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Original Research Article

Influence of Organic and Inorganic Sources of Nutrients on Changes in Nutrient Availability under Different Cropping System in Vertisol

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A B S T R A C T

A field experiment was conducted at Dry land Research Station, VNMKV, Parbhani during 2003-04 and 2004-05 in Vertisol with application of organics and inorganics sources of nutrients under different cropping system viz., soybean- pigeon pea and sorghum- pigeon pea. The treatment consisted of 50% RDF +FYM@ 2.5 t ha^{-1} and other treatments organic sources such as Glyricidia, FYM, Vermicompost, plant and weed residues, press mud cake, Neem seed cake, Biofertiliser and recommended dose of fertilizer and last is control. The data were generated on nutrient availability soil after harvest of soybean, pigeon pea, sorghum, pigeon pea after each crop in cropping sequence. The nutrient availability such as there was reasonably good buildup of available N after harvest of each crop in sequences. The highest availability of nitrogen (225 kg ha^{-1}) was recorded with treatment T_3 i.e. FYM @ 5 t ha^{-1}. There was progressive buildup of available phosphorus during both the years of experiment. Higher amount of available phosphorus (20.18 kg ha^{-1}) was recorded in treatment T_3 i.e. FYM @ 5 t ha^{-1} followed by T_6, T_1 and T_7 treatments. There was no significant effect of cropping systems on availability of potassium though both the cropping systems as soybean + pigeonpea and sorghum + pigeon pea give the significant results. The treatment T_3 i.e. FYM @ 5t ha^{-1} recorded maximum available K at 260 kg ha^{-1} followed by treatment T_2 i.e. glyricidia @ 6t ha^{-1} (255 kg ha^{-1}). Thus, application of organic sources helps in improving availability of the nutrient of soil.

Keywords

Nutrient availability, Cropping systems

Introduction

It is well known that the cropping sequence plays a key role in the transformation, recycling and availability of plant nutrients in soil. These studies further indicated that use of organic sources of nutrients along with chemical fertilizers or separately will be able to maintain soil fertility and sustain crop productivity. Organic manures helps to maintain the soil organic carbon and nutrient status. Besides these organic manures also helps for better moisture retention and influences favorably other properties of soil. Variation in multiple cropping systems and continuous use of manure and fertilizers exert great deal of influence in modifying the nutrient availability of soils.

Resources and Research Methods

The experiments involving two cropping systems such as Soybean (cv. JS -335) pigeon pea (cv. BSMR-853) and Sorghum (cv.CSH-9) pigeon pea (cv. BSMR - 853) were conducted at Organic farming and Dry

Land Agricultural Research Farm at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The field experiment was conducted for successive two years viz., 2003-2004 and 2004-2005. The experiment was laid out on fixed site in randomized block design with the ten treatments and three replications. The treatments comprised of inorganic and organics sources such as FYM, glyricidia, vermicompost, plant and weed residues, biofertilizers, neem seed cake, press mud cake etc. which were replicated thrice in a randomized block design. Treatment details of experiment are given below in Table 1. Composite surface (0-30cm) soil samples collected at the initial, flowering and harvesting stages from each plot between rows of each crop. The soil nutrient availability were carried out as per the methods such as Available N by Alkaline $KMnO_4$ (Subbiah and Asija, 1956), Available P by 0.5 M $NaHCO_3$ pH 8.5 method (Olsen *et al.*, 1954), Available K of soil by Neutral normal ammonium acetate method (Jackson, 1973) and available N, P, K 174.52, 14.29, 203.83 gm kg^{-1}, respectively.

Research findings and Discussion

The influence of various nutrient sources and their combination on availability of nutrient in soil as available N, available P, available K of soil as influenced by nutrient management treatment for Soybean + Pigeon pea and Sorghum + Pigeon pea cropping systems in year 2003-04 and 2004-05

Influence of organic farming on changes in nutrient availability in soil

Available nitrogen

The data pertaining to available nitrogen influenced by different nutrient management treatments are presented in Table 2 and are depicted in Figure 1.

