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Influenced of cotton based pulse intercropping on nutrient availability and yield on Vertisol

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Abstract
The field experiment on cotton based pulse intercropping on vertisol was conducted during to study the nutrient availability and crop yield. Treatments comprised of sole cropping of cotton, green gram and black gram, intercropping of cotton with green gram and black gram with 1:1 and 1:2 row ratios. The available nutrients in soil were estimated at sowing, at harvest of intercrops and cotton while, micronutrients (Fe, Mn, Zn and Cu) were estimated after completion of all cropping systems. Organic carbon and available N, P and K contents were found to be maximum at harvest of intercrop stage and then decreased at harvest of cotton, although, the values are higher than at sowing stage. Significantly maximum organic C (5.89 g kg^{-1}) and available N (225.18 kg ha^{-1}) were noted under sole green gram followed by sole black gram at harvest. Intercropping recorded the higher contents over sole cotton. At harvest of cotton, the higher organic C (5.49 g kg^{-1}) and available N (192.31 kg ha^{-1}) were recorded in cotton + green gram (1:2) row proportion followed by cotton + black gram (1:2). However, at the end of cropping systems, the maximum available P (22.53 kg ha^{-1}) and available K (384.36 kg ha^{-1}) were noticed under cotton + green gram (1:1) followed by cotton + black gram (1:1) intercropping as compared to sole cotton. Micronutrients were estimated after completion of each cropping system and significantly the highest contents of Fe, Mn, Zn and Cu (7.96, 20.28, 4.06 and 4.80 mg kg^{-1}, respectively) were observed under cotton + green gram (1:2) and the lowest were noted under sole cotton cropping. The highest seed cotton yield (2496.56 kg ha^{-1}) and stalk yield (7340.58 kg ha^{-1}) was produced under sole cotton. Among cotton based pulse intercropping, the higher cotton yield was noticed with 1:1 row proportion as compared to 1:2. However, the maximum seed and straw yield of green gram (1063.25 and 1493.05 kg ha^{-1}) and black gram (934.70 and 1274.21 kg ha^{-1}) were produced under sole cropping. In intercropping with cotton having 1:2 row proportion produced higher yields of green gram and black gram over 1:1 row proportion.

Keywords: nutrient availability, yield, intercropping, vertisol

Introduction
Intercropping is the practice of growing two or more crops together with a specific row proportion in a single field. The main purpose of intercropping is to produce a greater yield on a given piece of land by making the use of available recourses (Marer, *et al.* 2007) [4]. Intercropping being a unique property of tropical and sub-tropical areas is becoming popular day by day among small farmers. Other benefits of intercropping are related to the better soil cover, which reduce soil erosion and nutrients leaching (Fan, *et al.* 2006) [1]. On-farm biodiversity, if correctly assembled in time, can lead to agro ecosystems capable of maintaining their own soil fertility. Now-a-days, the practice of intercropping of green gram and black gram in cotton is very popular with farmers and many dry land farmers are adopting it. The integrated plant nutrient supply, envisaging conjunctive use of fertilizers and other nutrient source of organic origin under such intercropping is an ideal approach to improve the soil quality. A major agriculture research priority is to sustain soil productivity and to develop better methods to monitor changes in soil physical, chemical and biological properties as influenced by the management practices. The present investigation was therefore, conducted during *kharif* season of 2015 with an objective to quantify the availability of nutrients and yield obtained under cotton- pulse intercropping.

Material and Methods
Field experiment was conducted at the farm of Agronomy, College of Agriculture, Dhule, during *kharif* 2015. The experiment was laid out with seven treatments replicated thrice in Randomized Block Design.

Treatments comprised of sole cotton, green gram and black gram and intercropping of cotton with green gram and black gram with 1:1 and 1:2 row ratios. Variety used for cotton (Bt hybrid): Mallika, green gram: Vaibhav and black gram: TAU-1 with spacing 90 x 90 cm^2 for cotton and 30 x 10 cm^2 for black gram and green gram. Fertilizer dose applied for cotton was 125:65:65 NPK kg ha^{-1} and for black gram and green gram was 20:40:00 NPK kg ha^{-1} while, FYM was applied @ 10 t ha^{-1}. The available nutrients were estimated at sowing, at harvest of intercrops and cotton. Soil organic carbon was estimated by using wet oxidation method (Nelson and Sommer, 1982) [5]. The available N was estimated by alkaline permanganate (Subbiah and Asija, 1956) [9], available P by colorimetric 0.5 M $NaHCO_3$ (Watanabe and Olsen, 1965) [13] and available k by neutral N NH_4OAc flame photometry (Jackson, 1973) [2]. The DTPA extractable micronutrients (Fe, Mn, Zn, Cu) were estimated by atomic absorption spectrophotometer (Lindsay and Norvell, 1978) [3].

