Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 2072-2076
Received: 15-06-2020
Accepted: 13-08-2020

DV Mali
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

AY Padghan
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

SN Ingle
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

SM Bhoyar
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

DP Deshmukh
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

SM Jadhao
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

SD Jadhao
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

NW Raut
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

Corresponding Author:
DV Mali
Department of Soil Science and Agricultural Chemistry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

Soil nutrient status as influenced by resource consequence practices under cotton-soybean rotation in vertisols

DV Mali, AY Padghan, SN Ingle, SM Bhoyar, DP Deshmukh, SM Jadhao, SD Jadhao and NW Raut

Abstract

The present study was undertaken during 2016-17 at Research farm, Dr. PDKV, Akola. The experiment was laid out in Randomized Block Design with nine treatments replicated three times in Vertisols. The objectives were to evaluate the effect of different resource conservation practices on soil nutrient status under cotton based soybean rotation in Vertisols. The cotton based soybean rotation was followed since 2011-12. The present experiment was superimposed on soybean during 2016-17. The treatments comprised for soybean crop was recommended dose of fertilizer (RDF) alone and their compensation with organics *viz.*, FYM, phosphocompost, neemcake, bio mulch (farm waste) and green leaf manuring. The results of the present experiment indicated that, the organic carbon was improved with the application of RDF through FYM + remaining P through phosphocompst (100 % N through FYM + compensation of P through phosphocompost to previous crop) (6.32 g kg^{-1}). The application of RDF through FYM + phosphocompost (100% N through FYM and compensation of PC to previous cotton) recorded significantly higher available nitrogen (240.9 kg ha^{-1}), available P (16.14 kg ha^{-1}) and available K (352.1kg ha^{-1}). The DTPA micronutrients viz; Fe (10.14 mg kg^{-1}), Mn (9.09 mg kg^{-1}), Zn (0.58 mg kg^{-1}) and Cu (2.64 mg kg^{-1}) were significantly increased with the application of 100 % N (FYM) + compensation of P (phosphocompost) to cotton + N compensation through urea and 100 % RDF + Phosphocompost to soybean. Thus, it can be inferred that, the management intervention comprising use of RDF through FYM + remaining P through phosphocompst (100 % N through FYM + compensation of P through phosphocompost to previous crop) helps to improve soil organic carbon and nutrient status under cotton based soybean rotation in Vertisols. The correlation (Pearson’s correlation coefficient) coefficient was highest among available N and DTPA Cu (r = 0.977**).

Keywords: Conservation practices, soybean, FYM, phosphocompost, nutrient status, DTPA – micronutrients, vertisols

Introduction

Conservation agriculture in broader sense includes all those practices of agriculture, which help in conserving the land environment while achieving desirable sustainable yield levels. Conservation agriculture is the integration of ecological management with modern, scientific, agricultural production. Conservation agriculture employs all modern technologies that enhance the quality and ecological integrity of the soil but the application of these is tempered with traditional knowledge of soil husbandry gained from generations of successful farmers. This holistic embrace of knowledge, as well as the capacity of farmer to apply this knowledge and innovate and adjust that to evolving condition ensures the sustainability of those who practice conservation agriculture. A major strength of conservation agriculture is the step-like implementation by farmers of complementary, synergetic soil husbandry practices that build to a robust, cheaper, more productive and environmentally friendly farming system. These systems are more sustainable than conventional agriculture because of the focus of producing with healthy soils.

Increasing carbon sequestration in agricultural soils and making them a net sink for atmospheric carbon can be achieved by adoption of the best management practices involving use of balanced fertilization, crop residue management, use of organic manures and various soil conservation practices. It is essential to utilize all available organic resources and to develop crop management system for sustainable soybean production as well as maintenance of soil health. The primary factor having influence on soil health is organic matter fractions, which are under constant threat of depletion due to inadequate replenishment under rainfed farming system. The organic matter build up in tropical soil is not feasible, but its maintenance at a desirable level is essential.

Use of organics, crop residues, green manures, agricultural wastes, biofertilizers as the components of conservation agriculture improve soil health by changing rhizosphere environment. The organic matter in crop residues serves as a major source for replenishing various fractions of soil organic matter and subsequently influences aggregation, porosity and other soil properties.

