Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 3272-3277
Received: 16-03-2019
Accepted: 18-04-2019

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

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

VV Gabhane
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

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

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

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

Effect of various conservation practices on yield and nutrient uptake by soybean under soybean – cotton rotation in Vertisol

AB Age, PR Kadu, VV Gabhane, SD Jadhao, DV Mali and SD Zodge

Abstract
The present investigation was conducted during kharif 2016-17 with a view to study the effect of various Conservation Practices on Yield and Nutrient Uptake by Soybean under soybean –cotton rotation in Vertisol executed at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was carried out with main plot comprises two treatments i.e. conservation tillage (CNS) (one harrowing and two weeding) and conventional tillage (CNV) (one ploughing, one harrowing, two hoeing and two hand weeding) and eight sub plot treatments of integrated plant nutrient system consisting of control, 100 per cent RDF and use of chemical fertilizer along with organic source of nutrient in which 50 per cent N applied through organic sources (FYM, wheat straw, Glyricidia leaf manuring (GLM), composted cotton straw, Vermicompost and Phosphocompost) and remaining N was applied through chemical fertilizers. The soybean variety JS-335 was undertaken for the experiment with general recommended dose of fertilizer 30:75:30 N, P_2O_5, K_2O kg ha^{-1}. The experiment was framed in randomised block design (RBD) with three replications. The soil and plant samples were analysed after harvest of soybean during 2016-17. Among the tillage practices, significantly higher soybean seed yield and uptake of nutrients were recorded in conservation tillage as compared to conventional tillage under soybean-cotton rotation. The various integrated plant nutrient supply treatments influenced significantly soybean seed and straw yield with the application of phosphocompost in conjunction with chemical fertilizers. The significantly highest uptakes of nutrients were recorded with the application of phosphocompost in conjunction with chemical fertilizers followed by FYM, GLM and vermicompost under conservation tillage.

Keywords: Conservation tillage, green leaf Manuring, FYM, Vermicompost, wheat straw

Introduction
Conservation agriculture has emerged as a new paradigm to achieve the goals of sustainable agricultural production. It involves the new and innovative ways of generating and promoting technologies that focus on resource conservation as a way to enhance productivity in a sustainable manner. Conservation agriculture aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive cultivation and burning or removal of crop residues. Aggressive seed bed preparation with heavy machinery lead to declining soil fertility, biodiversity and erosion. The nutrient needs of the Indian agriculture are so large that no single plant nutrient source be it fertilizers, organic manures, green manures or biofertilizers is in position to meet the entire plant nutrient demand. Therefore, resource conservation becomes a top priority and restoration of precious soil resource by way of innovative means of management is the need of the day.

Soil is the only and finite natural resource of the production of different crops. The degradation of soil health has emerged as a major factor responsible for stagnation in agricultural production and is posing a serious threat to our national food security for the last few years. The degradation of soil health in many cultivated areas is manifested in terms of loss of soil organic matter and depletion of native soil fertility due to imbalanced and unscientific use of fertilizer. This has become a major constraint now in improving crop productivity. The escalating population, attenuating good quality land resources for crop production and increasing concern for declining soil quality and environment degradation highlight the urgency for continuously enhancing and sustaining the productivity of land. The high yielding hybrid varieties of many crops are being grown by the farmers in the country which resulted in heavy nutrient mining from the soil. The utility of land to produce yield is limited and limits of production are set by soil and climatic parameters.

Soybean cultivation is continuously increasing due to its dual utility as pulse as well as oil seed crop, besides it has better market price, high protein content (40-42 %) and oil content (20-22 %). It is the cheapest and richest source of high quality protein. It supplies most of the nutritional constituents essential for human health. Hence, soybean is called as "Wonder bean" or "Miracle bean". Soybean occupies an intermediate position between legumes and oilseed.It is grown in the area which receive 800-1200 mm rainfall and on almost all types of soil. Soybean crop contributes 24-30 q ha^{-1} residues which can be recycled and nutrient content therein be harnessed for the succeeding crop besides improving the soil fertility.

In India, area under soybean cultivation is approximately 9.95 m ha with production of 12.57 MT. Maharashtra ranks 2nd in soybean cultivated area and production in country. The area under soybean crop in Maharashtra is 35.80 lakh ha of total cultivated area of the country with an average productivity of 1102 kg ha^{-1} and production 39.45 lakh MT. (Anonymous, 2016) [1]. Out of total soybean cultivated area in Maharashtra 75 to 80% area is in Vidarbha. The area under soybean cultivation in Vidarbha is 25.50 lakh ha with production of 21.62 lakh MT and average productivity is 1050 kg ha^{-1}.

