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Impact of Intercropping System, Nutrient Management and Tree Leaf Extract Sprays on Post Harvest Soil Nutrient Status of Irrigated Cotton

C. Harisudan*, S. Senthivel and K. Arulmozhiselvan
Directorate of Extension Education, Tamil Nadu Agricultural University, Coimbatore -641 003

Response of intercropping system, inorganic fertilizers, biofertilizers, intercrop residues and leaf extract spray on post harvest soil nutrient status of irrigated cotton were evaluated by conducting field experiments at Agricultural College and Research Institute, Madurai during summer 2006 and winter 2006-2007. The experiments were laid out in a split plot design with three replications. Intercropping system *viz*., C_1 – Cotton sole, C_2 – Cotton + Blackgram, C_3 – Cotton + Greengram and C_4 – Cotton + Cluster bean were allotted to mainplot. The intercrops residues were incorporated at 65 DAS. The subplot consisted of six nutrient management and botanicals spray treatments *viz*., N_1 – 100 % RDF (Recommended Dose of fertilizer – 80:40:40 kg NPK/ha), N_2 – 75 % RDF, N_3 - 75 % RDF + biofertilizers, N_4 -75 % RDF + 5 % Morinda leaf extract spray at 60 and 80 DAS, N_5 - 75 % RDF + 5 % Vilvam leaf extract spray at 60 and 80 DAS, N_6 - 75 % RDF + 5 % Annona leaf extract spray at 60 and 80 DAS. The biofertilizers include *azospirillum* + Phosphobacteria + Silicate solubilizing bacteria each at 2.6 kg/ha. The results reveal that cotton + blackgram intercropping with application of 75 % RDF + combined application of *azospirillum*, phosphobacteria and silica solubilizing bacteria recorded higher soil available nitrogen and phosphorus content.

Key words: Intercropping, nutrient management, biofertilizers, leaf extract spray

Cotton known as "white gold" is an important commercial crop in India, sharing around 85 per cent of raw material supply in textile Industry. The present thrust should be to increase the productivity to meet the demand of textile industries. Increased and efficient use of nutrients is one of the options for increasing productivity. Chemical fertilizers increase cotton productivity, but at the same time it leads to deterioration of soil health. Our concern for sustainable agriculture with emphasis on eco-friendly inputs had renewed interest on searching new options for use of nitrogen fixing leguminous intercrop residues and biofertilizers as nutrient source and botanicals as growth regulators.

Inclusion of legumes as intercrop in cotton play a multi beneficiary role by providing grains and simultaneously it improves nitrogen status of soil through fixation of atmospheric nitrogen. The use of biofertilizers enriches the soil organic matter, soil enzymes, soil microbial population besides maintaining the long term fertility and ecological sustainability for increasing crop productivity. Research work is meagre in the integrated package involving intercropping, bioregulant and INM concept encompassing leguminous intercrop residue recycling, biofertilizers and inorganic fertilizers on soil health sustainability under high input requiring cotton based intercropping system. Taking these aspects into consideration, field investigations were carried out with the objective to study the response of intercropping system, inorganic fertilizers, biofertilizers, intercrop residues and leaf extract spray on post harvest soil nutrient status of irrigated cotton.

*Corresponding author email: agron_hari@rediffmail.com

Materials and Methods

Field investigation was carried out at Agricultural College and Research Institute, Madurai during summer 2006 and winter 2006-2007 to elicit the information on the effect of intercropping system, inorganic fertilizers, biofertilizers and leaf extract spray on post harvest soil nutrient status of irrigated cotton. The soil of the experimental site was vylogam series, a member of fine loamy kaolinite, iso-megathermic family of Typic Rhodustalfs with a pH of 8.1 and 6.9, EC of 0.31 dSm^{-1} and 0.42 dSm^{-1}, available N of 232.6 kg ha^{-1} and 155.0 kg ha^{-1}, available P of 11.4 kg ha^{-1} and 10.6 kg ha^{-1} and available K of 180 kg ha^{-1} and 290 kg ha^{-1} in field number D_5 and C_{42}, respectively. Cotton variety SVPR 2 with duration of 150 -165 days was chosen for this study. Blackgram (*Vigna mungo*) variety VBN (Bg) 4, greengram (*Vigna radiata*) cultivar Pusa bold and cluster bean (*Cyamopsis tetragonaloba* (L) Taub.) cultivar Pusa Navbahar were chosen as intercrops. The experiments were laid out in a split plot design with three replications. Intercropping system *viz*.,

