J. Soils and Crops 33 (1) 195-199, June 2023

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

IMPACT OF LONG TERM FERTILIZATION ON SOIL FERTILITY STATUS OF SOYBEAN GROWING SOILS IN RISOD TEHSIL, WASHIM DISTRICT, MAHARASHTRA

Rahul V. Jadhao[1], Ramkrushna M. Ghodpage[2], Amruta S. Ekapure[3] and Sanjay S. Balpande[4]

ABSTRACT

The study was undertaken during year 2021-2022 to assess the impact of long term fertilization on soil fertility status of soybean growing soils in Risod tehsil of Maharashtra. Total of 60 geo-referenced surface soil samples of 0-15 cm depth were collected after the harvest of soybean from the five villages of Risod tehsil, Washim district, Maharashtra. The results recorded that soils were black, clay to clay loam in texture and neutral to moderately alkaline in the reaction. The organic carbon content of the soil resulted in a low to moderately high range (3.3 – 6.3 kg ha^{-1}) and $CaCO_3$ in the study area was in a medium to high range (1.84 - 7.61 per cent).The value of available N of soil was under the low to the medium category with a range of 180.2 – 305.4 kg ha^{-1}. The available P in the soils was between the low to medium category with a range of 8.26 – 21.94 kg ha^{-1}. The available K present in soil was moderately high to very high category with a range of 217.5 – 588.0 kg ha^{-1}. The value of available S of soil was found under the low to the high category in all locations of the farmer's fields with different nutrient management practices with a range of 8.32 – 24.05 mg kg^{-1}. The yield of soybean was in the range of 10.50 to 25.00 q ha^{-1}. Organic carbon (r = 0.459), available phosphorus (r = 0.441**) and DTPA-extractable Zn (r = 0.365**) in soil showed a highly significant and positive correlation with the yield of soybean. This correlation study indicated that yield of soybean was increased with the increase in availability of SOC, available P and DTPA – Zn. Based on the result, it is inferred that a balanced amount of major chemical fertilizers in combination with sulphur @ 15- 25 kg ha^{-1} with FYM @ 3 to 5 t ha^{-1} applied on farmer's field for long term, increased the yield of soybean and also build up the soil fertility and micronutrient status.**

(Key words: Fertility status, Risod, sulphur, long term fertilization, soybean)

INTRODUCTION

Soybean (*Glycine max* L.) is a major oilseed crop of our country next only to groundnut, rapeseed, and mustard. India makes fourth in the world area (11.34 Mha) and third in production with 13.27 million tonnes (Anonymous, 2021). It can grow in various types of soils ranging from light sandy of Rajasthan to black heavy cotton soils of Maharashtra. The area under soybean crop in Maharashtra is 4.6 M ha and Vidarbha region area is 1.3 M ha. The average productivity of soybean in the Vidarbha region is 10.46 q ha^{-1}which is lower than the average productivity of Maharashtra (12.43 q ha^{-1}). It contains 40-45 per cent protein, 18-20 per cent oil, 24-26 per cent carbohydrates and a good amount of vitamins. Soybean is world's very important leguminous seed crop contributing 25 per cent need of oil globally and two-third supply of protein concentrates for feeding livestock (Karhale *et al.* 2021).

The lack of an integrated nutrient management approach coupled with imbalanced nutrition not only limits productivity but also leads to deterioration in soil quality (Sharma *et al.,* 2016). In continuous cropping, the use of imbalanced nutrients (N or NP alone) through inorganic fertilizers without organic manure cannot sustain the desired level of crop production (Thakur *et al.,* 2011).

Chemical fertilizers are playing a crucial role to meet the nutrient requirement of the crop; however persistent nutrient depletion is posing a greater threat to sustainable agriculture (Asefa and Wagari, 2021). Farmers should realize that fertility levels must be measured and then used to manage soil fertility.

Organic manures provide a good substrate for the growth of microorganisms and maintain a favorable nutritional balance and soil physical properties.To achieve higher productivity and soil most of the farmers generally apply imbalanced nutrients as per the traditional ways and also some farmers do not supply organic material to the soil.Therefore, it is essential to evaluate the influence of

1 and 3. P.G. Students, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur (MS)
2. Professor (CAS), Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur (MS)
4. Assoc. Professor, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur (MS)

long-term fertilization management on the status of soil fertility under soybean growing areas.