During the year 2003-04, the values of available nitrogen at harvest of soybean ranged from 178 (T_{10}) to 225 (T_3) kg ha^{-1} with a mean value of 192 kg ha^{-1} and 172 (T_{10}) to 200 (T_3) kg ha^{-1} with a mean value of 180 kg ha^{-1} after harvest of pigeon pea. During the year 2004-05, the values of available nitrogen content after harvest of sorghum ranged from 170 (T_{10}) to 210 ($T_{3)}$ kg ha^{-1} with a mean value of 183 kg ha^{-1} and 167 ($T_{10)}$ to 193 (T_3) kg ha^{-1} with a mean value of 178 kg ha^{-1} after harvest of pigeon pea.

The results on availability of nitrogen in soil after harvest of various cropping systems were found significant. Soybean + pigeon pea cropping system recorded maximum available nitrogen. This may be because of addition of N through nitrogen fixation by legume crops. George and Prasad (1989) also reported that inclusion of legumes in cropping sequences improved the status of organic carbon and available nitrogen.

The availability of N was enhanced in organic treatment. Highest availability of nitrogen was recorded with treatment T_3 i.e. FYM @ 5 t ha^{-1}. Subbaiah and Kumarswamy (2000) also observed the increase in available nitrogen status due to application of FYM or green manure which they attributed to higher retention of N as NH_3 ions in the soil. Indulkar and Malewar (1990) also found that application of 10 t FYM ha^{-1}resulted in significant increase in availability of nitrogen in rice-gram sequence on Vertisols. Similar results were reported by Prasad *et al.*, (1995) indicating that the use of green manure with chemical fertilizer helped to build up availability of nutrients (N, P, K) and was much more effective than that of chemical fertilizers

alone in augmenting crop productivity and nutrient availability in calcareous soil.

Available phosphorus

Available phosphorus status after harvest of soybean, sorghum as well as pigeon pea under both the years of experimentation is presented in Table 3 and is depicted in Figure 2.

During the year 2003-04, the available phosphorus concentration at harvest of soybean ranged from 14.52 (T_{10}) to 20.18 (T_3) kg ha^{-1} with a mean value of 17.01 kg ha^{-1}. The concentration ranged from 14.40 (T_{10}) to 18.11 (T_3) kg ha^{-1} with a mean value of 16.15 kg ha^{-1} after harvest of pigeon pea. During the year 2004-05, the concentration of available phosphorus after harvest of sorghum ranged from 14.10 (T_{10}) to 19.00 (T_3) kg ha^{-1} with a mean value of 16.56 kg ha^{-1}, and after harvest of pigeon pea from 14.00 (T_{10}) to 18.37 (T_3) kg ha^{-1} with a mean value of 15.95 kg ha^{-1}.

From the table, it is observed that available phosphorus status in treated plots (T_1 to T_9) was significantly higher over the control (T_{10}) indicating the need to apply plant nutrients to every crop in sequence, to prevent the depletion in available nutrient status and ensure the sustainability of yields of the component crops in a cropping system.

The results indicated that availability of phosphorus with various cropping system, was significant. However, cropping system as soybean + pigeon pea showed the highest available phosphorus at harvest in both the years of experimentation. This might be due to addition of soybean and pigeonpea residues to soil. Similar results were reported by Manna and Hajra (1996) indicating that by use of slurry @ 5 t ha^{-1} + 5 kg P_2O_5 was and biofertilizer in maize, the status of organic carbon, available N and P was increased.

The data on available phosphorus status as influenced by organic and inorganic nutrient sources, indicated that higher amount of available phosphorus was recorded with treatment T_3 i.e. FYM @ 5 t ha^{-1} during two years of experimentation. The results were significant.