In view of the importance of the resource conservation practices for improvement in various soil chemical properties in general and soil organic carbon in particular, the present investigation was undertaken to assess the effect of various resource conservation practices on yield of soybean and soil nutrient status under cotton based soybean rotation in Vertisols.

Materials and Methods

The present experiment was carried out during 2016 -17 on cotton based soybean rotation at Research Farm, Department of Soil Science and Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Randomized Block Design with nine treatments replicated three times located at between on $22^0 42'$ N latitude and $77^0 02'$E longitude at an altitude of 307.42 m above MSL and has a subtropical climate. The soil of the experimental site was clayey in nature, Bulk density 1.41 mgm^{-3} with pH 8.33 (1:2 soil: water) (Piper, 1996), low in EC (Piper, 1996), low in organic matter content of 5.4 g kg^{-1} (Jackson, 1967), low in available N (Kjeldahls method) (Subbiah and Asija, 1956) [2], medium in available P (Jackson, 1967) and high in available K (Jackson, 1967) at the start of experiment.

The experiment was laid out in Randomized Block Design with nine treatments replicated three times. The treatments for cotton based soybean rotation is given below.

Table 1: Treatment details under cotton based soybean rotation

Tr.	Rotation	
	Cotton	**Soybean**
T_1	100% RDF(50:25:00 kg NPK ha^{-1})	RDF
T_2	*Sesbania aculeta* 25% N + compensation of RDF	RDF
T_3	Cotton stalk 25% N composted with *trichoderma viride* + compensation of RDF	RDF
T_4	Wheat straw 25% N + compensation of RDF	RDF
T_5	Bio mulch (farm waste) 25% N + compensation of RDF	RDF
T_6	Conc. organics (Neemcake) 25% N + compensation of RDF	RDF
T_7	100% N through FYM+ compensation of P through phosphocompost	RDF through FYM + remaining P through phosphocompost
T_8	50% N through FYM + compensation of P through phosphocompost & remaining N through urea	RDF through FYM + remaining P through phospho- compost
T9	*Leucaena loppings* 50% N + compensation of P through phosphocompost & remaining N through urea	RDF through FYM + remaining P through phospho compost

The RDF of soybean was 30:75:30 kg N, P and K ha^{-1}. The N, P and K were applied through fertilizers viz. urea, single super phosphate (SSP) and muriate of potash containing 46, 16.0 and 60 per cent N, P_2O_5 and K_2O, respectively.

Soil samples were collected at 0-15 cm depth from nine treatment plots of all the three replications before sowing in kharif and after harvest of soybean crop during 2016-17. The air dried samples were carefully and gently ground with the wooden pestle to break soil lumps (clods) and were passed through 2 mm diameter sieve and used for soil chemical analysis.

In brief, the soil organic carbon was determined by Walkley and Black method as described by Nelson and Sommers (1982) [3]. The available nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija (1956) [2]. The available phosphorous was determined by Olsen's method using 0.5 M sodium bicarbonate pH (8.5) as an extractant. Darco G-60 was used to absorb the dispersed organic matter and make the filtrate colorless for further colorimetric analysis (Watanabe and Olsen, 1965) [4]. The available potassium was determined by the flame photometer using neutral N ammonium acetate (pH 7.0) as an extractant as described by (Jackson, 1967). DTPA extractable micronutrient determined by the Atomic Absorption Spectrophotometer by Lindsay and Norvell (1978) [5].

The plant biomass dry matter of each net plot were threshed, cleaned and weighed. Net plot yield and yield per hectare was calculated separately. The data on different parameters were tabulated and analyzed statistically by the methods described by Panse and Sukhatme (1971) [6].

Results and Discussion

Organic Carbon

The organic carbon varied in the range of 5.82 to 6.32 g kg^{-1}. The application of RDF through FYM + remaining P through phosphocompst (100% N through FYM + compensation of P through phosphocompost to previous crop) recorded higher organic carbon (6.32 g kg^{-1}) followed by RDF through FYM + remaining P through phosphocompost (50% N through FYM + compensation of P through phosphocompost and remaining N through urea).