Material and Methods

The field experiment was conducted on research farm of Department of Soil Science and Agricultural Chemistry. The effect of conventional and conservation tillage was assessed along with different organic and inorganic fertilizers. The study was conducted in Kharif 2016-17. The effect of tillage and organic sources were studied on soil properties under soybean and cotton crop rotation.

The experiment was carried out with main plot comprises two treatments i.e. conservation tillage (CNS) (one harrowing and two weeding) and conventional tillage (CNV) (one ploughing, one harrowing, two hoeing and two hand weeding) and eight sub plot treatments of integrated plant nutrient system consisting of control, 100 per cent RDF and use of chemical fertilizer along with organic source of nutrient in which 50 per cent N applied through organic sources (FYM, wheat straw, Glyricidia leaf manuring (GLM), composted cotton straw, Vermicompost and Phosphocompost) and remaining N was applied through chemical fertilizers. The experiment was framed in randomized block design with three replications. The variety JS-335 was sown in the present investigation. The general recommended dose of fertilisers 30:75:30 N, P_2O_5, K_2O kg ha^{-1} was used. The N, P and K were applied in the form of urea, single super phosphate and muriate of potash. Treatment wise basal doses (half nitrogen and full phosphorus and potassium) of fertilizers were calculated and applied at the time of sowing and remaining half dose of nitrogen was applied at flowering to soybean, thoroughly mixed in the soil. The crop residues were decomposed by PDKV decomposer. FYM, wheat straw, composted cotton stalk, vermicompost, phoshpocompost and glyricidia green leaves were applied as a source of nutrient in soil. The different organics and crop residues were applied based on NPK content. The crop residues and Glyricidia green leaves were applied in between two rows of soybean and thoroughly mixed in the soil. Simultaneously the crop residue samples were collected and analysed for nutrient composition. The plant samples of soybean seed and straw were collected at the time of harvest and analysed for various nutrient content and uptake of nutrients and plot wise soybean and straw yields were recorded.

Result and discussion

Seed Yield of Soybean

The various tillage practices significantly influenced on soybean seed and straw yield (Table1). The soybean seed yield was recorded maximum (24.64 q ha^{-1}) in conservation tillage as compared to conventional tillage (22.61 q ha^{-1}). The highest soybean seed yield in conservation tillage might be due to its cumulative effect of soil moisture which ultimately helps in improving nutrient supplying capacity of soil, use efficiency, thus it directly influences on uptake of higher nutrients in conservation tillage than conventional tillage. Similar finding was reported by Khan *et al*., (2015) and Mehdi *et al*., (2016) [8, 10].

The highest seed yield of soybean was recorded with the application of 100 % N through phoshpocompost + remaining P through chemical fertilizer (25.80 q ha^{-1}) followed by the use of 50 % N through vermicompost + remaining RD through chemical fertilizer (25.67 q ha^{-1}), 50 % N through FYM + remaining RD through chemical fertilizer (25.00 q ha^{-1}), 50% N through GLM + remaining RD through chemical fertilizer (24.55 q ha^{-1}) and 100 % RDF (23.69 q ha^{-1}). The increase in yield with IPNS treatments may be due addition of organics which enhances soil fertility and resulted in higher yield. These results are in close conformity with the findings Saini *et al.* (2005) [13] and Kundu *et al.* (2008) [9]. Due to solubilisation of native as well as applied nutrient fertilizers at higher level with crop residues produces complexing agents and nutrients are released after microbial decay of crop residue ultimately increase the grain yield. Similar findings were reported by Deshmukh *et al.* (2010) [3].

The increase in seed yield of soybean with 100 % N through phoshpocompost + remaining P through chemical fertilizer could be attributed to cumulative effect of better growth that produced more number of pods which ultimately increased the seed yield. Similar findings were reported by Singh and Kumar (2012) and Sikka *et al.* (2012) [15], The increased in seed yield due to residual effect of balanced fertilization with secondary nutrients and micronutrients was also recorded by Jadhao *et al.* (2018) [6].

