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Long-Term Effect of Organic and Inorganic Sources of Nutrients on Soil Properties and Uptake of Nutrients in Greengram (*Vigna radiata* Wilzeck)

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Abstract

Long-term field experiment on greengram—sorghum system was initiated during 1990-91 to generate data on crop yield and soil physico- chemical properties. However, the composition and nutrient uptake by the crop were not assessed. Hence, field experiment was carried out during *kharif* season of 2004-05 to study the long term residual effect of application of organic and inorganic sources of nutrient on growth and yield of greengram (*Vigna radiata* Wilzeck). The results indicate that the bulk density of soil decreased due to incorporation of FYM as compared to application of recommended dose of fertilizers alone. The per cent pore space in control was 50.18, which increased significantly to 53.58% due to application of recommended dose of fertilizers in combination with FYM. There was no change in the soil pH and electrical conductivity of soil due to continuous application of inorganic fertilizers either alone or in combination with FYM. The organic carbon content of soil in control was 0.32%, which increased significantly to 0.65% due to application of recommended dose of fertilizers along with FYM. Application of RDF along with FYM also increased the uptake of N, P and K significantly. The uptake of Zn and Fe by greengram increased significantly due to application of RDF in combination with organic manure.

Key words : Green gram, Inorganic and organic, Nutrients, Soil properties, Uptake.

Soil is a living, complex and fragile medium that has to be protected and nurtured to ensure its long term productivity and stability. By using or with fertilizers, no doubt we can double the production but in the long run yield will be decreased due to soil deterioration. Further, imbalanced use of chemical fertilizers may result in nutritional disorders in plant. Under continuous cultivation, soil is loosing organic matter faster than its replenishment. Organic matter is one of the factors that contribute most to the fertility of soils. On the other hand, the organic manures though it keeps soil health and quality, it may not be sufficient to all the cultivated lands. Hence, judicious and combined use of organic manures and fertilizers is necessary to ensure not only the productivity but also to improve soil health. Pulses occupy a unique position in world agriculture, due to their high protein content and their ability for fixing atmospheric nitrogen. On an average, pulse crop adds up to 30 kg nitrogen per hectare to the soil. Greengram is third most important pulse crop of India, only after chickpea and pigeonpea. Greengram is preferred due to its high quality protein in India, it is grown in an area of 3.53 lakh hectare with a production of 1.62 lakh tonnes. The average yield is 447 kg per hectare. Greengram has capacity to fix atmospheric nitrogen, but in early growth stage supply of nitrogen is required for growth and development. With this in view, a long term experiment was being conducted at Agricultural Research Station, Bheemarayanagudi. The data are generated on the effect of integrated use of organic and inorganic fertilizers on sorghum crop and residual effect on greengram crop. Thus, the present investigation was undertaken to assess the residual impact of continuous use of organic and inorganic sources of nutrients grown on greengram crop on soil properties and uptake.

Methods

A permanent manurial field trial was initiated in vertisols of Agricultural Research Station, Bheemarayanagudi, university of agricultural sciences, Dharwad during 1988. The experiment was conducted continuously till 2003-2004.The experiment consisting of 10 treatments (T_1—Control, T_2—FYM at 5.0 t/ha, T_3—FYM at 10.0 t/ha, T_4—50% RDF, T_5—100% RDF (100 : 75 : 40 NPK kg/ha), T_6—FYM at 5.0

t/ha + 50% RDF, T_7—FYM at 5.0 t/ha + 100% RDF, T_8—FYM at 10.0 t/ha + 50% RDF, T_9—FYM at 10.0 t/ha + 100% RDF and T_{10}—100% N and P only) with three replications were laid out in randomized block design. The greengram crop, variety Pusa baisaki was grown as test crop during *kharif* season of 2004. The crop was raised with 30 × 10 cm spacing by adopting the standard cultural practices. The recommended doses of fertilizers at 100 kg N, 75 kg P and 40 kg K per hectare were applied to sorghum crop grown in *rabi* season on the same field greengram was grown under residual condition.

Core sampler method is adopted to determine bulk density of soil sample (1). Porosity of a soil is calculated using the bulk density data and standard particle density value of 2.65 Mg/m^3 by the formula as given below.

$$\text{Porosity (\%)} = 1 - \frac{BD}{PD} \times 100$$

The Keen's cup method is adopted to determine the maximum water holding capacity of soil. The double ring infiltrometer is adopted to determine the infiltration rate of soil. Soil reaction of the soil : water suspension (1 : 2.5) was determined using pH meter (2). Electrical conductivity was determined in 1 : 2.5 soil : water extract using conductivity meter (2). The organic carbon content of finely ground soil sample was determined by Walkley's and Black rapid titration method (3).

