyber Pakhtunkhwa sorghum crop was grown on a total area of 6.4 thousands ha with a total production of 3.7 thousands tones during 2008-09. The yield of sorghum in this province was lower than the average for the rest of Pakistan at 578kg ha^{-1}. Keeping in view the importance of P in crops production and improving its solubility from RP through composting with different organic materials, this study was planned to determine and compare the effect of composts prepared from different organic materials with RP on reclamation of salt affected soil and on yield and nutrients uptake of sorghum crop.

Materials and Methods

A field experiment was conducted to investigate the effects of different organic materials such as Farm yard manure (FYM), Humic acid (HA) and Press mud (PM) composted with rock phosphate (RP) on sorghum growth and phosphorus uptake at the research site of Botanical Garden Azakhel Nowshera in Kharif season 2012. The experiment was laid out in Randomized Complete Block design with 3 replications. The chemical fertilizers were applied at the rate of 120, 90 and 60 kg ha^{-1} N, P and K, respectively. The nitrogen sources used in the experiment were composts of organic materials and urea. The fertilizers SSP, RP, organic materials and their composts were used for P sources and SOP for K. The concentrations of N, P and K in organic materials and in their composts were determined and applied to soil at the time of sowing. There were 11 treatments, each having 3 × 5 m^2 sizes. Nitrogen in the form of urea was applied in 3 splits, while all SSP and SOP were applied at once before sowing of crop. Organic materials in composted and non composted form were applied alone and in different combinations to determine their influence on sorghum growth and nutrient uptake in salt affected soils.

Composite soil sample was collected at 0-20cm depth from the experimental site before crop sowing and fertilizers application. Soil samples at the depth of 0-20 cm were also collected from each treatment after crop harvest. Soil samples were air dried, ground, sieved through 2mm sieve and analysed for various properties. Soil Texture was determined by (Koehler *et al*., 1984).), Soil pH (McClean, 1982), SOM (Nelson & Sommers,1982), Lime by (Richard, 1954). AB-DTPA extractable P and K by (Soltanpour & Schwab, 1977), Total N by Kjeldhal method (Bremner, 1996). Sodium was determined by Flame photometer in the water extract of soil and $Ca^{2+} + Mg^{2+}$ concentrations was determined by titration method as given by Richard (1954). Following formula was used to calculate SAR in soil extract.

$$SAR = Na^{+} / [(Ca^{2+} + Mg^{2+})/2]^{0.5}$$

Representative plant samples from each treatment were analyzed by wet digest method for nutrients concentration and their uptake by sorghum plants by the method as described by Jarrell and Beverly (1981). Data regarding different parameters were collected properly and analyzed statistically according to the procedure as given by Steel and Torrie (1980) using MStatC package and Least Significant Difference (LSD) test was used for any significant difference among the treatments.

Results

Field experiment was conducted to investigate the effects of composts of different organic materials on sorghum growth and phosphorus uptake. The soil under investigation was silty loam in texture, alkaline in reaction, highly salt affected calcareous in nature, low in organic matter, poor in AB-DTPA extractable P and total N contents.

Concentration of N and P of organic materials: Data in Table 1 revealed nutrients concentrations in organic materials under investigations. Total N concentration in FYM was found as 1.07%, HA 0.47% and PM as 0.66%. The P_2O_5 concentration were as 0.64%, 0.45% and 0.009% in FYM, HA and PM, respectively. The pH values of the FYM, HA and PM were noted as 8.29, 9.24 and 8.30, respectively. Total N concentration in FYM composted with RP was observed as 1.41%, in HA compost as 0.69% and in PM compost as 0.86%. The P_2O_5 concentrations were as 2.32%, 0.7% and 0.01% in FYM, HA and of PM composts, respectively. The pH values of the FYM, HA and PM composts were recorded as 8.25, 9.11 and 8.25 respectively.

Table 1. Concentration of N and P of organic materials and their pH values.