Table 1: Effect of tillage and IPNS on soybean seed and straw yield under soybean-cotton rotation

Tr.	IPNS	Soybean yield (q ha^{-1})					
		Seed			Straw		
		CNS	CNV	Mean	CNS	CNV	Mean
T_1	Control	19.70	17.44	18.57	26.66	21.48	24.07
T_2	100 % RDF	24.36	23.02	23.69	31.61	29.31	30.46
T_3	50 % N through FYM + remaining RD through chemical fertilizer	26.24	23.76	25.00	34.06	29.09	31.57
T_4	50% N through WS+ remaining RD through chemical fertilizer	24.76	21.61	23.19	32.15	26.71	29.43
T_5	50% N through GLM + remaining RD through chemical fertilizer	25.76	23.44	24.55	33.03	29.88	31.45
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	22.74	22.37	22.56	32.41	26.49	29.45
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	26.80	24.55	25.67	33.30	32.41	32.85
T_8	100 % P through phoshpocompost+ remaining N through chemical fertilizer	26.89	24.71	25.80	34.55	32.53	33.54
	Mean	24.64	22.61		31.24	28.49	
		Tillage	NM	Int.	Tillage	NM	Int.
	SE (m) ±	0.53	0.45	0.64	0.37	0.74	1.05
	CD (at 5%)	1.53	1.30	1.84	1.07	2.15	3.03

Total uptake of Nutrients by soybean

Nitrogen uptake

The different tillage practices significantly influenced on uptake of nitrogen by soybean seed and straw (Table 2). The uptake of nitrogen by soybean seed was recorded maximum (142 kg ha^{-1}) in conservation tillage as compared to conventional tillage (128 kg ha^{-1}). However, the nitrogen uptake in straw of soybean was recorded significantly highest (24.64 kg ha^{-1}) in the conservation tillage over the conventional tillage (21.63 kg ha^{-1}). The total nitrogen uptake was significantly increased (166 kg ha^{-1}) with the adoption of conservation tillage over the conventional tillage (150 kg ha^{-1}). Similar findings were reported by Gandura *et al*., (2017) [4]. The highest uptake of N in conservation tillage might be due to supply of required higher quantity of nutrients for soybean growth thus it directly influences on uptake of higher nutrients in conservation tillage than conventional tillage.

The effect of different IPNS on uptake of nitrogen by seed, straw and total uptake of soybean proved most effective and significantly increased total uptake. The uptake of nitrogen by soybean seed was in the range of 93 to 162 kg ha^{-1}. The uptake of nitrogen by seed varied phenomenally within the treatments and indicated numerical increase over 100 % RDF. Significantly the maximum nitrogen uptake by seed (162 kg ha^{-1}) was recorded with application of 100 % N through phoshpocompost + remaining P through chemical fertilizer followed by the use of 50 % N through vermicompost + remaining RD through chemical fertilizer (153 kg ha^{-1}) and 50 % N through FYM + remaining RD through chemical fertilizer (147 kg ha^{-1}).

The uptake of nitrogen by straw also influenced by various nutrient management practices and it ranges from 16.06 to 28.97 kg ha^{-1}. The significantly highest N uptake by straw (28.97 kg ha^{-1}) was recorded with application of 100 % N through phoshpocompost + remaining P through chemical fertilizer followed by 50 % N through vermicompost + remaining RD through chemical fertilizer (25.70 kg ha^{-1}) and 50 % N through FYM + remaining RD through chemical fertilizer (23.54 kg ha^{-1}) recorded significantly higher nitrogen uptake by soybean straw as compared to control. The higher uptake of nitrogen under combined application of NPK with phoshpocompost, vermicompost, GLM, FYM wheat straw, and composted cotton straw might be due to their optimum availability and complementary interaction among themselves which help in higher uptake of nitrogen, higher dry matter production due to increased availability of nutrients from combined application of organic and recommended dose of fertilizer. Similar results were also obtained by Singh *et al.* (2010) [16] and Sikka *et al.* (2012) [15].

