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Effect of integrated nutrient management on soil properties and yield of soybean (*Glycine max*)

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ABSTRACT

A field experiment was conducted at Amravati (Maharashtra) during Kharij season of 2010 and 2011 to study the effect of integrated nutrient management on yield of soybean (Glycine max), soil properties.. The experiment was conducted in randomized block design with twelve treatments and three replications. The results revealed that seed and straw yield of soybean under 75% NP + 4t FYM + 25 kg S ha^{-1} was significantly higher than that under 100% chemical fertilizer applied to the crop and was on par with 75% NP + 4t FYM + 4kg Zn ha^{-1}. The improvement in soil fertility observed with respect to organic carbon, available N, P, K, S and Zn was prominent with the application of 75% NP + 4t FYM +25kg S ha^{-1}. The organic carbon, available N, P, K, S and Zn increased with increasing levels of fertilizers whereas pH and EC decreased. The organic carbon content increased from its initial value of 4.0 to 5.2g kg^{-1}, available N from 180 to 242.2 kg ha^{-1}, available P from 16.6 to 22.3 kg ha^{-1}, K from 350 to 374 kg ha^{-1}.S from 10.2 to 17.1 kg ha^{-1} and Zn from 0.52 to 0.91 mg kg^{-1}. No addition of fertilizer or organic manure (control) led to the significant reduction in available nutrients. Inoculation of PSB along with 75% NP + 4t FYM ha^{-1} improved the status of available phosphorus in post harvest soil.

Keywords: FYM, fertilizers, crop yield, soil fertility, soybean.

INTRODUCTION

Fertilizers play vital role in production and productivity of any crop but continuous and imbalanced use of high analysis chemical fertilizer badly influences production potential and soil health. Imbalanced use of fertilizers resulted in deterioration of soil fertility, decline in factor productivity, low diversity of production system and increasing cost of production. The problem is more severe in soils which are under intensive cropping. Use of chemical fertilizers in combination with organic manure is essentially required to improve soil health (Raghuwanshi *et al.* 2016). Increase in fertilizer use efficiency must be insured to achieve sustainable production.Soybean is the important crop but the productivity is low in the country which may be due to poor soil fertility and inadequate imbalanced and inefficient use of fertilizers to this crop organic manures hold promise to supply good amount of plant nutrients, improve soil health and can contribute to crop yield substantially. Integrated nutrient management of fertilizers and manures, therefore, is one of the viable options for sustaining soil health vis-à-vis crop productivity Limited work has been done to work out the optimum proportion of organic manure and chemical fertilizers for soybean under Amravati conditions. The present investigation, was, therefore undertaken to study the effect of integrated nutrient management on soybean productivity and soil fertility.

MATERIALS AND METHODS

The experiment was conducted at the Sri Shivaji Agriculture College, Amravati (22° 42' latitude, 77° 42' E longitude with an elevation of 315 meters above mean seal level), Maharashtra, India during rainy season of 2010 and 2011. Amravati has subtropical climate with an annual rainfall of about 824mm which is mainly confined to south-west monsoon extending from June to September in the region. The sunface soil (0-15cm) was alkaline (pH 7.7), low in organic carbon (4.1 g kg^{-1}) and available N (202 kg ha^{-1}) medium in available P (18 kg ha^{-1}) and high in K (366 kg ha^{-1}). It contained 11.6 kg S ha^{-1} and 0.56 mg kg Zn. There were 12 treatments namely, T_1 control, T_2 50% recommended dose of N and P, T_3 75 RD of NP, T_4 50% NP + 4t FYM ha^{-1}, T_5 -50% NP + 4t FYM + 25 kg S ha^{-1}, T_6-50% NP, 4t FYM + 5 kg Zn ha^{-}

[1], T_7-50% NP + 4t FYM + PSB, T_8-75% NP + 4t FYM ha^{-1}, T_9-75% NP + 4t FYM + 25 kg S ha^{-1}, T_{10}-75% NP + 4t FYM + 5 kg Zn ha^{-1}, T_{11}-75% NP +4t FYM + PSP and T_{12} 100% RD of NP. The treatments were laid out in a randomized block design with 3 replications. Recommended doses of 30 kg N and 75 kg P_2O_5 ha^{-1} were applied through urea and triple superphosphate, respectively. Sulphur and zinc were applied at sowing through elemental sulphur and zinc oxide, respectively. Well decomposed FYM (0.65% N, 0.25% P and 0.55% K) was added to the plots as per treatments one week before sowing. The seeds of soybean var. JS-335 treated with PSB was done in lines at 45cm apart using a seed rate of 75 kg ha^{-1} in July of both the years. Pendimethalin (Stomp 30EC) herbicide @ 0.45 ha^{-1} was applied using 500 litres water on the same day of sowing followed by one hoeing (4 weeks after sowing in both the years to control weeds). Data on yield were recorded at the time of harvesting. The soil samples collected after harvest of soybean crop were analysed for pH, EC, organic carbon by adopting standard procedures (Jackson 1973). Soil samples were also analysed for available N (Subbiah and Asija 1956), P (Olsen *et al.* 1954) K (Hanway and Heidel 1952), S (Chesnin and yien 1951) and Zn (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