To determine the N content one gram of powdered plant sample was pre-digested with concentrated nitric acid overnight. Further digestion was done with 5 ml of diacid mixture ($HNO_3 + HClO_4$) until clear solution was obtained. The residue was dissolved in 6 N HCI and the volume was made upto 50 ml using distilled water. A blank was prepared in the same manner without plant material and this was used in the determination of nutrients. The phosphorus content in the digested plant sample was determined by Vanadomolybdophosphoric acid yellow color method using spectrophotometer at 660 mm wave length (3). The potassium content in the digested plant sample was determined by flame photometer after making proper dilution (3). The content of copper, iron, zinc and manganese in the digested plant sample were determined after making proper dilution by atomic absorption spectrophotometer (Model, GBC 932 B).

Results and Discussion

Long-Term Effect of Organic and Inorganic Sources of Nutrients on Soil Properties

Bulk Density. The bulk density of soil decreased due to incorporation of FYM as compared to application of recommended dose of fertilizers alone (Table 1). The results revealed that the bulk density in control (1.320 mg/m^3) reduced to 1.243 mg/m^3, when recommended dose of fertilizers were applied in combination of FYM. However, it was non-significant among the different combination of FYM and

Table 1. Long term residual effect of organic and inorganic sources of nutrients on physical properties of soil.

Treatments	Bulk density (mg/m^3)	Porosity (%)	Water holding capacity (%)	pH	EC (dS/m)	Organic carbon (%)
T_1—Control	1.32	50.18	70.8	8.53	0.23	0.32
T_2—FYM 5.0 t/ha	1.25	52.85	72.8	8.52	0.23	0.43
T_3—FYM 10.0 t/ha	1.23	53.58	73.4	8.51	0.23	0.42
T_4—50% RDF	1.27	52.08	72.2	8.56	0.25	0.37
T_5—100% RDF	1.28	51.60	72.4	8.57	0.24	0.39
T_6—FYM 5.0 t/ha + 50% RDF	1.25	52.84	74.3	8.52	0.25	0.56
T_7—FYM 5.0 t/ha + 100% RDF	1.25	52.80	74.4	8.53	0.24	0.60
T_8—FYM 10.0 t/ha + 50% RDF	1.24	53.20	74.5	8.51	0.24	0.62
T_9—FYM 10.0 t/ha + 100% RDF	1.23	53.58	74.6	8.50	0.24	0.73
T_{10}—100% NP	1.27	52.07	72.1	8.56	0.23	0.46
SE ±	0.012	0.362	0.586	0.049	0.006	0.011
CD at 5%	0.034	1.076	1.739	NS	NS	0.033

Table 2. Long term residual effect of organic and inorganic sources of nutrients on total uptake of nutrients (kg/ha).

Treatments	Nitogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Zinc (g/ha)	Iron (g/ha)
T_1 —Control	50.76	8.01	31.88	78.7	550.0
T_2—FYM 5.0 t/ha	71.35	18.25	41.76	152.3	590.0
T_3—FYM 10.0 t/ha	72.86	20.75	42.80	187.9	655.0
T_4—50% RDF	81.26	23.16	45.67	128.1	590.0
T_5—100% RDF	82.27	25.20	46.45	140.2	600.0
T_6—FYM 5.0 t/ha + 50% RDF	88.15	33.20	51.05	166.9	635.0
T_7—FYM 5.0 t/ha + 100% RDF	91.65	35.81	52.55	183.5	630.0
T_8—FYM 10.0 t/ha + 50% RDF	93.31	37.15	53.95	215.1	650.0
T_9—FYM 10.0 t/ha + 100% RDF	98.10	38.30	57.25	230.0	670.0
T_{10}—100% NP	77.75	22.32	44.40	118.7	573.0
SE ±	4.80	0.483	1.029	3.65	5.45
CD at 5%	14.27	1.435	3.05	10.84	16.17

inorganics. These results are in confirmity with the findings of Sharma et al. (4). It was attributed to deterioration of soil structure due to continuous use of inorganic fertilizers. The reduction in bulk density with the application of organics along with fertilizers might be due to increase in organic matter status of soil and improvement in soil structure (5).