Results and Discussion

Soil organic C and available NPK

Results pertaining to the organic carbon content in soil affected by cropping systems was presented in Table 1. It is quite evident from the data that, slight differences were occurred in organic carbon content in soil due to cropping systems. However, increased content of organic C were recorded with increased cropping intensity. At sowing stage, the organic C content varied from 5.34 to 5.38 g kg^{-1}. Slight and significant increase in organic C content in soil was observed after harvest of intercrop and the maximum content (5.89 g kg^{-1}) was noted with sole green gram followed by sole black gram (5.76 g kg^{-1}). Cotton based pulse intercropping significantly increase the organic Cover sole cotton. However, the organic C content found higher under cotton + green gram (1:2) and cotton + black gram (1:2) i.e. 5.73 and 5.69 g kg^{-1}, respectively as compared to their 1:1 row proportion. Further, it may be conceived that, at harvest of cotton, the organic C content was declined although, the values were slightly higher than at sowing stage. The magnitude of increase in organic C content at the end of cropping systems was in the order of cotton + green gram (1:2), cotton + black gram (1:2), cotton + green gram (1:1) and cotton + black gram (1:1) i.e. 2.04, 1.49, 1.30 and 0.74 per cent, respectively over sole cotton. The soil and crop management practices such as cultivation, crop rotation and residue management can enhance the amount of organic C in the soil. The best combination for organic matter accumulation was legumes intercropped with other crops. Verma *et al.* (2014) [11] observed that the extent of increase in soil organic C over initial value was 24.0, 17.4, 28.2 and 57.5 per cent when geranium was intercropped with wheat, barley, oat and berseem, respectively. The increase in the organic C is ascribed to the accumulation of root residues and shedding of leaves by the leguminous crops was opined by Sharma *et al*. (2015) [6].

At sowing stage of crops, the available nitrogen ranged between 162.27 to 164.47 kg ha^{-1}. It could be seen from the results that, the available N content in soil further increased at harvest of intercrop and then gradually declined at harvest of cotton crop. After harvest of intercrop, the significantly maximum available N content (225.18 kg ha^{-1}) was recorded with sole green gram followed by sole black gram (220.19 kg ha^{-1}) and both these cropping found at par with each other. Among the intercropping systems significantly the highest available N content (216.14 kg ha^{-1}) was noted under cotton + green (1:2) and this was at par with cotton + black gram (1:2) row proportion (212.81 kg ha^{-1}). Intercropping of cotton with green gram and black gram having 1:1 row proportion also found to be increased the available N content. At harvest of cotton or at the end of cropping systems, the available N content was higher as compared to at sowing stage. Appraisal of the results paint out that cotton + green gram (1:2) intercropping recorded the highest available N content (192.31 kg ha^{-1}) followed by cotton + black gram (1:2) (185.77 kg ha^{-1}). It is seen that cotton based pulse intercropping increases the available N content when compared with sole cotton cropping. The increase in available N content at the end of intercropping was in the order of cotton + green gram (1:2), cotton + black gram (1:2), cotton + green gram (1:1) and cotton + black gram (1:1) i.e. 12.84, 9.00, 6.48 and 4.86 per cent, respectively over sole cotton. The present findings are in accordance with those of Yusuf *et al.* (2009) [14], they pointed out that the N was significantly affected by cropping systems with an increase of 28 per cent in soybean rotations compared with continuous maize. It could also be attributed to the greater multiplication of soil microbes which could convert organically bound N to mineralized from (Singh *et al*. 2013) [7].