Yield

The minimum seed and straw yields of soybean were recorded in control plots which may be attributed to low fertility status of the soil (Table 1). There was significant increases in soybean yield over control with 50, 75 and 100% NP fertilizers. The increases in seed and straw yield with 50, 75 and 100% NP over control were 10.7 and 12.7, 21.2 and 23.8 and 37.6 and 34.5%, respectively, (Tripathi 2007). Application of 4t FYM ha^{-1} alongwith 50 and 75% NP fertilizer further improved the crop production. This could be attributed to a sustained availability of major as well as trace element. Similar results were reported by Arbad and Ismail (2011).Application of 50 and 75% NP alongwith 4t FYM + 5kg Zn ha^{-1} significantly increased the seed and straw yields over NP level + 4t FYM ha^{-1}. Increases in seed and stover yield with 75% NP + 4t FYM + 5kg Zn ha^{-1} over control were 48.0 and 45.2%, respectively. The response of crop to Zn may be attributed to low status of available Zn and role of Zn in bio synthesis of indole acitic acid. Application of 50 and 75% NP alongwith 4t FYM + 25 kg S ha^{-1} significantly increased the yield over NP levels + 4t FYM ha^{-1} (Dixit *et al.* 2009, Kumar *et al.* 2011). Application of PSB along with FYM and NP levels also enhanced the yield over control. The maximum grain (28.81 q ha^{-1}) and straw (42.57 q ha^{-1}) yields were recorded with 75% NP + 4t FYM + 25kg S ha^{-1} which proved significantly superior over 100% NP alone indicating the beneficial effect of integrated use of nutrients.

Chemical properties of soil

The use of fertilizers did not affect the soil pH significantly. However, a slight increase in pH was noted with the addition of fertilizers. The integrated use of organics and inorganics reduced the soil pH over control. The soil pH varied from 7.62 in 100% NPK through fertilizers to 7.38 in 75% NPK + 4t FYM ha-1 + PSB treatment. Application of S and Zn also reduced the soil pH but S was more effective than Zn in reducing soil pH. This marginal decrease in soil pH in integrated treatments might be due to the moderating effect of organic manure as it produces organic acids on decomposition.The EC ranged from 0.29 dSm^{-1} to 0.31 dSm^{-1} in post harvest soil. Application of fertilizers either alone or in combination with organics slightly increased the EC of the soils over control. However, the EC was not affected markedly with S and Zn along with NP levels and FYM (Kumar *et al.* 2011).

Soil Organic Carbon

The soil organic carbon, one of the crucial factors in sustaining agricultural production, also improved under integrated nutrient management (Table 2). Its values varied from 4.00 g kg^{-1} under control to 5.12 g kg^{-1} under the treatment receiving 75% NP + 4t FYMN + 25 kg S ha^{-1}. The data revealed a definite build up of organic carbon in all the treatments except control over its initial value of 4.0 g kg^{-1}. Improvement in soil organic carbon status in treatments receiving organics may be due to their stimulating effect on growth and

Table1. Effect of various treatments on yield of soybean and soil properties

Treatment	Yield (q ha^{-1}) Seed	Stover	pH	EC (dSm^{-1})	Org. Carbon (g kg^{-1})
T_1 control	17.63	25.23	7.62	0.30	4.0
T_2 50% NP	20.30	29.43	7.61	0.31	4.3
T_3 75% NP	23.75	34.56	7.60	0.30	4.4
T_4 50% NP +4t FYM ha^{-1}	23.24	34.64	7.58	0.30	5.1
T_5 50% NP +4t FYM +25kg S ha^{-1}	25.76	37.13	7.59	0.30	5.0
T_6 50% NP +4t FYM +5kg Zn ha^{-1}	25.51	37.01	7.57	0.31	5.0
T_7 50% NP +4t FYM + PSB	24.80	36.24	7.56	0.29	5.1
T_8 75% NP +4t FYM ha^{-1}	25.90	38.82	7.59	0.30	5.1
T_9 75% NP +4t FYM +25kg S ha^{-1}	28.81	42.57	7.58	0.29	5.2
T_{10} 75% NP +4t FYM +5kg Zn ha^{-1}	28.53	41.81	7.58	0.30	5.1
T_{11} 75% NP +4t FYM + PSB	27.97	41.54	7.38	0.29	5.1
T_{12} 100% NP	26.05	38.67	7.60	0.32	4.5
SEm$\pm$	1.33	2.51	0.011	0.02	0.17
CD (P=0.05)	2.91	5.50	0.024	NS	0.37

activity of micro organics. This effect was further enhanced by addition of fertilizers that improved the root and shoot growth. Higher production of root biomass might have increased the organic carbon content (Ram Lakshmi *et al.* 2015).