The increase in status of available phosphorus might be due to decomposition of organic manures releasing organic acids which in turn helped in releasing phosphorus. Similar results are recorded by More (1994) and reported that application of FYM and pressmud recorded highest available phosphorus. Bellakki and Badanur (1997) also indicated that the available phosphorus increased significantly with organic sources of nutrients either alone or in combination with fertilizer alone in Typic Chromustert at Regional Research Station, Bijapur.

Available potassium

The data on available potassium status after harvest of soybean, sorghum as well as pigeon pea are presented in Table 4 and depicted in Figure 3. It was indicated that there is a significant reduction in control plot over the treated one, whereas among the treated plots the available potassium status was found to be almost at a par both after harvest of soybean, sorghum as well as pigeon pea in both the years.

During the year 2003-04, the content of available potassium at harvest of soybean ranged from 211 (T_{10}) to 247 (T_3) kg ha^{-1} with a mean value of 230.8 kg $ha^{-1}$and 218 (T_{10}) to 252 (T_3) kg ha^{-1} with a mean value of 237 kg ha^{-1} after harvest of pigeon pea.

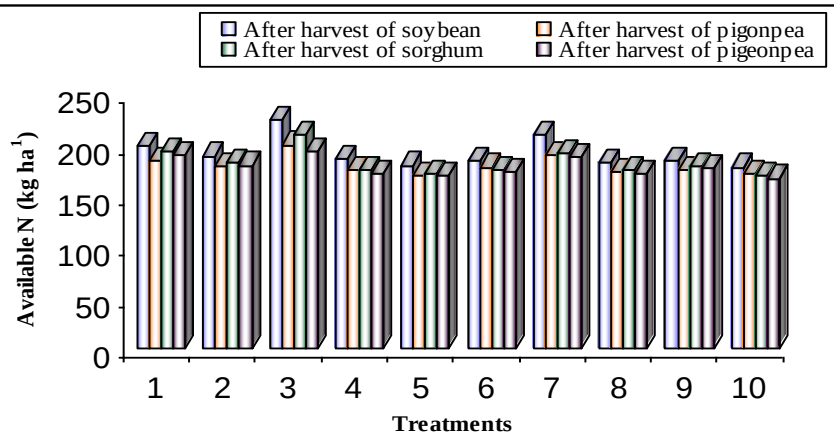

Fig-11 Available N (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

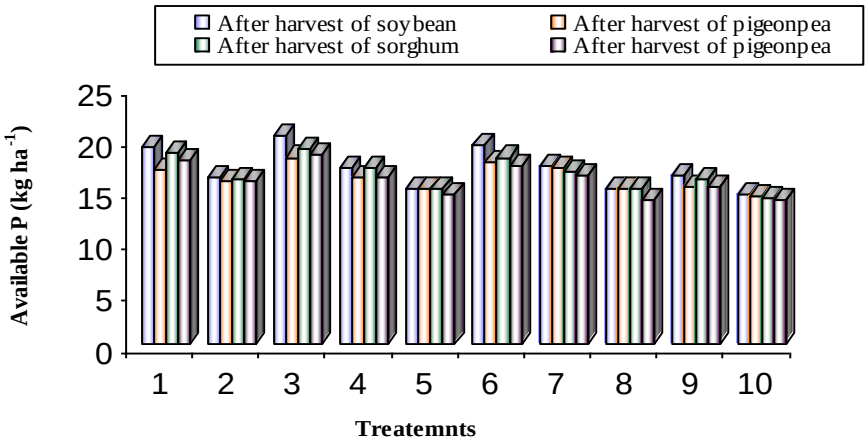

Fig-12 Available P (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

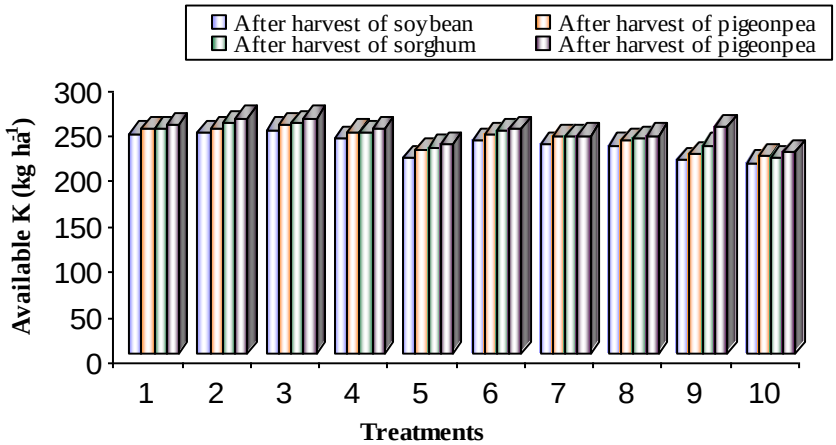

Fig-13 Available K (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

Table.1 The treatment details of experiment are as given below

A) Cropping systems	
	C_1= Soybean + Pigeonpea (4:2)
	C_2 = Sorghum + Pigeonpea (4:2)

B) Treatment details

Treatment codes	Treatment details
T_1	50% RDF + FYM@ 2.5t ha^{-1}
T_2	Glyricidia @ 6 t ha^{-1}
T_3	FYM @ 5 t ha^{-1}
T_4	Vermicompost @ 1 t ha^{-1}
T_5	Plant and weed residues (*in situ)*
T_6	Pressmud cake @ 3 t ha^{-1}
T_7	Neem seed cake @ 1t ha^{-1}
T_8	Biofertilizer (Rhizobium and Azotobactor)