C_1 – Cotton sole, C_2 – Cotton + Blackgram, C_3 – Cotton + Greengram and C_4 – Cotton + Cluster bean were allotted to mainplot. The intercrops after few harvests were incorporated as green manure at 65 DAS. The subplot consisted of six nutrient management and botanicals spray treatments *viz*., N_1-100 % RDF (Recommended Dose of fertilizer – 80:40:40 kg N,P,K/ha), N_2 - 75 % RDF, N_3 - 75 % RDF + biofertilizers, N_4 -75 % RDF + 5 % Morinda leaf extract spray at 60 and 80 DAS, N_5 - 75 % RDF + 5 % Vilvam leaf extract spray at 60 and 80 DAS, N_6 - 75 % RDF + 5 % Annona leaf extract spray at 60 and 80 DAS. The biofertilizers include *azospirillum* + Phospho bacteria + Silicate solubilizing bacteria each at 2.6 kg/ha. Composite pre-sowing and individual plot wise post harvest samples were collected using screw auger at a depth of 15 cm. The soil samples were air dried and sieved through 2 mm sieve before analysis for nutrients. The data on post harvest soil nutrient status was further statistically analysed and tabulated.

Result and Discussion

Post harvest soil nutrient status

The post harvest soil analysis showed that the exhaustive nature of cotton crop just compensated by the restorative nature of leguminous intercrop. There was a significant improvement in the post harvest soil fertility status when compared to initial soil fertility level.

Post harvest soil available N

The data on post harvest soil available nitrogen status after the harvest of cotton showed statistical significance due to system of cropping, nutrient management and leaf extracts spray. The increased availability (Table 1) of N (237.9 and163.2 kg ha^{-1}) was observed under cotton + blackgram (C_2) intercropping system during both seasons. However it was on par with cotton + greengram intercropping system (C_3). Incorporated blackgram residue has favoured the rate of mineralization and steady release of nutrients to the soil pool. This probably resulted in lower demand of soil nitrogen by intercrop and there is no loss of N from the soil. The legume effect and release of nitrogen to be available to soil nutrient pool was also reported by Muruganandam (1984) and Balasubramanian (1987).

Table 1. Effect of intercropping system, nutrient management and tree leaf extract sprays on post harvest soil available N (kg ha^{-1}) of cotton

Treatment	Summer 2006					Treatment	Winter 2006-07				
	C_1	C_2	C_3	C_4	Mean		C_1	C_2	C_3	C_4	Mean
N_1	225.9	241.9	240.4	236.2	236.1	N_1	154.4	166.7	165.7	163.2	162.5
N_2	223.1	231.5	230.7	230.8	229.0	N_2	152.1	160.7	158.2	156.1	156.8
N_3	227.9	245.1	244.1	238.9	239.0	N_3	154.8	172.3	169.1	164.2	165.1
N_4	223.1	236.9	233.9	231.9	231.5	N_4	152.8	160.2	158.1	156.0	156.8
N_5	222.9	236.0	233.2	231.1	230.8	N_5	152.9	160.0	157.8	155.8	156.6
N_6	222.8	235.9	233.9	230.9	230.9	N_6	152.7	159.2	157.7	155.9	156.4
Mean	224.3	237.9	236.0	233.3		Mean	153.3	163.2	161.1	158.5	
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	1.39	2.04	3.97	4.07		S.Ed	0.95	1.39	2.72	2.79	
CD(P=0.05)	3.39	4.11	NS	NS		CD(P=0.05)	2.32	2.82	NS	NS	

The nitrogen availability was low under pure stand of cotton (C_1). The pure stand of cotton would have depleted the available N in the soil without further addition of N as under intercropping system by intercrops (Sivakumar, 2003).

Nutrient management and botanicals spray treatment also exerted difference in post harvest soil N status. Post harvest availability of N in the soil was high (239.0 and 165.1 kg ha^{-1}) during both summer 2006 and winter 2006-07 with application of 75 % RDF + biofertilizers (*azospirillum*, phosphobacteria and silica solubilizing bacteria). Increase in available N in soil might be due to the direct addition of N through inorganic sources and greater multiplication due to applied and soil reserve microbes, which could convert organically bound N to inorganic form (Anup Das *et al*., 2006). The increased population of microorganism might have also influenced steady and higher supply of nitrogen by mineralization and the release of organic acids by *azospirillum*, which enables the solubilization of nutrients is evident from the status of soil available N.

Combination of intercropping, nutrient management and leaf extracts spray did not show any interaction effect which is evidenced by the statistical data which is non significant.