Treatments	Total N (%)	AB-DTPA extractable P (%)	pH values
Farm Yard Manure (FYM)	1.07	0.64	8.29
FYM compost	1.41	2.32	8.25
Humic acid (HA)	0.47	0.45	9.24
HA compost	0.69	0.7	9.11
Press mud (PM)	0.66	0.009	8.30
PM compost	0.86	0.01	8.25

Table 2. Effect of organic materials on total dry matter yield, emergence m^{-2} and plant height of sorghum in salt affected soils.

Treatments	Total dry matter yield (Kg ha^{-1})	Emergence (m^{-2})	Plant height (cm)
Control (no fertilizer)	14500 f*	83.6 g*	105 g*
N and K Fertilizer as basal dose	16600 cdef	93.0 ef	122 de
Single super Phosphate (SSP)	22467 ab	138.3 ab	144 ab
Farm yard manure (FYM)	18967 bcde	95.3 ef	124 d
Humic acid (HA)	15633 ef	89.3 g	110 fg
Press mud (PM)	15933 def	100.6 e	115 ef
Compost of FYM	21467 ab	131.3 bc	124 d
Compost of HA	20033 bc	123.3 cd	130 c
Compost of PM	16333 def	118.3 d	126 d
FYM + HA + PM	19500 bcd	132.3 b	137 bc
Composts of FYM, HA and PM	23733 a	142.6 a	147 a
LSD (0.05)	3567.7	8.3016	7.5286

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

Total dry matter yield: Data presented in Table 2 indicated that total dry matter yield of sorghum significantly ($p \leq 0.05$) affected by the application of different organic materials composted with RP. The highest dry matter yield of 23733 Kg ha^{-1} was produced in treatment where Compost of FYM, Humic acid and Press mud were applied in combination followed by the treatments where SSP and compost of FYM were applied. Lowest sorghum dry matter yield of 14500kg ha^{-1} was recorded in control, statistically at par with the treatments of Humic acid and press mud. There was a pronounced percent increase of the applied treatments over control however treatment received combination of composts of FYM, HA and PM showed the highest percent increase of 63 over control (Fig. 1). The same results were presented by Datta *et al*., (1983) who found that the application of press mud increased maize and wheat yield by 29 and 65% over control in its direct and residual values respectively, and the net return was significantly high. The results compiled by Ahmad *et al*., (2009) show a significant ($p \leq 0.05$) increase in total dry matter yield of crop by the application of organic and inorganic fertilizers. Dost and Khattak (2009) presented same findings and observed that applying press mud on saline sodic soil increased maize yield. He also showed the ameliorative effects of press mud on salt affected soils were also showed by these workers.

Plants emergence: Data indicated that the highest emergence of 142 plants m^{-2} was noted in treatment where composts of FYM, HA and PM were applied in combination. Lowest emergence of 83 plants m^{-2} was recorded in control, which was statistically similar to humic acid having emergence of 89 plants m^{-2}. Treatment received SSP as a source of fertilizer showed the highest % increase of 65, while the lowest was recorded in HA having increase of only 7% (Fig. 2). These results were supported by the research done by Ahmad *et al*., (2009) who reported that various organic and inorganic N treatments had significant effects on emergence (Table 2).

Plants height: Data in Table 2 showed that there was a significant ($p<0.05$) differences in plant height with respect to different treatments. The data showed that the highest plant height of 147 cm was obtained in treatment where a combination of composts of FYM, HA and PM were applied. Lowest plant height of 105 cm was observed in control which was statistically at par with humic acid having plant height of 110 cm. The highest increase of 37% in plants height was noted in the treatment received SSP as a source of fertilizer, while the lowest increase of 5% was recorded in HA treatment (Fig. 3). These results are in consistence with Ahmad *et al*., (2009) who observed that application of FYM has resulted in taller plants than sole N. Results regarding the plant height as influenced by the application of enriched and non enriched compost alone and in combination with N as urea were studied by Akhtar *et al*., (2007) who revealed that composts enriched with chemical fertilizers significantly influenced plant height.