Significant Increased in phosphorus content (Table 1) was observed at harvest of intercrop. However, at this stage, sample taken from the sole cotton showed the highest available P content (29.48 kg ha^{-1}). Followed by this, the maximum available P content (28.50 kg ha^{-1}) was recorded under cotton + green gram (1:1) and this cropping was on par with sole cotton. Cotton + green gram (1:2) also recorded higher available P content (23.15 kg ha^{-1}) and this was on par with cotton + black gram (1:2) (22.17 kg ha^{-1}) and sole green gram (22.75 kg ha^{-1}) cropping. At harvest of cotton, the higher content of phosphorus (22.53 kg ha^{-1}) was noted with cotton + green gram (1:1) followed by cotton + black gram (1:1) cropping (20.28 kg ha^{-1}). Close examination of the results indicated that available phosphorus content in soil was found to be increased after completion of all cropping systems over initial content. It also indicated that intercropping increased the P content over sole cropping. The increase in phosphorus content was in the order of cotton + green gram (1:1), cotton + black gram (1:1), cotton + green gram (1:2) and cotton + black gram (1:2) i.e. 32.53, 19.29, 11.88 and 8.53 per cent respectively, over sole cotton. However, Song *et al*. (2015) [8] proved that phosphorus availability was increased with maize + peanut intercropping via legumes root release of organic acids, also closely related to the modified microbial communities and the enzyme activities.

At sowing stage, the potassium content in soil was significantly varied from 352.99 to 354.66 kg ha^{-1} which was further, significantly increased at harvest of intercrop stage. At this stage, the highest availability of potassium (410.67 kg ha^{-1}) was recorded in the soil sample taken from the sole cotton. However, amongs the intercropping, the maximum K content (405.38 kg ha^{-1}) was recorded in cotton + green gram (1:1) which was on par with cotton + black gram (1:1) cropping (400.23 kg ha^{-1}). Cotton + green gram and black gram 1:2 row proportion also significantly increases the K content as compared to sole pulse crops. Although, at the harvest of cotton, the maximum K content (384.36 kg ha^{-1}) was noted in cotton + green gram (1:1) followed by cotton + black gram (1:1) intercropping (380.64 kg ha^{-1}). The magnitude of increase in K content at the end of cropping was in the order of cotton + green gram (1:1), cotton + black gram (1:1), cotton + green gram (1:2) and cotton + black gram (1:2) i.e. 3.79, 2.78, 1.93 and 1.27 per cent, respectively over sole cotton.

The foregone results will certainlly throw light in understanding the contribution of pulse legumes to the pool of soil fertility and sustainable crop production in vertisols. Sharma *et al*. (2015) [6] reported that the inclusion of leguminous crops increased the soil organic C, available N, P and K content of the soil due to the addition of nutrients by biological N fixation of these crops. Nutritional status including available N, P and K in the soil of sole cucumber could be improved by intercropping with green garlic, and the observed increases in available N, P and K in the soil could be attributed to higher soil enzyme activities in the green garlic and cucumber intercropping system (Song *et al*., 2015) [8].

Available micronutrients

Soil available micronutrients content after harvest of each cropping system are presented in Table 2. The highest content of Fe, Mn, Zn and Cu (7.96, 20.28, 4.06 and 4.80 mg kg^{-1}, respectively) were recorded in cotton + green gram (1:2) followed by cotton + black gram (1:2) intercropping (7.52, 20.22, 3.17 and 4.74 mg kg^{-1}, respectively). Both intercropping was found at par for Fe, Mn, and Cu content. Higher Fe content (6.74 mg kg^{-1}) was also noted in sole green gram which was at par with sole black gram (6.67 mg kg^{-1}), cotton + green gram (1:1) (6.30 mg kg^{-1}) and cotton + black gram (1:1) (5.87 mg kg^{-1}) cropping. Sole green gram cropping also recorded higher Mn, Zn and Cu contents (17.29, 2.62 and 3.79 mg kg^{-1}, respectively) which were at par with sole black gram. When compared with sole cotton, it is clearly evident that, available micronutrients content were significantly improved by sole pulse cropping and cotton + pulse intercropping. The availability of micronutrients viz., Fe, Mn, Zn and Cu with different cotton based pulse intercropping systems were increased by 3.35 to 40.14, 19.24 to 63.94, 43.75 to 217.18 and 43.85 to 269.23 per cent, respectively over sole cotton. Sharma *et al*. (2015) [6] reported that the cultivation of legumes is viewed more as a soil fertility improver than as independent crops grown for their grain output. Further, they noticed that the availability of Fe, Cu, Zn and Mn were increased by 15.6, 23.2, 28.7 and 16.5 per cent, respectively with pomogranate – urd – pea intercropping over pomogranate monocropping. Results of this study lend support to earlier fundings that the inclusion of pulse legumes in cropping systems favourably increased the nutrient availability.