T_9	Recommended dose of fertilizer, NPK (30:60:30)
T_{10}	Control (No manures or fertilizers)

Table.2 Available N (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

Treatments	2003-04		2004-05	
	After harvest of soybean	After harvest of pigeon pea	After harvest of sorghum	After harvest of pigeon pea
T_1	199	185	194	190
T_2	189	179	183	180
T_3	225	200	210	193
T_4	187	175	175	172
T_5	180	170	172	170
T_6	184	178	176	174
T_7	210	190	192	188
T_8	183	174	175	172
T_9	184	176	179	177
T_{10}	178	172	170	167
Mean	192	180	183	178
SE (±)	3.03	3.18	1.88	2.60
CD at 5%	9.00	9.42	5.57	7.72
Initial	175	---	176	---

Table.3 Available P (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

Treatments	2003-04		2004-05	
	After harvest of soybean	After harvest of pigeon pea	After harvest of sorghum	After harvest of pigeon pea
T_1	19.10	16.90	18.53	17.90
T_2	16.18	15.80	15.99	15.77
T_3	20.18	18.11	19.00	18.37
T_4	17.17	16.12	17.09	16.12
T_5	15.12	15.00	15.06	14.49
T_6	19.23	17.73	18.11	17.24
T_7	17.22	17.11	16.80	16.38
T_8	15.11	15.13	15.00	14.03
T_9	16.42	15.19	16.05	15.20
T_{10}	14.52	14.40	14.10	14.00
Mean	17.01	16.15	16.56	15.95
SE (±)	0.63	0.57	0.09	0.13
CD at 5%	1.87	1.69	0.26	0.37
Initial	14.30	---	14.60	---

Table.4 Available K (kg ha^{-1}) of soil as influenced by various organic and inorganic sources of nutrients

Treatments	2003-04		2004-05	
	After harvest of soybean	After harvest of pigeon pea	After harvest of sorghum	After harvest of pigeon pea
T_1	243	248	248	253
T_2	244	249	255	260
T_3	247	252	255	260
T_4	238	245	244	249
T_5	216	225	228	231
T_6	235	242	246	249
T_7	231	240	239	241
T_8	230	235	238	241
T_9	214	220	230	250
T_{10}	211	218	216	222
Mean	230.87	237.40	239.83	245.70
SE (±)	3.45	3.42	4.36	3.20
CD at 5%	10.24	10.16	12.95	9.50
Initial	205	---	210	---

During the year 2004-05, the status of available potassium after harvest of sorghum ranged from 216 (T_{10}) to 255 (T_2 andT_3) kg $ha^{-1}$with a mean value of 240 kg ha^{-1}while the range was 222 (T_{10}) to 260 (T_2 and T_3) kg ha^{-1} with a mean value of 246 kg ha^{-1} after harvest of pigeon pea.