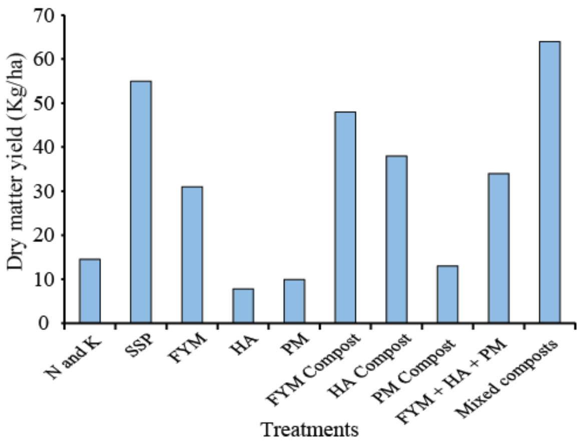

Fig. 1. Effect of composts on percent increase of total dry matter yield of sorghum.

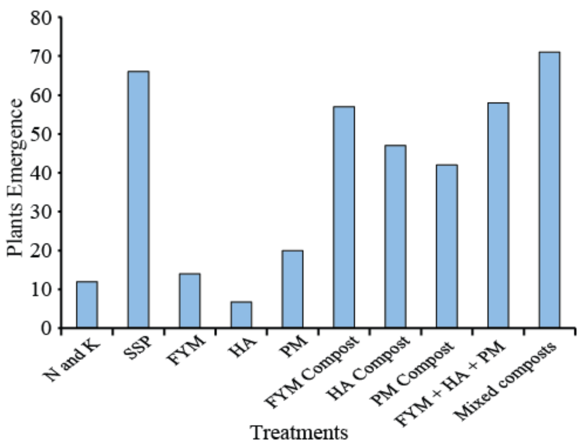

Fig. 2. Effect of composts on percent increase in emergence of sorghum plants.

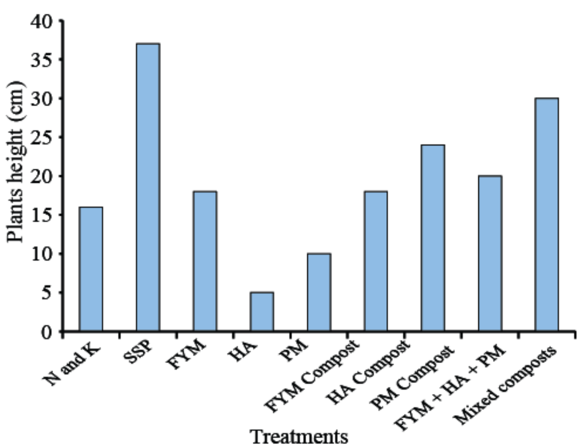

Fig. 3. Effect of composts on percent increase in plant height of sorghum.

Post harvest soil O.M, pH, EC and SAR values: It is evident from the data that maximum soil organic matter (SOM) content of 1.69% was found in the treatment which received composts of FYM, HA and PM in combination followed by 1.52% in treatment received compost of FYM. The minimum SOM content of 0.6% was noted in control closely similar to the treatments of HA (Table 3). A striking percent increase in SOM content was noted in all treatments over control. The highest % increase in SOM content was observed in treatment where a combination of composts of FYM, HA and PM were applied. Sharif *et al*., (2004) concluded that the application of organic fertilizers (Humic acid and FYM) along with inorganic fertilizers increases soil organic matter content. Tomayo *et al*., (1997) supported these results by their findings in a research trial and concluded that with the application of organic materials composted with RP, a significant improvement was observed in soil organic matter content (Table 3).