MATERIALS AND METHODS

The research work was carried out on the farmer's fields growing soybean who were using various doses of organic and inorganic fertilizers during the *kharif* season of 2021-2022. A total of 60 surface soil samples (0-15 cm depth) were collected after the harvest of soybean from farmer's fields of five different villages (Mop, Koyali, Kenwad, Gobhani and Netansa) of the Risod tehsil of Washim district. Out of 60 soil samples, 30 soil samples were from the field of farmers, who have been applying sulphur for past 8 to 10 years.The farmers were categorized based on various doses i.e., category I: chemical fertilizer with sulphur (17.22:36.15:00:20.17 NPKS kg ha^{-1}), category II: chemical fertilizer without sulphur (25.93:40.57:19.48 NPK kg ha^{-1}), category III: integrated nutrient management with sulphur (19.28:30.65:00:17.89 NPKS kg ha^{-1}, FYM @ 4.14 t ha^{-1}), category IV: integrated nutrient management without sulphur (26.11:45.36:15.46 NPK kg ha^{-1},FYM @ 3.89 t ha^{-1}).

The estimation of pH was done by a glass electrode pH meter, electrical conductivity by an electrical conductivity meter (Jackson, 1973), organic carbon by wet oxidation method (Walkley and Black, 1934), calcium carbonate by rapid titration method (Piper, 1966), nitrogen by alkaline $KMnO_4$ method (Subbiah and Asija, 1956), phosphorus by Olsen's method (Olsen, 1954), potassium by Ammonium Acetate method by using flame photometer (Jackson, 1973) and sulphur by the turbidimetric method using Morgan's extractant solution by using a spectrophotometer (Chesnin and Yien, 1951). The micronutrients like zinc, iron, copper and manganese were estimated using DTPA extractant (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

Physicochemical properties of soils

The soils of the study area were neutral to moderately alkaline in soil reactions with the pH of 7.4 to 8.4 in different locations of five villages under the practices of various nutrient management. EC varied from 0.51 to 0.89 in different locations of five villages. in the present study, the values of soil organic carbon in the farmer's field of soybean ranged from 3.5 to 5.9, 3.9 to 6.1, 3.3 to 6.3 and 3.7 to 6.2 g kg^{-1} with the mean value of 4.4, 4.8, 4.6, 4.9 g kg^{-1} under the categories of chemical fertilizers with sulphur (category I), chemical fertilizers without sulphur (category II) integrated nutrient management with sulphur (category III), and integrated nutrient management without sulphur (category IV), respectively. The maximum value of soil organic carbon (6.3 g kg^{-1}) was observed under category III comprise of integrated nutrient management with sulphur. This might have been due to the incorporation of a good source of organic C and its rapid mineralization which is available through the organic source.The value of soil organic carbon in the study area was from the low to moderately high range.This variation in the range of 4.4 to 4.9 might be due to different management practices and manuring. Khamparia *et al.* (2018) reported the initial value of organic carbon as 5.7 g kg^{-1} and attained a maximum value of 9.85 g kg^{-1} in the treatment that received 100% NPK along with FYM.

Calcium carbonate denotes the presence of calcareousness in soils.The value of calcium carbonate ranged from 1.98 to 7.61, 1.84 to 7.21, 1.98 to 7.59 and 1.89 to 7.03 per cent with the mean value of 4.15, 4.03, 4.51 and 3.94 per cent under the category I, II, III and IV, respectively The value of calcium carbonate in the study area resulted in a medium to high range. The soils of the study area may be calcareous due to the presence of calcium carbonate in the parent material and by a calcic horizon.

Available macronutrient status in the soils

The available N in the farmer's field was observed between 180.2 to 248.5, 186.6 to 285.1, 182.9 to 279.1, and 208.7 to 305.4 kg ha^{-1} with the mean value of 210.6 229.8, 218.4 and 238.5 kg ha^{-1} in category I, II, III and IV, respectively. The value of available N of soil was under the low to the medium category. The maximum value of available N (305.4 kg ha^{-1}) was observed under category IV comprising integrated nutrient management without sulphur. The results revealed that a slight increase in soil available N under the application of integrated nutrient management without sulphur might be due to more N fixation in the soil, on account of more amount of application of nitrogen along with other nutrients, FYM and other organic sources, higher microbial activity and leaching to better mineralization of organic N with other nutrient applications.