Table 2: Effect of tillage and IPNS on total uptake of nitrogen by soybean under soybean-cotton rotation

	Treatments	Total N uptake (kg ha^{-1})		
	(a)Tillage	**Seed**	**Straw**	**Uptake**
	Set I-Conservation tillage	142	24.64	166
	Set II -Conventional tillage	128	21.63	150
	SE(m)±	2.27	0.48	2.53
	CD at 5 %	6.54	1.40	7.31
	(b) Integrated plant nutrient system			
T_1	Control	93	16.06	109
T_2	100 % RDF	132	23.50	155
T_3	50 % N through FYM + remaining RD through chemical fertilizer	147	23.54	170
T_4	50% N through WS+ remaining RD through chemical fertilizer	129	20.46	150
T_5	50% N through GLM + remaining RD through chemical fertilizer	140	23.44	164
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	125	23.42	149
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	153	25.70	179
T_8	100 % P through phoshpocompost+ remaining N through chemical fertilizer	162	28.97	191
	SE(m)±	4.53	0.97	5.06
	CD at 5 %	13.08	2.80	14.61
	(c) Interaction	NS	NS	NS

Phosphorus uptake

The data pertaining to the total uptake of phosphorus as influenced by tillage and various integrated plant nutrientssystems are presented in Table 3. The total uptake of phosphorus was significantly increased with adoption of conservation tillage. However, the significantly highest phosphorus uptake by grain (9.98 kg ha^{-1}) and straw (4.51 kg ha^{-1}) was recorded with the conservation tillage practice followed by conventional tillage. Similar trend was exhibited with respect to the total uptake of phosphorus. The available P under conservation tillage helped to restore high P in soil which led to improved uptake by soybean. This can be ascribed to the immediate availability of readily assimilable form of phosphorus in fertilizer treatment by plants, while in organic treatments P availability is initially less due to immobilization which is released subsequently, thereby, ensured availability of P throughout the growing period. Similar findings were reported by Nehra (2006) [11], Tomar (2005) [18].

The total uptake of phosphorus by soybean varied from 8.23 to 16.08 kg ha^{-1}. The significantly maximum total phosphorus (16.08 kg ha^{-1}) uptake by soybean was recorded in treatment which was at par with total uptake recorded in treatments with application of 50 % N through vermicompost + remaining RD through chemical fertilizer and 50 % N through FYM + remaining RD through chemical fertilizer. The higher uptake of phosphorus under combined application of NPK with phoshpocompost, vermicompost, GLM, FYM and wheat straw were also reported by Katkar et *al*., 2002 observed that P uptake by cotton mulched with greengram, glyricidia, sunhemp, FYM was found to be higher than no fertilizers. The improvement in soil physical condition caused due to addition of organics is beneficial for enhanced uptake at INM. The organics also help in enhancing nutrients available in soil by reducing fixation of phosphorus, which improves the efficient use of added phosphorus. The results are in confirmation with the findings of Ravankar *et al.* (2005) [12] and Tetarwal *et al.* (2011) [17].

Table 3: Effect of tillage and IPNS on total uptake of phosphorus by soybean under soybean-cotton rotation

	Treatments	**Total P uptake (kg ha^{-1})**		
	(a)Tillage	**Seed**	**Straw**	**Uptake**
	Set I-Conservation tillage	9.98	4.51	14.50
	Set II -Conventional tillage	8.72	3.59	12.31
	SE(m)±	0.15	0.09	0.21
	CD at 5 %	0.42	0.27	0.60
	(b) Integrated plant nutrient system			
T_1	Control	5.90	2.33	8.23
T_2	100 % RDF	9.30	4.14	13.44
T_3	50 % N through FYM + remaining RD through chemical fertilizer	10.31	4.65	14.96
T_4	50% N through WS+ remaining RD through chemical fertilizer	8.86	3.75	12.61
T_5	50% N through GLM + remaining RD through chemical fertilizer	9.79	4.37	14.16
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	8.53	3.72	12.25
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	10.82	4.67	15.49
T_8	100 % P through phoshpocompost+ remaining N through chemical fertilizer	11.30	4.78	16.08
	SE(m)±	0.29	0.19	0.42
	CD at 5 %	0.84	0.54	1.20
	(c) Interaction	NS	NS	NS

Potassium uptake

The uptake of potassium by soybean seed and straw influenced significantly with the various tillage practices (Table 4).The total uptake of potassium was significantly increased (50.15 kg ha^{-1}) in the conservation tillage over the conventional tillage (43.90 kg ha^{-1}). Similar findings were reported by Nehra *et al.* (2006) [11].

The total uptake of potassium by soybean varied from 33.41 to 53.86 kg ha^{-1}. The significantly maximum total potassium (53.86 kg ha^{-1}) uptake by soybean was recorded with the application of 100 % N through phosphocompost + remaining P through chemical fertilizer which was at par with total uptake recorded with use of the 50 % N through vermicompost + remaining RD through chemical fertilizer and 50 % N through FYM + remaining RD through chemical fertilizer.