Post harvest soil electrical conductivity determined in saturation extract (EC_e) influenced significantly ($P \leq 0.05$) by different organic materials and their composts. It is clear from the data in Table 3 that the lower $EC_{(e)}$ of 3.93 dS m^{-1}) was noted in treatment where a combination of composts of FYM, humic acid and press mud was applied, statistically similar to the treatment of combined application of FYM, humic acid and press mud. Decreasing trend was observed in EC_e by the application of organic materials and composts. All treatments showed decreases over control especially composts of FYM, HA and PM. Decrease of 39.5% was observed in treatment received combination of FYM, HA and PM. Data on soil pH values revealed that there was no pronounced effect on soil pH by different organic materials and their composts as pH can only be modified on micro-site level. Sodium adsorption ratio was significantly influenced by different organic materials and their composts. Mean values of the data revealed that higher SAR value of 19.7 was noted in control statistically similar to the basal dose where only nitrogen and potassium fertilizers were applied. The lowest SAR value of 12.4 was observed in treatment where a combination of the composts of FYM, HA and PM were applied, which is statistically similar to the treatment where FYM, HA and PM in non composted form were applied in combination (Table 3). The SAR values decreased by the application of organic materials and their composts. A decrease of 36.99% was observed in the treatment received combination of composts of FYM, HA and PM. These results are in agreement with Dost and Khattak (2009) who observed that the application of PM on saline sodic-soils significantly affect EC_e and SAR. The mean post harvest soil values of ECe and SAR consistently decreased with increasing level of PM.

Plants nitrogen, phosphorus and potassium uptake: Application of organic materials and their composts improved N uptake by sorghum plants significantly ($p<0.05$). Maximum plants N uptake of 158.9 kg ha^{-1} was recorded in treatment where composts of FYM, HA and PM were applied in combination closely followed by the treatment where SSP was added as a fertilizer source. The lowest N uptake of 62.19 kg ha^{-1} was observed in check plot (Table 4). The highest increase of 155.6% N was observed in treatment received the combination of FYM, HA and PM (Fig. 4). Awaad *et al*,. (2009) reported that plants N uptake increased by the combined use of P source such as RP mixed with organic fertilizers.

Table 3. Effect of organic materials composted with RP on post harvest soil organic matter content and pH, EC and SAR values in salt affected soils.

Treatments	SOM (%)	pH	$EC_{(e)}$ dS m^{-1}	SAR
Control (no fertilizer)	0.6 g*	8.8	6.49 a*	19.7 a*
N and K Fertilizer as basal dose	0.86 ef	9.0	6.27 a	19.2 ab
Single super Phosphate (SSP)	0.98 e	8.7	6.13 ab	19.1 ab
Farm yard manure (FYM)	1.47 bc	8.9	4.20 ef	13.8 e
Humic acid (HA)	0.78 f	8.7	5.16 bcde	15.9 d
Press mud (PM)	1.37 c	8.9	5.86 abc	18.4 bc
Compost of FYM	1.52 b	8.9	4.91 cdef	16.1 d
Compost of HA	1.22 d	8.7	4.61 def	15.6 d
Compost of PM	1.19 d	8.7	5.53 abcd	17.7 c
FYM + HA + PM	1.13 d	8.8	4.04 f	13.2 ef
Composts of FYM, HA and PM	1.69 a	8.9	3.93 f	12.4 f
LSD (0.05)	0.1410	N. S	1.0385	1.0887

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

Table 4. Plants N, P and K uptake as effected by different organic materials in salt affected soils.

Treatments	N	P	K
	Uptake (kg ha^{-1})		
Control (no fertilizer)	62.19 e*	5.70 g*	125.6 g*
N and K Fertilizer as basal dose	77.79 de	16.0 fg	195.9 fg
Single super Phosphate (SSP)	149.6 a	53.1 ab	488.1 ab
Farm yard manure (FYM)	85.65 cd	10.6 fg	188.9 fg
Humic acid (HA)	71.60 de	9.80 g	167.3 fg
Press mud (PM)	75.86 de	18.2 efg	209.9 fg
Compost of FYM	126.1 b	43.5 bc	424.1 bc
Compost of HA	110.4 b	36.1 cd	359.2 cd
Compost of PM	83.50 de	26.1 def	235.0 ef
FYM + HA + PM	107.1 bc	33.0 cde	309.5 de
Composts of FYM, HA and PM	158.9 a	62.47 a	557.2 a
LSD (0.05)	22.523	15.874	89.871