The available P in the soils was observed between low to medium range. The data of available phosphorus of the soils varied from 8.63 to 20.88, 7.19 to 21.71, 8.26 to 20.54 and 8.36 to 21.94 kg ha^{-1} with the mean value of 13.92, 14.21, 13.80, and 15.59 kg ha^{-1} in the category I, II, III and IV, respectively. Singh *et al.*(2014) reported the soil fertility status of alluvial and medium black soil and their correlation. They found that available P was 7.00 to 29.5 kg ha^{-1} in medium black soil. Bairwa *et al.* (2020) reported a significant reduction of available P in soil under the application of N alone and unfertilized treatments.

The available K of soil ranged from 329.2 to 466.8, 329.2 to 588.0, 217.5 to 588.0 and 311.6 to 470.4 kg ha^{-1} with the mean value of 380.7, 468.5, 379.6 and 373.0 kg ha^{-1} in category I, II, III and IV, respectively. The available K present in soil was moderately high to very high range in all locations of soybean growing farmer's fields with different nutrient management practices. The maximum value of soil available K (588.0 kg ha^{-1}) was observed under chemical fertilizer without sulphur and integrated nutrient management with sulphur (Category II and III). The higher availability of K might be due to the occurrence of potash-rich minerals like mica and feldspar in these soils. Similar findings were observed by Patel *et al.* (2018), who reported the maximum value of available K is 372 kg ha^{-1} under 100% NPK +FYM.

The data with respect to available sulphur in the soils after the harvest of the soybean crop are presented in Table 2. The available S in soil was observed between 9.86 - 21.73, 8.32 – 17.12, 8.98 – 24.05 and 9.54 – 19.58 mg kg^{-1} with the mean values of 16.04,13.84, 17.67 and 15.72 in category I, II, III and IV, respectively. The value of available S of soil was found under the low to the medium category in all locations of the study area. The highest value of sulphur was observed (24.05 mg kg^{-1}) in category III. The results revealed that a slight increase in available S under category I and category III might be due to the application of sulphur-containing fertilizer.

Available micronutrient status in the soils

The mean values of Zn were 0.61, 0.61, 0.58 and 0.61 mg kg^{-1} in the category I, II, III and IV, respectively. The value of available zinc in soil was under the low to medium category in all locations of study area. Considering the critical limit (< 0.60 mg kg^{-1}) of available Zn, in the present study 55 per cent of soil samples were falling under deficient in available Zinc. The mean values of Fe were 4.81, 4.91, 4.51 and 5.18 mg kg^{-1} in the category I, II, III and IV, respectively. In the present study area 40 per cent soil samples were deficient in available Fe. The value of available iron of soil was under low to medium category in all locations of the study area.

The mean values of Mn were 5.21, 5.65, 5.21 and 5.19 mg kg^{1}under the category I, II, III and IV, respectively. The value of available manganese of soil was under medium (2.00 to 8.00 mg kg^{-1}) to moderately high (> 8.00 mg kg^{-1}) category in all locations of the study area. The mean values of Cu were 1.77, 1.71, 1.58 and 1.80 mg kg^{1} under the category I, II, III and IV, respectively. The value of available copper of soil was under moderately high (0.2 to 0.8 mg kg^{-1}) to very high (> 0.8 mg kg^{-1}) category in all locations of the study area. A Similar finding was observed by Katkar *et al.*(2019), who found available Cu in the range of 0.77 to 6.84 mg kg^{-1} in the study area.

Yield data of soybean

The data revealed that the yield of soybean ranged from 12.50 to 25.00, 12.50 to 21.75, 10.50 to 25.00 and 13.50 to 24.00 q ha^{-1} with the mean values of 19.16, 17.55, 20.10 and 19.01 q ha^{-1}in the category I, II, III and IV, respectively. The highest grain yield of soybean (25 q ha^{-1}) was observed under sulphur-containing category I and category III. The yield of soybean was enhanced by 8.40 % and 5.42 % with the practices of chemical fertilizer with sulphur and integrated nutrient management with sulphur, over the application of chemical fertilizers without sulphur and integrated nutrient management without sulphur respectively.