The increase in total potassium uptake was due to incorporation of decomposed material like FYM, phoshpocompost, vermicompost, and glyricidia green leaf mannuring along with inorganic fertilizers which can be attributed to the greater capacity of organic colloids to hold K ions on the exchange sites which enhanced the availability of potassium is responsible for more uptakes. Similar results have also been quoted by Sharma and Mishra (1997) [14].

Table 4: Effect of tillage and IPNS on total uptake of potassium by soybean under soybean-cotton rotation

	Treatments	**Total K uptake (kg ha^{-1})**		
	(a)Tillage	**Seed**	**Straw**	**Uptake**
	Set I-Conservation tillage	19.50	33.59	50.15
	Set II -Conventional tillage	17.32	28.31	43.90
	SE(m)±	0.24	0.47	0.53
	CD at 5 %	0.68	1.37	1.52
	(b) Integrated plant nutrient system			
T_1	Control	13.06	23.24	33.41
T_2	100 % RDF	18.43	35.31	47.55
T_3	50 % N through FYM + remaining RD through chemical fertilizer	20.11	33.26	51.09
T_4	50% N through WS+ remaining RD through chemical fertilizer	17.86	28.81	44.99
T_5	50% N through GLM + remaining RD through chemical fertilizer	19.07	31.55	49.10
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	17.28	29.15	45.19

T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	20.34	31.04	51.04
T_8	100 % P through phoshpocompost+ remaining N through chemical fertilizer	21.10	35.22	53.86
	SE(m)±	0.47	0.95	1.05
	CD at 5 %	1.36	2.74	3.04
	(c) Interaction	NS	NS	NS

Sulphur uptake

The data pertaining to sulphur uptake influenced by various treatments are presented in (Table 5). The uptake of sulphur by soybean seed, straw and total uptake of soybean influenced significantly with different tillage. The total uptake of sulphur was recorded significantly highest (19.87 kg ha^{-1}) in the conservation tillage over the conventional tillage (16.23 kg ha^{-1}). Similar findings were reported by He *et al*., (2009) [5].

The total uptake of sulphur by soybean varied from 13.89 to 21.80 kg ha^{-1}. The significantly maximum total sulphur uptake by soybean was recorded in application of 100 % N through phoshpocompost + remaining P through chemical fertilizer (21.80 kg ha^{-1}). Application of organics which enhances the release of ions in the soil and it ultimately improves the grain yield and concentration of sulphur in plants which results into improving the total uptake of sulphur reported by Bairathi *et al.* (1974) [2]. The significantly highest uptake in respect of seed, straw and total uptake of sulphur by soybean was associated with organic and inorganic fertilizers might be attributed to better supply of nutrients throughout crop growing period.

Table 5: Effect of tillage and IPNS on total uptake of sulphur by soybean under soybean-cotton rotation

	Treatments	**Total S uptake (kg ha^{-1})**		
	(a)Tillage	**Seed**	**Straw**	**Uptake**
	Set I-Conservation tillage	11.59	8.28	19.87
	Set II -Conventional tillage	9.60	6.66	16.23
	SE(m)±	0.27	0.17	0.33
	CD at 5 %	0.77	0.49	0.96
	(b) Integrated plant nutrient system			
T_1	Control	8.22	5.67	13.89
T_2	100 % RDF	9.89	7.16	17.05
T_3	50 % N through FYM + remaining RD through chemical fertilizer	11.45	8.56	20.01
T_4	50% N through WS+ remaining RD through chemical fertilizer	9.59	6.76	16.35
T_5	50% N through GLM + remaining RD through chemical fertilizer	11.33	7.31	18.64
T_6	50 % N through composted cotton stalk+ remaining RD through chemical fertilizer	8.98	6.44	15.42
T_7	50 % N through vermicompost+ remaining RD through chemical fertilizer	12.38	8.68	21.06
T_8	100 % P through phoshpocompost+ remaining N through chemical fertilizer	12.91	8.89	21.80
	SE(m)±	0.53	0.34	0.66
	CD at 5 %	1.54	0.99	1.92
	(c) Interaction	NS	NS	NS

Conclusion

Among the tillage practices, significantly higher soybean seed yield and uptake of nutrients were recorded in conservation tillage as compared to conventional tillage under soybean-cotton rotation. The various integrated plant nutrient supply treatments influenced significantly highest soybean seed and straw yield of soybean with the application of phosphocompost in conjunction with chemical fertilizers. The significantly highest uptake of nutrients were recorded with the application of phosphocompost in conjunction with chemical fertilizers followed by FYM, GLM and vermicompost under conservation tillage.