The results on availability of potassium with different cropping system were reported in Table 4. The soybean + pigeon pea cropping system recorded maximum amount of available potassium. Sonar and Zende (1984) also reported that the crop sequence involving legume either in *kharif* or *rabi* season resulted in increasing available potassium status in calcareous and non-calcareous Vertisols of Rahuri.

Availability of potassium was increased with organic combined with inorganic treatments over T_9 i.e. RDF and T_{10} i.e. control. There was highest K availability with treatment T_3 i.e. FYM @ 5 t ha^{-1}. The application of FYM or other organic forms like glyricidia, significantly improved available K status possibly due to progressive incorporation of K through organic manures, as well as disintegration of K minerals due to release of organic acids from decomposing organic matter. The beneficial effect of organic matter on the availability of K is also due to the reduction of K fixation and release of K due to interaction of organic matter with clay resulting in the available K pool of the soil (Bellakki and Badanur, 1997).

Badanur *et al.,* (1990) reported that the available nitrogen and phosphorus contents were significantly increased with subabul, green manuring and FYM applications over chemical fertilizer alone.

Bhal and Pasricha (1991) stated that long term recycling of crop residue (wheat and rice straw) considerably increased the content of available N, P, and K in soil and increased N supply of soil. In other experiment, available phosphorus and potassium in both surface and subsurface soil was found to be increased significantly due to the application of crop residues and levels of P fertilizers under groundnut-wheat rotation (Dhillon and Dhillon, 1991). Reddy (1997) reported increase in availability of NPK in soil due to application of organic manures in the order glyricidia > press mud cake > FYM > wheat straw over control.

Mariam *et al.,* (2000) noticed that application of organic manures either as FYM or as green manure along with inorganic fertilizers has resulted into improvement in contents of organic carbon, available nitrogen, available phosphorus and available potassium after harvest of the second crop showing an increase over the initial level.

Yengade *et al.,* (2002) observed that in sorghum-sunflower cropping sequence the status of NPK and S was significantly higher with organic manuring treatments over fertilizers alone.

Patel *et al.,* (2003) reported significant increase in organic carbon, available N, P and K contents in soil with treatments receiving either full or half dose of recommended N through glyricidia leaves.

Rajkhowa *et al.,* (2003) reported that the treatment of vermicompost alone or in combination with fertilizer improved available N, P and K status, which clearly indicated the possibility of saving 25 to 50 per cent fertilizer through addition of 2.5 t ha^{-1} vermicompost. Similar results were also found by Tolanur and Badanur (2003).

Varalakeshmi *et al.,* (2005) conducted an

experiment at a farmer field and recorded an improvement in the organic C, available N, P and K contents in treatment with 100 % recommended fertilizer + 7.5 t FYM ha^{-1}in cropping system.

With respect to the influence of cropping system on the nutrient availability in soil, the legume based cropping system either as a component of intercrop or sequence crop was found to influence the nutrient availability in soil, favorably as compared to cereal-cereal combination.

Since, all these nutrient availabilities in soil are interrelated with each other a favourable impact of organics or legume crop was found influence other nutrient availability favourably.

Thus, it proved beyond doubt that inclusion of organics as source of plant nutrition or legume crops in cropping systems to augment nutritional supply, both being very important components of organic farming practices a long way in long term sustainability of soil fertility and productivity.

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