Correlation of soil properties with the yield of soybean (n=60)

The results indicated that, the available nitrogen (r = 0.304*), and available sulphur (r = 0.321*) were significant and maintained a positive correlation with the yield of soybean and the organic carbon (r = 0.459**), available phosphorus (r = 0.441**) and DTPA-extractable Zn (r = 0.365**) in soil showed a highly significant and positive correlation with the yield of soybean. This correlation study indicated that the yield of soybean was increased with an increase in the availability of SOC, available P, available N, available S and DTPA – Zn. Patel *et al.* (2018) investigated that a highly significant positive correlation was observed between available N (r = 0.930**), available P (r = 0.981**) and available S (r = 0.994**) and the total productivity.

Based on the result, it is inferred that a balanced amount of major chemical fertilizers in combination with sulphur @ 15- 25 kg ha^{-1} with FYM @ 3 to 5 t ha^{-1} applied on farmer's field for long term sustained the yield of soybean and also in building up the soil fertility and micronutrient status. The soil properties including soil organic carbon, available N, available P, available S, and available Zn showed a significantly positive relationship with the yield of soybean.

Table 1. Range and mean of soil chemical properties

Category	pH			EC (dS m^{-1})			OC (g kg^{-1})			$CaCO_3$ (%)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Category I	7.4 -8.2	7.8	0.19	0.52 - 0.68	0.56	0.03	3.5 - 5.9	4.4	0.65	1.98 - 7.61	4.15	1.71
Category II	7.5 - 8.4	7.9	0.21	0.51 -0.89	0.60	0.09	3.9 - 6.1	4.8	0.66	1.84 - 7.21	4.03	1.71
Category III	7.6 - 8.3	7.7	0.19	0.52- 0. 77	0.60	0.05	3.3 - 6.3	4.6	0.91	1.98 - 7.59	4.51	1.97
Category IV	7.5 - 8.4	7.9	0.21	0.51-0.86	0.58	0.08	3.7 - 6.2	4.9	0.83	1.89 - 7.03	3.94	1.65

Table 2. Range and mean of fertility status of soil

Category	Available N (kg ha^{-1})			Available P (kg ha^{-1})			Available K (kg ha^{-1})			Available S (mg kg^{-1})		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Category I	180.2 - 248.5	210.6	19.81	8.63 - 20.88	13.92	3.15	329.2 - 466.8	380.7	34.47	9.86 - 21.73	16.04	3.46
Category II	186.6 - 285.1	229.8	29.96	7.19 - 21.71	14.21	3.96	329.2 – 588.0	468.5	74.49	8.32 - 17.12	13.84	2.81
Category III	182.9 - 279.1	218.4	27.03	8.26 -20.54	13.80	4.41	217.5 – 588.0	379.6	86.44	8.98 - 24.05	17.67	4.80
Category IV	208.7 - 305.4	238.5	26.11	8.36 - 21.94	15.59	3.58	311.6 - 470.4	373.0	46.22	9.54 - 19.58	15.72	3.11

Table 3. Range & mean of DTPA-extractable micronutrient status of the soils

Category	Zn (mg kg^{-1})			Fe (mg kg^{-1})			Mn (mg kg^{-1})			Cu (mg kg^{-1})		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Category I	0.31-0.94	0.61	0.21	3.45-6.32	4.81	0.92	3.74-6.29	5.21	0.89	0.97-2.64	1.77	0.44
Category II	0.42-0.85	0.61	0.14	3.62-6.41	4.91	0.82	3.97-7.39	5.65	1.07	0.89-2.53	1.71	0.60
Category III	0.34-0.94	0.58	0.16	3.37-6.12	4.51	0.64	3.94-7.21	5.21	0.84	0.71-3.21	1.58	0.70
Category IV	0.37-0.86	0.61	0.13	3.28-6.94	5.18	1.13	4.2-6.51	5.19	0.61	0.91-3.21	1.80	0.73

Table 4. Range and mean of the yield in soybean

Category	Yield (q ha^{-1})		
	Range	Mean	SD
Category I	12.50 – 25.00	19.16	3.42
Category II	12.50 – 21.75	17.55	3.16
Category III	10.50 – 25.00	20.10	3.62
Category IV	13.50 – 24.00	19.01	2.43

Table 5. Correlation of soil properties with yield of soybean (n = 60)