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

Data regarding plant P uptake by sorghum significantly ($p \leq 0.05$) increased over control. Maximum plant P uptake of 62.47 kg ha^{-1} was noted in treatment where the combinations of composts of FYM, HA and PM were used. Minimum plant P uptake of 5.701 Kg ha^{-1} was recorded in control which was similar to the treatment received FYM (Table 4). The highest increase of 996% was observed in treatment where composts of FYM, HA and PM were applied in combination (Fig. 5). These results are similar to Erdal *et al*., (2000) who reported that nutrients accumulations in plant were enhanced by the use of organic materials mixing with chemical fertilizers. Taalab *et al*., (2008) found that N and P uptake by plants were enhanced by application of RP mixed with organic fertilizers. Plants K uptake by sorghum significantly ($p \leq 0.05$) increased over control. Highest plant K uptake of 557.2 kg ha^{-1} was noted in treatment where combinations of the composts of FYM, HA and PM were used (Table 4). Treatment received combination of composts of FYM, HA and PM showed the highest increase in K uptake by sorghum plant of 343.4% (Fig. 6). These results are in consistence with Aziz *et al*., (2010) who noted that phosphorus and potassium bioavailability were increased by organic manure application. Maximum increase in shoot K concentration was observed when press mud was added at the rate of 10 tons ha^{-1} followed by poultry manure and farm yard manure. Awaad *et al*., (2009) reported that the application of Farmyard Manure Combined with Some Phosphate Sources on the N, P and K concentration and their uptake by canola plant were increased significantly.

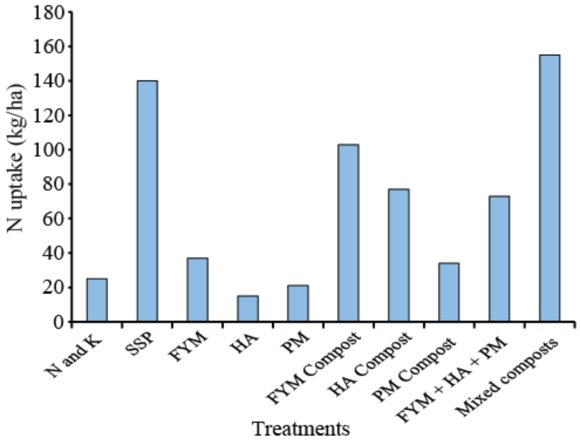

Fig. 4. Effect of composts on percent increase in plant N uptake.

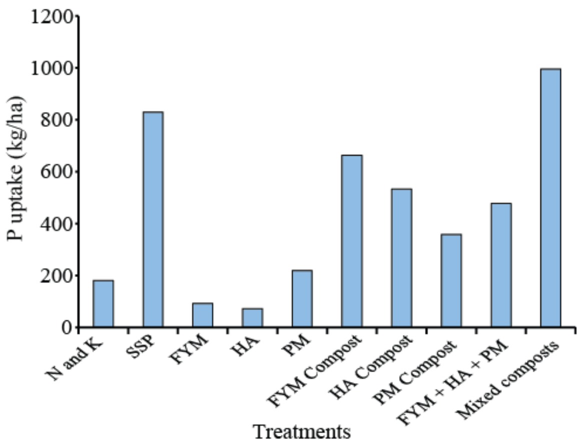

Fig. 5. Effect of composts on percent increase in plant P uptake.

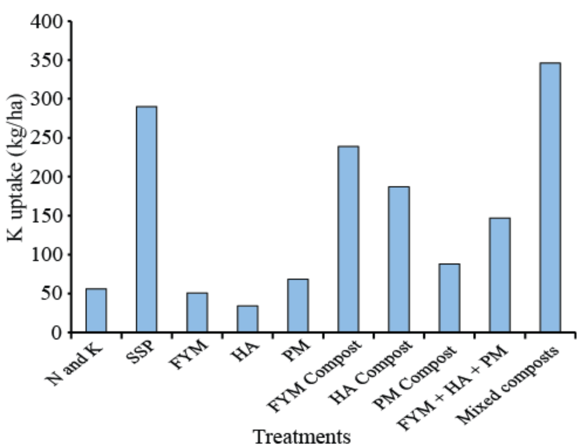

Fig. 6. Effect of composts on percent increase in plant K uptake.