Application of recommended dose of fertilizer to both the crop resulted slight decline in the status of organic carbon (5.82 g kg^{-1}). The significantly higher organic carbon was noted where plant residue, FYM, phosphocompost and cotton stalk was applied. Proportionally higher carbon content was recorded in treatment receiving organic addition to both the crops which might be due to slower breakdown or constant mineralization of added organic residue. The similar findings are noted by Halemani *et al.* (2004) [7] and Thakur *et al.* (2011) [8].

Available N

Nitrogen is the most important primary nutrient largely required by the crops and at the same time it is very difficult to maintain in the soils in its plant utilizable form. The application of RDF through FYM + phosphocompost (100% N through FYM and compensation of PC to previous cotton) recorded significantly higher available nitrogen (240.9 kg ha^{-1}) followed by RDF (*Sesbania aculeta* 25% N + compensation of RDF) (230.1 kg ha^{-1}), these treatments were found at par with each other. The application of RDF (100% RDF) resulted substantially decreased the available N (217.4 kg ha^{-1}) status. Similar results were also reported by Singh *et al.* (2011) [9].

The available nitrogen although showed increase under INM, it has not been increased much due to the prevailing climatic condition, accelerating oxidation of organic matter as well as its losses through volatilization and leaching. In this view, the results of present investigation suggest that the maintenance of soil available nitrogen levels is more challenging. This necessitates regular addition of organics for maintenance of soil fertility in the soils of semi-arid areas.

Available P

The available P after harvest of soybean was significantly influenced by various treatments. The highest available P (16.14 kg ha^{-1}) was observed with the application of RDF through FYM + remaining P through phosphocompost (100% N through FYM and compensation of PC to previous crop) followed by RDF through FYM + remaining P through phosphocompost (50% N through FYM + P compensation through phosphocompost + N compensation through urea) (16.07 kg ha^{-1}) and application of RDF through FYM + remaining P through phosphocompost (50% N through *leuceana lopping* + P compensation through phosphocompost + N compensation through urea to previous crop) (15.64 kg ha^{-1}), which were found at par with each other.

The lowest available P was observed under the application of RDF (Cotton stalk 25% N composted with *trichoderma viride* + compensation of RDF) (14.68 kg ha^{-1}). This could be attributed to the effect of applied fertilizer and mineralization of organic sources or through solubilization of the nutrients from the native sources during the process of decomposition. Similar observation recorded by Singh *et al.* (2011) [9].

The black soils which have high phosphorus fixation problems are specifically becoming deficient under the intensive cropping systems. Under these circumstances the crops having potential of adding considerable biomass to the soil have special significance in black soils. The results also suggested that in spite of phosphorus fixation in swell-shrink soil, the conjunctive use of organics with chemical fertilizers is beneficial for improving available P which is also evidenced by the reduced calcium carbonate contents of the soil there by reducing phosphorus fixation. Similar results were reported Katkar *et al.* (2005) [10] and Chitale *et al.* (2003) [11].

Available potassium

The available K after harvest of soybean was significantly influenced by various treatments. The highest available K (352.1 kg ha^{-1}) was observed with the application of RDF through FYM + remaining P through phosphocompost (100% N through FYM and compensation of PC to previous crop) followed by RDF through FYM + remaining P through phosphocompost (50% N through FYM + P compensation through phosphocompost + N compensation through urea to previous crop) (347.5 kg ha^{-1}), RDF (100% RDF to previous crop) (338.8 kg ha^{-1}) and RDF (*Sesbania aculeta* 25% N + compensation of RDF) (T_2) (336.2 kg ha^{-1}). The lowest available K was recorded with the application of RDF (wheat straw 25% N + compensation of RDF to previous crop) (322.6 kg ha^{-1}).

The chemical fertilizers with organic manures helps to increase potassium content in the soil, this might be due to the reduction of potassium fixation and release of K due to the interaction of organic matter with clay, besides direct K addition in available K pool. The crop residues having considerable concentration of potassium have enough potential for enhancing the potassium availability in black soils which can partially reduce the chemical fertilizers to some extent. The Similar results were reported by Bhattacharyya *et al*. (2008) [12] and Shivakumar and Ahlawat (2008) [13].

DTPA Micronutrients

The DTPA – Fe content of soil as influenced by various treatments ranged from 7.73 to 10.62 mg kg^{-1}. Significantly highest DTPA - Fe was recorded with the application of RDF through FYM + remaining P through phosphocompost (50% N through FYM + compensation of P through phosphocompost & remaining N through urea previous crop cotton) (10.62 mg kg$^{-1)}$. The lower DTPA - Fe was reported in control treatment. Addition of FYM and phosphocompost has beneficial effect on DTPA - Fe content of soil, the similar result was also reported by Babhulkar *et al.* (2000) [15].