Soil properties	Correlation coefficient (r)
pH	-0.125
Electrical conductivity	-0.046
$CaCO_3$	-0.116
Organic carbon	**0.459****
Available nitrogen	**0.304***
Available phosphorus	**0.441****
Available potassium	0.133
Available sulphur	**0.321***
DTPA-Extractable zinc	**0.365****
DTPA-Extractable iron	0.177
DTPA-Extractable manganese	0.194
DTPA-Extractable copper	0.194

***Significant at 5 % level (r = 0.255)** ****Significant at 1 % level (r = 0.331)**

REFERENCES

Anonymous, 2021. Area, production and productivity of soybean in India. Database. https://pjtsau.edu.in

Asefa, F. and A. Wagari, 2021. Effect of organic and chemical fertilizers on growth, yield and yield components of soybean (*Glycine max* L.) in Western Ethiopia. J. Soils and Crops. **31**(1): 1-6.

Bairwa, J. B., S. Dwivedi, A. Rawat, R. K. Thakur and N. Mahawar, 2020. Long-term effect of nutrient management on soil microbial properties and nitrogen fixation in a vertisol under soybean– wheat cropping sequence in Madhya Pradesh. J. Indian Soc. Soil Sci. **69** (2):171-178.

Chesnin, L. and C. H Yien, 1951. Turbidimetric determination of available sulphate, SoilSci.Soc.America.**15**:149-151.

Jackson,M.L.1973.Soil Chemical Analysis, Prentice Hall of India. Pvt.Ltd.New Delhi. pp. 151-153.

Karhale, A. R. M. R. Parlawar, M. R. Deshmukh, A. P. Karunakar, D. V. Mali and D. J. Jiotode, 2021. Moppho-physiological response and yield of soybean as influenced by nutrient management. J. Soils and Crops, **31**(1):69-73.

Katkar, R. N. S. R. Lakhe, S. S. Hadole and P. A. Sarap, 2019. Assessment of spatial variability of major and micronutrients in soils of Amravati district of Maharashtra. PKV Res. J. **43**(1):81-89.

Khamparia, N. K., R. Thakur, and S. D. Sawarkar, 2018. Effect of continuous use of inorganic fertilizers and organic manure on crop productivity, soil fertility and sustainability of soybean wheat cropping system in a Vertisol. J. Soils and Crops. **28**(1): 19-25.

Lindsay, W. L. and W. A. Norvell, 1978. Development of a DTPA soil test for zinc, iron,manganese, and copper. Soil Sci. Soc. Am. J. **42**(3):421-428.

Olsen, S. R. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circ. 939, United States Department of Agriculture; Washington D. C.

Patel, G., B. S. Dwivedi, A. K. Dwivedi, R. Thakur and M. Singh, 2018. Long-term effect of nutrient management on soil biochemical properties in a vertisol under soybean–wheat cropping sequence in Jabalpur. J. Indian Soc. Soil Sci. **66**(2):215-221.

Piper, C. S. 1966. Soil and Plant Analysis, Interscience Publishers Inc., New York, USA.

Ramamoorthy, B., J. C. Bajaj, 1969. Soil fertility map of India. Indian Agriculture Research Institute,New Delhi.

Sharma, S. K., V. P. Singh, N. Chouhan and, R. Sawarkar, 2016. Effect of long-term fertility management practices on soil, crop quality and productivity of soybean grown in vertisols of Western Madhya Pradesh. Int. J. Agric. Sci. **8** (60): 3374-3377.

Singh, V., Y. K. Sharma, A. K. Singh and L. J. Bordoloi, 2014. Sulphur distribution in inceptisol of Northern India and genotypic differences in sulphur uptake of rice. African J. Agril. Res. **8**(10):855-867.

Subbaiah, B.V.and G. L. Asija, 1956. Arapid procedure for the estimation of available nitrogen in soils. Curr. Sci. **25**:259-260.

Thakur, R. K. S. D. Sawarkar, U. K. Vaishya and M. Singh, 2011. Impact of continuous use of inorganic fertilizers and organic manure on soil properties and productivity under soybean-wheat intensive cropping of a Vertisol. J. Indian Soc. Soil Sci. **59** (1):74-81.

Walkley, A. J. and I. A. Black, 1934. An examination of Degtjareff method for determining soil organic matter and proposed modification of the chromic acid titration method. J. Soil Sci. **37**:29-37.

Rec. on 15.11.2022 & Acc. on 08.12.2022