Discussion

Phosphorus plays role in the metabolic pathways of biosynthesis and degradation as an energy transfer. A major portion of several cell components such as nucleic acids, phospholipids and ATPs constitutes phosphorus. Sufficient supply of P greatly affects many physiological processes like metabolic respiration, photosynthesis, cell division, early flowering, seed maturity and plant roots system. Most of the enzymatic activities and metabolic pathways are controlled by P. During vegetative growth stages, absorption of P occurs mainly and thereafter most of the absorbed P is re-translocated into fruits and seeds during reproductive stages. It has been observed that the level of P supply during reproductive stages regulates the partitioning of photosynhates between the source leaves and the reproductive organs, an essential phenomena for N-fixing legumes (Marschner, 1993). For normal metabolic processes healthy animals and human beings also require substantial amounts of P in their food (Anon., 1984, 1995). Pakistan has RP deposits in Hazara division of KPK. The reserves are wide spread in the Kakul, Galdaman, Tarnawai and Lagerban villages of District Abbottabad. The so far reported exploration indicates that total reserves are about 35.7 million tones. Out of which 14.7 million tones are of proven quality which contains 26-31% P_2O_5. The remaining reserves of 21 million tones are of inferred quality. The total proven quality reserves are 14.7 million tones while the inferred are 21 million tonnes. The proven reserves at Tarnawai have a potential sustained annual production of 60,000 tons for 30 years.

Composting is a natural biological process by which microorganisms like bacteria, fungi and other organisms convert organic materials, such as leaves, manure, sludge, paper, grass clippings and food wastes into a soil like material called compost or humus. During composting microbes utilize carbon of organic material as a source of energy and for synthesis of new microbial cells. Carbon serves as both building block and an energy source for microbes. Aerobic composting is the process where decomposition takes place in the presence of oxygen. As the quickest way to produce high quality compost, aerobic composting is a widely accepted way of stabilizing organic wastes and converting them to a usable, and value added compost product (Liang *et al*., 2003; Ikram *et al*., 2012). Using wastes in agriculture is an economical disposal of these materials, and it is interesting from an ecological point of view as it reduces negative effects on the environment. Composts improve soil physical properties as the saturated and unsaturated hydraulic conductivity, water retention capacity, bulk density, total porosity, pore size distribution, soil resistance to penetration, aggregation and aggregate stability and enlarge the air spaces in soils, which help in the reclamation of salts affected soil (Aggelides & Londra 2000). Many researchers have proved that many microorganisms in soil produce organic acids like carbonic acids, acetic acids, citric acids etc. These acids create favorable environment for the enhancement of P solubility from the applied RP. Kucey *et al*., (1989) have shown the microbial solubilization of soil phosphate in liquid medium studies have often been due to excretion of organic acids. Application of RP without organic fertilizers produced wheat yield with less net profit. Many researchers have reported that crop yield is increased by the addition of RP with HA and organic fertilizers (Malik & Azam, 1985). It is often reported that the application of FYM and other organic materials increases the efficiency of RP (Pillai *et al*., 1985; Fabunmi *et al*., 2012). The findings of many research experiments suggested that soil fertility and crop productivity may be enhanced significantly by the application of different organic materials for longer time. Hence, instead of using inorganic chemical fertilizer alone, the integrated use of these fertilizers might be more effective and sustainable for sustainable environment and agricultural production.

Conclusions

Sorghum total dry matter yield, emergence and plant height increased significantly by the application of composts of different organic materials in salt affected soils. Electrical conductivity of soil saturation extract and sodium adsorption ratio decreased by the combined application of FYM, HA and PM in salt affected soils. Post harvest soil N, P and K contents improved by the addition of different organic materials composted with rock phosphate. Plants N, P and K uptake by sorghum improved significantly by the combined application of composts of FYM, HA and PM in the area under study. The solubility of P may be enhanced from rock phosphate when composted with different organic materials and has the potential to improve crop growth and reclamation of salt affected soils. Further research is needed to investigate the effects of composts of different organic materials on the growth and nutrient uptake of different crops in different types of salt affected soils of Pakistan.

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