The DTPA – Mn as influenced by various treatments ranged from 7.51 to 9.58 mg kg^{-1}. Significantly highest DTPA – Mn was recorded in the treatment of application of RDF through FYM + remaining P through phosphocompost (50% N through FYM + compensation of P through phosphocompost and remaining N through urea previous crop cotton) (9.58 mg kg^{-1}) The lower DTPA – Mn content was reported in control treatment (7.48 mg kg^{-1}). Addition of organic materials (FYM) phosphocompost has beneficial effect on DTPA – Mn content in soil, the similar result was also reported by Vipin Kumar and Singh (2010) [14].

The status of DTPA – Zn after harvest of soybean ranged from 0.45 to 0.62 mg kg^{-1}**.** Significantly highest DTPA – Zn status was recorded with the application of RDF through FYM + remaining P through phosphocompost (50% N through FYM + compensation of P through phosphocompost and remaining N through urea previous crop cotton) (0.62 mg kg^{-1}) and RDF along with PC to soybean and 50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea) to preceding cotton (0.58 mg kg^{-1}). However, DTPA – Zn content recorded by this treatment found statistically at par with each other. The lower DTPA – Zn content of was reported in control treatment (0.45 mg kg^{-1}). The increase in DTPA - Zn content may be due to use of organic manures in the form of both the compost. The similar trend was recorded by Babhulkar *et al.* (2000) [15].

The DTPA – Cu as influenced by various treatment ranged from 1.97 to 2.93 mg kg^{-1}. Significantly highest available copper status was recorded in the treatment of application of RDF through FYM + remaining P through phosphocompost (50% N through FYM + compensation of P through phosphocompost and remaining N through urea previous crop cotton) (2.93 mg kg^{-1}) followed by RDF along with PC to soybean and 50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea) to preceding cotton (2.64 mg kg^{-1}). However, DTPA – Cu content recorded by this treatment found statistically at par with each other. The lower DTPA – Cu content of was reported in control treatment (1.97 mg kg^{-1}).

The similar result was also reported by Vipin Kumar and Singh (2010) [14].

Table 2: Effect of different resource conservation practices on soil nutrient status after harvest of soybean

Tr.	Treatment details		Organic carbon (g kg^{-1})	Available Nutrient (kg ha^{-1})		
	Cotton	Soybean		N	P	K
T_1	RDF	RDF	5.82	217.4	14.83	338.8
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	6.04	230.1	15.07	336.2
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	5.89	219.9	14.68	324.2
T_4	25 % N (Wheat straw) + RDF compensation	RDF	5.95	223.7	14.74	322.6
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	5.94	219.7	15.05	331.3
T_6	25 % N (Neemcake) + RDF compensation	RDF	5.96	222.9	15.08	326.1
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	6.32	240.9	16.14	352.1
T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	6.20	229.5	16.07	347.5
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	6.14	226.5	15.64	325.1
	SE (m) ±		0.09	2.66	0.30	6.46
	CD at 5%		0.28	11.78	0.91	19.38
	Initial value		5.4	213.2	14.85	403.2

Table 3: Effect of different resource conservation practices on DTPA extractable micronutrient status of soil after harvest of soybean

Tr.	Treatment details		DTPA extractable micronutrient (mg kg^{-1})			
	Cotton	Soybean	Fe	Mn	Zn	Cu
T_1	RDF	RDF	7.73	7.78	0.45	2.28
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	9.44	9.07	0.54	2.52
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	8.29	8.04	0.50	2.46
T_4	25 % N (Wheat straw) + RDF compensation	RDF	8.18	8.23	0.48	2.33
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	8.19	7.51	0.49	1.97
T_6	25 % N (Neemcake) + RDF compensation	RDF	7.87	7.71	0.49	2.03
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	10.62	9.58	0.62	2.93
T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	10.14	9.09	0.58	2.64
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	9.96	8.88	0.56	2.43
	SE (m) ±		0.51	0.45	0.02	0.16
	CD at 5%		1.52	1.36	0.06	0.47