Post harvest soil available P

The data on post harvest soil available P status (Table 2) was significantly enhanced by legumes particularly blackgram intercropping (18.65 and 16.58 kg ha^{-1}) during both seasons. Increase in post harvest soil available phosphorus might be due to decomposition of legume residues and increase in P solubilization. The organic materials form a cover on sesquioxides and thus reduce the phosphate fixing capacity of the soil. This was in conformity with Kaleeswari *et al*. (2005) who reported that

Table 2. Effect of intercropping system, nutrient management and tree leaf extract sprays on post harvest soil available P (kg ha^{-1}) of cotton

Treatment	Summer 2006 C_I	C_2	C_3	C_4	Mean	Treatment	Winter 2006-07 C_I	C_2	C_3	C_4	Mean
N_1	14.20	19.00	18.90	17.60	17.43	N_1	12.10	17.10	16.80	15.50	15.38
N_2	14.00	18.40	17.20	16.90	16.63	N_2	12.00	16.30	15.10	14.70	14.53
N_3	14.60	19.80	19.70	17.70	17.95	N_3	12.40	17.70	17.60	15.60	15.83
N_4	13.90	18.30	17.20	16.80	16.55	N_4	11.50	16.20	15.10	14.70	14.38
N_5	13.80	18.20	17.10	16.70	16.45	N_5	11.50	16.10	15.00	14.60	14.30
N_6	13.70	18.20	17.00	16.60	16.38	N_6	11.60	16.10	15.90	14.60	14.55
Mean	14.03	18.65	17.85	17.05		Mean	11.85	16.58	15.92	14.95	
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	0.29	0.53	1.02	1.07		S.Ed	0.44	0.51	1.02	1.01	
CD(P=0.05)	0.71	1.08	NS	NS		CD(P=0.05)	1.06	1.02	NS	NS	

organic acids produced during decomposition of crop residues converted insoluble Ca, Fe and Al bound P into soluble and post harvest soil available P through chelation and complex formation.

Cotton under pure stand recorded low availability of P (14.03 and 11.85 kg ha^{-1} during summer 2006 and winter 2006 -07 respectively) which might be due to exhaustive nature of cotton which depleted the post harvest soil available P for its growth and development.

Application of 75 % RDF + biofertilizers (*azospirillum*, phosphobacteria and silica solubilizing bacteria) recorded higher post harvest soil available P of 17.95 during summer 2006 and 15.83 kg ha^{-1} during winter 2006-07 but statistically on par with treatment receiving 100 % RDF. The probable reason for high post harvest soil available P under application of 75 % RDF + biofertilizers (*azospirillum*, phosphobacteria and silica solubilizing bacteria) might be due to increased availability of P though solubilization of insoluble compounds by applied phosphobacteria. Further inoculation of phospho bacteria might have enhanced the phosphorus availability by solubilizing the insoluble phosphorus compound fixed in the soil by their secretion of aliphatic and aromatic acids coupled with enzyme such as phytase and phospholipids. Under favourable condition of microbial population recorded from the treatment plot receiving 75 % RDF + biofertilizers (*azospirillum*, phosphobacteria and silica solubilizing bacteria) might have released higher phosphorus.

Table 3. Effect of intercropping system, nutrient management and tree leaf extract sprays on post harvest soil available K (kg ha^{-1}) of cotton

Treatment	Summer 2006 C_I	C_2	C_3	C_4	Mean	Treatment	Winter 2006-07 C_I	C_2	C_3	C_4	Mean
N_1	164.9	168.7	167.9	166.2	166.9	N_1	273.7	274.8	276.8	275.1	275.1
N_2	167.4	165.9	165.5	165.7	166.1	N_2	273.3	274.8	274.4	274.6	274.3
N_3	165.3	170.2	169.0	167.1	167.9	N_3	274.2	279.1	278.2	276.0	276.9
N_4	164.3	165.8	165.4	165.5	165.3	N_4	273.1	275.7	274.2	274.3	274.3
N_5	164.2	165.7	165.3	165.4	165.2	N_5	273.0	274.7	274.1	274.2	274.0
N_6	164.1	165.6	165.3	165.3	165.1	N_6	277.8	274.6	274.1	274.1	275.2
Mean	165.0	167.0	166.4	165.9		Mean	274.2	275.6	275.3	274.7	
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	4.65	5.51	11.08	11.01		S.Ed	8.67	12.55	24.49	25.09	
CD(P=0.05)	NS	NS	NS	NS		CD(P=0.05)	NS	NS	NS	NS	

The set of treatment receiving 75 % RDF + leaf extracts spray and the treatment receiving 75 % RDF (N_2) alone has recorded lesser soil available P status and they were statistically on par with each other during both seasons.

Post harvest soil available K

The post harvest soil available K (Table 3) ranged from 164.1 to 170.2 kg ha^{-1} during summer 2006 and from 273.0 to 279.1 kg ha^{-1} during winter 2006–07.Cropping system, nutrient management and leaf extracts spray did not show any significant change on potassium. Potassium status was not significantly altered by cropping system and nutrient management. This might be due to high potassium status observed at the start of experiment and native potassium might have supplied the potassium demand of cotton. Similarly there was poor response to potassium by pulses. Hence there was no perceptible difference in potassium status after harvest of cotton. Solaiappan (1995) also reported similar results on available K after harvest.

The study revealed that cotton + blackgram intercropping (C_2) with application of 75 % RDF + combined application of *azospirillum*, phosphobacteria and silica solubilizing bacteria (N_3) recorded higher post harvest soil available nitrogen and phosphorus content.

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