Crop yield

Results on crop yield (Table 3) indicates that sole cotton cropping produced the maximum seed cotton yield (2496.56 kg ha^{-1}) and stalk yield (7340.58 kg ha^{-1}) as compared to other cropping. Among the cotton based pulse intercropping, the higher cotton yield was noted under cotton + green gram (1:1) followed by cotton + black gram (1:1) as compared to 1:2 row proportion. While, the highest seed and straw yield of green gram (1063.25 and 1493.05 kg ha^{-1}, respectively) and black gram (934.70 and 1274.21 kg ha^{-1}, respectively) was recorded with their sole cropping. Among the intercropping, the higher yield of green gram and black gram were recorded under (1:2) row proportion followed by 1:1 row ratio with cotton. The results of the present investigation are in congruence with those of Vekariya *et al*. (2015) [10], they reported that sole cotton produced comparatively higher seed cotton yield than intercropping system. Wankhade *et al.* (2000) [12] found that straw yield was significantly higher in cotton + green gram than cotton + black gram intercropping. Further, may be récapitulâted that, eventhough, higher yield produced under monocropping, but intercropping specially with legumes increased the land productivity.

Table 1: Soil organic carbon, available N, P and K contents under cotton based pulse intercropping

Treatment	Organic C (g kg^{-1})			Available N (kg ha^{-1})			Available P (kg ha^{-1})			Available K (kg ha^{-1})		
	At sowing	At harvest of intercrop	At harvest of cotton	At sowing	At harvest of intercrop	At harvest of cotton	At sowing	At harvest of intercrop	At harvest of cotton	At sowing	At harvest of intercrop	At harvest of cotton
T_1 Sole cotton	5.34	5.53	5.38	162.27	190.30	170.43	15.29	29.48	17.00	354.35	410.67	370.34
T_2 Sole green gram	5.37	5.89	-	164.47	225.18	-	14.93	22.75	-	353.49	378.43	-
T_3 Sole black gram	5.38	5.76	-	164.27	220.19	-	14.94	21.51	-	353.68	375.27	-
T_4 Cotton + green gram (1:1)	5.34	5.60	5.45	162.53	205.19	181.48	15.38	28.50	22.53	354.62	405.38	384.36
T_5 Cotton + green gram (1:2)	5.36	5.73	5.49	163.83	216.14	192.31	15.10	23.15	19.02	352.99	398.72	377.50
T_6 Cotton + black gram (1:1)	5.36	5.56	5.42	162.71	198.92	178.71	14.72	25.26	20.28	354.30	400.23	380.64
T_7 Cotton + black gram (1:2)	5.37	5.69	5.46	163.66	212.81	185.77	14.80	22.17	18.45	354.66	381.18	375.03
SE (m)±	0.01	0.01	-	0.44	2.42	-	0.12	0.83	-	0.30	2.45	-
CD at 5%	0.03	0.03	-	1.35	7.46	-	0.35	2.58	-	0.91	7.57	-

Table 2: Available micronutrients influenced by cropping systems

Treatment	*Available micronutrients (mg kg^{-1})			
	Fe	Mn	Zn	Cu
T_1 Sole cotton	5.68	12.37	1.28	1.30
T_2 Sole green gram	6.74	17.29	2.62	3.79
T_3 Sole black gram	6.67	17.28	2.83	3.31
T_4 Cotton + green gram (1:1)	6.30	15.55	1.86	2.94
T_5 Cotton + green gram (1:2)	7.96	20.28	4.06	4.80
T_6 Cotton + black gram (1:1)	5.87	14.75	1.84	1.87
T_7 Cotton + black gram (1:2)	7.52	20.22	3.17	4.74
SE (m)±	0.33	0.54	0.20	0.18
CD at 5%	1.02	1.67	0.62	0.54

* Samples analyzed at the end of each cropping systems

Table 3: Cotton and intercrop yield influenced by cotton based pulse intercropping