Table 4: Pearson's correlation among seed yield of soybean and soil properties

Properties	Seed Yield	Av. N	Av. P	Av. K	Fe	Mn	Zn	Cu
Seed Yield	1.000	0.304	0.101	0.307	0.010	0.379	0.357	0.258
Av. N	0.304	1.000	0.928	0.943	0.628	0.953	0.885	0.977
Av. P	0.101	0.928	1.000	0.799	0.661	0.880	0.911	0.918
Av. K	0.307	0.943	0.799	1.000	0.727	0.893	0.770	0.908
Fe	0.010	0.628	0.661	0.727	1.000	0.619	0.608	0.628
Mn	0.379	0.953	0.880	0.893	0.619	1.000	0.946	0.976
Zn	0.357	0.885	0.911	0.770	0.608	0.946	1.000	0.912
Cu	0.258	0.977	0.918	0.908	0.628	0.976	0.912	1.000

Conclusion

It can be concluded that, the soil organic carbon, nutrient status (available N, P, K, DTPA- Zn, Fe, Mn and Cu) was improved with the integrated use of chemical fertilizers and various organics viz; FYM, phosphocompost, cotton stalk, wheat straw, bio-mulch and dhaincha loppings under cotton based soybean rotation in Vertisols. The correlation (Pearson's correlation coefficient) coefficient was highest among available N and DTPA Cu (r = 0.977**).

References

1. Jackson ML. Soil chemical analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
2. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soil. Curr. Sci. 1956; 25:259-260.
3. Nelson DW, Sommer LE. Total carbon, organic carbon and organic matter. In: Methods of Soil Analysis Part-II. Page, A.L. (Ed.). Am. Soc. of Agron. Inc. Soil Sci. Soc. Am. Madison, Wisconsin, USA, 1982, 539-577.
4. Watanabe FS, Olsen SR. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts. Soil Sci. Soc. Amr. Proc. 1965; 29:677-678.
5. Lindsay WL, Norvell WA. Devlopment of DTPA soil text for Zn, Fe, Mn and Cu. Soil sci. Soc. Amr. J. 1978; 42(3):270-283.
6. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi, 1971.
7. Halemani HL, Hallikeri SS, Nooli SS, Nandagavi RA, Harish Kumar HS. Effect of organics on cotton productivity and physico-chemical properties of soil. In Int. symposium on strategies for sustainable cotton production – A global vision 2. Crop Production, UAS, 2004, 123-129.
8. Thakur R, Sawarkar SD, Vaishya UK, Singh M. 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. 2011; 59(1):74-81.
9. Singh YV, Dhar DW, Agarwal B. Influence of organic nutrient management on Basmati rice (*Oryza sativa*)-

wheat (*Triticum aestivum*)-greengram (*Vigna radiate*) cropping system. Indian J of Agron. 2011; 56(3):169-175.
10. Katkar RN, Wankhade SG, Turkhede AB, Lambe SP. Effect of integrated nutrient management in cotton growing in shallow soil on growth, seed cotton yield. PKV Res. J. 2005; 29(2):210-214.
11. Chitale SR, Bajapai RK, Upadhyay SK, Joshi BS. Influence of cereal-legume, legume-cereal and cereal-cereal sequence on productivity, economics and soil fertility status. Madras Agric. J. 2003; 90:733-735.
12. Bhattacharya R, Prakash V, Kundu S, Ghosh BN, Gupta HS. Potassium availability as influenced by farmyard manure application under continuous soybean-wheat cropping in a typic haplaquept, J Indian Soc. Soil Sci. 2008; 56(2):182-185.
13. Shivkumar BG, Ahlawat IPS. Integrated nutrient management in soybean (*Glycine max*) – wheat (*Triticum aestivum*) cropping system. Indian J Agron. 2008; 53(4):273-278.
14. Vipin Kumar, Singh AP. Long-term effect of green ganuring and farmyard manure on yield and soil fertility status in rice-wheat cropping system. J Indian Soc. Soil Sci. 2010; 58(4):409-412.
15. Babhulkar PS, Badole WP, Balpande SS. Residual effect of long term application of FYM and fertilizer on soil properties (Vertisol) and yield of soybean J Indian. soc. Soil. Sci. 2000; 48(1):89-92.