References

1. Anonymous, 2016. www.cci.co.in.
2. Bairathi RC, Gupta MM, Seth SP. Effect of different legume crop residues on soil properties, yield and nutrient uptake by succeeding wheat crop. J Indian Soc. Soil sci. 1974; 22(4):304-307.
3. Deshmukh PW, Bhoyar PN, Magare PN, Shendurse SM. Prouctivity and Economics of soybean-chickpea crop sequence under crop residue management PKV Res. J 2010; 34(1):49-52.
4. Gandura OA, Gamal Eld-Deen Mohamed, Nouri Mosa Moumen. Influence of Tillage Practices on Soil Physical Properties and Growth and Yield of Maize in Jabal al Akhdar, Libya. Open Journal of Soil Science. 2017; 7:118-132.
5. He J, Kuhn NJ, Zhang XM, Zhang XR, Li HW. Effect of 10 years of conservation tillage on soil properties and productivity in the farming-pastoral ectone of Inner Mongolia, china. Soil use and management. 2009; 25:201-209.
6. Jadhao SD, Dipali Arjun, Mali DV, Muneshwar Singh, Kharche VK, Wanjari RH *et al*. Effect of long-term manuring and fertilization on depth wise distribution of potassium fractions under sorghum-wheat cropping sequence in vertisol, Journal of the Indian Society of Soil Science. 2018; 66(2):172-181.
7. Katkar RN, Turkhede AB, Solanke VM, Wankhade ST. Response of cotton to integrated management of various types of organic manures and fertilizers. Crop Res. 2002; 23:194-197.
8. Khan N, Usmanb K, Yazdanc F, Dinc SU, Gull S, Khan S. Impact of tillage and intra-row spacing on cotton yield and quality in wheat–cotton system. Archives of Agron and Soil Sci. 2015; 61(5):581-597.
9. Kundu S, Bhattacharya R, Prakash V, Gupta HS. Carbon sequestration potential of Inceptisols under long term soybean–wheat rotation in Sub-temperate rainfed agro-ecosystem of North-Waste Himalayas. J Indian Soc. Soil Sci. 2008; 56(4):423-429.
10. Mehdi Abdeshari, Esfahani, Hamid RJ, Rezagolparvar A. "Effect of tillage methods on growth period of spring safflower (*Carthamus tinctorius* L.) grown in Isfahan province of Iran". Res. on Crops. 2016; 17(3):493-495

11. Nehra PL. Effect of tillage and residue management practices on growth and yield of cotton wheat cropping system of north western Rajasthan. J Cotton Res. Dev. 2006; 20(1):71-76.
12. Ravankar HN, Gajbhiye NN, Sarap PA. Effect of organic manures and inorganic fertilizers on yield and availability of nutrients under sorghumwheat sequence. Indian J Agric. Res. 2005; 39(2):142-145.
13. Saini VK, Bhandari SC, Sharma SK, Tarafdar JC. Assessment of microbial biomass under integrated nutrient management in soybean-winter maize cropping sequence. J Indian Soc. Soil Sci. 2005; 53(3):346-351.
14. Sharma RA, Misra OR. Crop residues, FYM and fertilizer use in relation to growth, yield and nutrient uptake by soybean. Crop Res. 1997; 13(1):51-57.
15. Sikka R, Singh D, Deol JS. Productivity and nutrient uptake by soybean as influenced by integrated nutrient and some other agronomic management practices. Legumes Res. 2012; 36(6):545-551.
16. Singh H, Singh G, Deol JS. Nodulation and uptake of nitrogen and potassium by grain and straw of soybean (*Glycine max* (L.) Merrill) as affected by potassium and nitrogen. Legumes Research. 2010; 33(4):249-255.
17. Tetarwal JP, Baldev Ram, Meena DS. Effect of integrated nutrient management on productivity, profitability, nutrient uptake and soil fertility in rainfed maize (*Zea mays*). Indian J of Agron. 2011; 56(4):373-376.
18. Tomar RS. Productivity of upland cotton (*Gossypium hirsutum*) genotypes under different levels of fertility and spacing. Indian Journal of Agronomy. 2005; 45(4):776-777.