Treatments	Cotton yield		Green gram/black gram yield	
	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 Sole Cotton	2496.56	7340.58	-	-
T_2 Sole Green gram	-	-	1063.25	1493.05
T_3 Sole Black gram	-	-	934.70	1274.21
T_4 Cotton + Green gram(1:1)	2277.08	6980.05	390.52	545.68
T_5 Cotton + Green gram(1:2)	2037.03	6786.72	640.27	895.17
T_6 Cotton + Black gram(1:1)	2160.48	6848.67	304.15	424.85
T_7 Cotton + Black gram(1:2)	2002.73	6598.20	472.73	658.09

Conclusions

Soil fertility in terms of organic carbon, available N, P, K and micronutrient (Fe, Mn, Zn and Cu) contents found improved with these cotton based pulse intercropping. Higher yield of cotton, green gram and black gram were produced under monocropping, however, cotton based pulse legume intercropping increased the land productivity. The capacity of a soil to function within ecosystem boundaries is to sustain biological productivity and maintain soil health by several factors. The cropping system and crops can play an important role in soil chemical and biological properties. The overall interpretation of these diverse sets of data is that the quality of soil enhanced with the incorporation of pulse legumes in cotton especially in 1:2 row proportion over sole cropping, ultimately increased the crop production per unit area. However, there is a need of long term monitoring to quantify cumulative effects of various cropping intervention eventually to make recommendations for wider dissemination and for each cropping system in order to enhance soil fertility and sustain food production.

References

1. Fan F, Zhang F, Song Y, Sun J, Bao X, Guo T, *et al*. Nitrogen fixation of faba bean interacting with a non-legume in two contrasting intercropping systems. Plant and Soil. 2006; 283:275-286.
2. Jackson ML. Soil Chemical Analysis. Prentice Hall Pub, Pvt. Ltd. New Delhi, 1973.
3. Lindsay WL, Norvell WA. Development of DTPA soil test of Zn, Fe, Mn and Cu. Soil Sci. Soc. Am. J. 1978; 42:421-428.
4. Marer SB, Lingaraju BS, Shashidhara GB. Productivity and economics of maize and pigeon pea intercropping under rainfed condition in northern transitional zone of Karnataka. Karnataka J Agric. Sci. 2007; 20(1):1-3.
5. Nelson DW, Sommer LE. Total carbon, organic carbon and organic matter. In: Methods of Soil Analysis, Part-II, Page, A.L. (Ed.), American Soc. Agron. Inc. Soil Sci. Am. Inc. Madison, Wisconsin, USA, 1982, 539-579.
6. Sharma SD, Kumar P, Bhardwaj SK, Chandel A. Agronomic performance, nutrient cycling and microbial biomass in soil as affected by pomegranate based multiple crop sequencing. Scientia Horticulture. 2015; 197:504-515.
7. Singh RJ, Ahlawat IPS, Singh S. Effects of transgenic Bt cotton on soil fertility and biology under field conditions in subtropical inceptisol. Environ Monit Assess. 2013; 185:485-495.
8. Song LQ, Kun WL, Jun C, Khan MA, Main LX, Xiong LW. Biochemical and microbial properties of rhizospheres under maize – peanut intercropping. Journal of Integrative Agriculture. 2015; 15(1):101-110.
9. Subbiah B, Asija G. A rapid procedure for determination of available nitrogen in soil. Curr. Sci. 1956; 25:256-260.
10. Vekariya PD, Khokhani MG, Gajera MS, Akbari KN. Productivity and economics of cotton (*Gossypium hirsutum* L.) based intercropping system under rainfed conditions of north Saurashtra agro climatic zone of Gujarat, J Cotton Res. Dev. 2015; 29(2):264-267.
11. Verma RK, Yadav A, Rahman LU, Kalra A, Patra DD. Influence the status of soil chemical and biological properties by intercropping. Int. J Recycling Organic Waste Agriculture. 2014; 3(1):1-7.
12. Wankhade ST, Turkhede AB, Solanike VM, Maivi SS, Katkar RN. Effect of intercropping on yield of cotton. Crop Res. 2000; 19(3):409-413.
13. Watanabe FS, Olsen SR. Test of ascorbic acid methods for phosphorus in water and sodium bicarbonate extract of soil. Proc. Soil Sci. America. 1965; 21:677-678.
14. Yusuf AA, Abaidoo RC, Iwuafor ENO, Olufajo OO, Sanginga N. Rotation effects of grain legumes and fallow on maize yield, microbial biomass and chemical properties of an Alfisol in the Nigerian savanna. Agriculture, Ecosystems and Environment. 2009; 129:325-331.