Available Nitrogen

There was a significant decrease in available N content in soil under control. Nitrogen content varied from 180 kg ha^{-1} in control to 242.4 kg ha^{-1} in 75% NP +4t FYM + 25kg S ha^{-1}. Application of fertilizers either alone or in combination with organics was significantly superior to control. Increase in available N with organics may be attributed to its direct addition through organics as FYM which contained N, which was released on mineralization with time. The favourable soil conditions might have helped in the mineralization of soil N leading to its higher build up in these treatments (Raghuwanshi *et al.* 2016).

Table 2: Effect of various treatments on available N, P, K, S (kg ha^{-1}) and zinc (mg kg^{-1}) in post harvest soil

Treatment	Nitrogen	Phosphorus	Potassium	Sulphur	Zinc
T_1	180.0	16.6	350.0	10.2	0.52
T_2	219.6	18.2	353.0	12.0	0.54
T_3	230.0	19.0	353.0	12.2	0.54
T_4	218.0	21.6	374.0	13.4	0.61
T_5	239.0	21.6	372.0	16.8	0.62
T_6	238.2	21.3	373.5	13.7	0.89
T_7	237.8	22.1	370.8	13.5	0.60
T_8	239.2	21.8	374.0	13.3	0.63
T_9	242.4	22.0	372.6	17.1	0.63
T_{10}	240.5	21.4	372.1	13.8	0.91
T_{11}	240.0	22.3	371.3	13.7	0.61
T_{12}	222.0	19.2	363.6	12.7	0.55
SEm$\pm$	1.90	1.21	4.21	1.49	0.04
CD (P=0.05)	4.16	3.67	9.32	3.29	0.09

Available Phosphorus

The available P content of the post harvest soil varied from 16.69 kg ha^{-1} in control to 22.31 kg ha^{-1} in 75% NP +4t FYM + PSB (Table 2). There was an increase in available P content over control in all the treatments, where P was added. Treatment 75% NPK + 4t FYM + PSB recorded the highest available P content which was statistically at par with 75% NP +4t FYM ha^{-1} + 25kg S ha^{-1}. In general, integrated use of organics and fertilizers recorded higher available

P content over application of inorganic fertilizers alone. Build up in available P with the conjoint use of fertilizers with organics was ascribed to the release of organic acids during decomposition which in turn helped in releasing native phosphorus through solubilizing action of these acids. These findings are in agreement with those of Singh (2011).

Available Potassium

The amount of available K in post harvest soil ranged from 350.1 to 374.1 kg ha^{-1}. The lowest value of available K was recorded under control which may be ascribed to higher production of soybean crop which must have exhausted the soil K. Application of 75% NP +4t FYM ha^{-1} resulted in higher available K content in soil which may be attributed organic acids liberated during decomposition of organic matter which increased the status of potassium in soil. Arbad and Ismail (2011) reported an increase in available K with FYM application.

Available Sulphur

The available S content of the soil was significantly influenced by application of different treatments (Table 2) over control. Available S varied from a minimum in control to a maximum under 75% NP + 4t FYM + 25 kg S ha^{-1}, the values being 10.29 and 17.09 kg ha^{-1} respectively. The data revealed that the application of either fertilizers alone or in combination with FYM recorded an increase in the available S content of the soil over control. Low S content in control could be due to no addition of S and its removal by the crop. The increase in the available S with the application of fertilizers might be due to the addition of sulphur fertilizer. Addition of FYM contributed an appreciable amount of S which resulted in increased S content of the soil over control. These results are in close conformity with the findings of Arbad and Ismail (2011) and Kumar *et al.* (2011).

Available Zinc

Available Zn in post harvest soil varied from the lowest value of 0.52 mg kg^{-1} in control to the highest level of 0.91 mg kg^{-1} in 75% NP +4t FYM +5 kg Zn ha^{-1} (Table 2). Low Zn content in control treatment may be due to no addition of zinc fertilizers and its removal by the crop. The maximum value of Zn in 75% NP + 4t FYM + 5 kg Zn ha^{-1} may be attributed to zinc application which improved the Zn status of post harvest soil. Application of NP levels slightly improved the status of available Zn over control. The available Zn was significantly improved with the zinc application alongwith NP levels and FYM. The higher availability of zinc in soil under FYM was mainly due to its function in mobilizing the native zinc and chelation of Zn. Similar results were reported by Arbad and Ismail (2011).

The over all study clearly indicates that application of N and P fertilizers (100% RDF) is essential for harvesting higher seed and straw yield of soybean. For sustenance of soil health in terms of higher organic carbon and available nutrients (nitrogen, phosphorus, potassium, sulphur and zinc), application of organic manure in combination of N and P fertilizers is quite worthy to be considered in the present day context. Application of PSB, sulphur and zinc also improved the yield and soil fertility.

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