Soil Porosity. Porosity of soil was influenced significantly by the application of FYM in combination with fertilizers (Table 1). The per cent pore space in control was 50.18, which increased significantly to 53.58% due to application of recommended dose of fertilizers in combination with farm yard manure. The increase in soil porosity might be attributed to better aggregation and reduction in bulk density due to higher organic matter content leading to higher soil porosity and better aeration. These results are in conformity with the findings of Babhulkar et al. (6). They reported that application of organic manures improved soil aggregation resulting in favorable pore geometry, which inturn increased soil porosity.

Water Holding Capacity. Water holding capacity was significantly increased due to long term application of organic and inorganic sources of nutrients. Similarly FYM application also recorded maximum water holding capacity, may be due to application of FYM and improved the aggregation, resulting in favorable pore geometry of the soil. The above stated results are in close conformity with that of Acharya et al. (7).

Infiltration. Infiltration was more in FYM treatments compared to other treatments. The NPK + FYM treatment showed a higher infiltration rate. This may be due to higher per cent of non-capillary force and lower BD.

Soil Reaction. There was no change in soil pH due to application of various levels of inorganic fertilizers either alone or in combination with FYM. However, combined application of FYM along with inorganic fertilizers recorded comparatively lower soil pH that with inorganic fertilizers alone.

Electrical Conductivity. The results indicated that there was no change in the electrical conductivity of soil due to continuous application of inorganic fertilizers either alone or in combination with FYM. Similar results were reported by Badanur et al. (8)

Organic Carbon. The organic carbon content of soil in control was 0.32%, which increased significantly to 0.65% due to application of recommended dose of fertilizers along with FYM which is attributed to the addition of organic materials and also due to better root growth and their subsequent decomposition and their influence on the physico-chemical characteristics of the soil. These observation are in conformity with the findings of Babu and Reddy (9) and they revealed that organic carbon content of soil significantly increased due to application of FYM along with inorganic fertilizers.

Long-Term Effect of Organic and Inorganic Sources of Nutrients on Uptake in Greengram

Major Nutrients Uptake. The uptake of N, P and K nutrients by greengram in control was 50.76, 8.01 and 43.97 kg per hectare which increased significantly to 98.10, 38.2 and 57.25 respectively due to applica-

tion of RDF in combination with organic manures (T_{10}). Application of RDF along with FYM also increased the uptake of N, P and K significantly. The favorable effect of FYM on N uptake is attributed to the release of N during decomposition of organic materials and their uptake by the greengram crop. The increased uptake of P and K may be ascribed to more availability of these nutrients from the added fertilizer sources and to the solubility action of organic acids produced during the decomposition of organic materials thus resulting in more release of both the native and applied P and K nutrients.

Further, combined application of higher doses of fertilizers in combination with organic manures significantly increased the uptake of N, P and K to 98.10, 38.2 and 57.0 kg per hectare, respectively. This has been attributed to the increase in the availability of these nutrients in soil due to the addition of organic manures and also conversion of unavailable forms of nutrients into available forms. The increased uptake of nutrients may also due to continuous availability of N, P and K nutrients throughout the crop growth period as the nutrients from inorganic sources were available to the crop at the early stages and the nutrients released from the organic sources become available at the later stages of crop growth. On the contrary, the control and RDF recorded lower uptake of N, P and K. This is due to the less microbial population which rendered available nutrients into low available status and uptake.

Micronutrient Uptake (Zn and Fe). The uptake of Zn and Fe by greengram in control was 3.87 and 5.25 mg/kg respectively which increased significantly to 9.92 and 10.99 mg/kg, due to application of RDF in combination with organic manure. This increased uptake may be due to microbial decomposition of organic manures with simultaneous release of organic acids which might have favored the availability of micronutrients in soil and their uptake by greengram.

Addition of organic manures to soil, besides increasing the availability of micronutrients in soil, the complexing properties of these manure with micronutrients might have prevented precipitation, fixation, leaching and kept them in soluble form which might have resulted in higher uptake of these micronutrients by greengram. Similar increase in Fe and Zn uptake by crops was reported by Sharma et al. (4). The reported that incorporation of FYM and green manures along with RDF resulted in higher uptake of micronutrients than RDF alone.

Application of 100% RDF significantly increased the uptake of Zn and Fe to 7.28 and 8.10 mg/ha, respectively. This is mainly due to the fact that yield in these plots were higher than that in control plots. Similarly Bharadwaj et al. (10) reported that the uptake of micronutrient by crop increased with increasing dosage of inorganic fertilizers. The treatments receiving only recommended dose of fertilizers recorded significantly lower uptake of cationic micronutrients compared to that of FYM + RDF. This may be due to the reason that inorganic fertilizers in the absence of organic matter might reduce the availability of micronutrients due to precipitation.

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