ISSN 1996-3351

Asian Journal of Biological Sciences

http://knowledgiascientific.com

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

OPEN ACCESS Asian Journal of Biological Sciences

ISSN 1996-3351
DOI: 10.3923/ajbs.2018.217.222

Research Article
Evaluation of Intercropping System, Nutrient Management and Tree Leaf Extract Spray on Irrigated Cotton

Harisudan Chandrasekaran and Manivannan Venkatesan

Regional Research Station, Vridhachalam 606001, Tamil Nadu, India

Abstract

Background and Objective: Cotton is the backbone of Indian textile industry, accounting for 75% of total fibre consumption in textile sector and 38% of the country's export. To increase the yield of cotton and in order to meet the demand of cotton industry, development of appropriate cropping system and nutrient management strategies to cotton has becomes crucial. Therefore, study on the effect of intercrops, inorganic fertilizers, biofertilizers and tree leaf extract spray on seed cotton yield was taken up. **Materials and Methods:** Intercropping system viz., C_1-Cotton sole, C_2-Cotton+Blackgram, C_3-Cotton+ Greengram and C_4-Cotton+Cluster bean were allotted to main plot. The intercrops residues were incorporated at 65 DAS. The subplot consisted of six 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, N_5-75% RDF+5% Vilvam leaf extract spray, N_6-75% RDF+5% Annona leaf extract spray. The experiments were laid out in a split plot design with three replications. Leaf extracts were sprayed at 60 and 80 DAS. The biofertilizers include *Azospirillum*+Phosphobacteria+Silicate solubilizing bacteria each at 2.6 kg ha^{-1}. **Results:** Intercropping system, nutrient management and botanicals treatment showed significant response interms of seed cotton yield. Among the different intercropping system and nutrient management, cotton + blackgram intercropping with integrated nutrient management involving application of 75% RDF+seed treatment and soil application of biofertilizers recorded higher seed cotton yield (1619 and 1715 kg ha^{-1} during winter 2007 and Summer 2007-08, respectively). **Conclusion:** Cotton+blackgram intercropping system with application of 75% RDF+seed treatment and soil application biofertilizers may be recommended for higher seed cotton yield.

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

Citation: Harisudan Chandrasekaran and Manivannan Venkatesan, 2018. Evaluation of intercropping system, nutrient management and tree leaf extract spray on irrigated cotton. Asian J. Biol. Sci., 11: 217-222.

Corresponding Author: Chandrasekaran Harisudan, Regional Research Station, Vridhachalam 606001, Tamil Nadu, India Tel: 09842210248

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cotton known as "white gold" is an important commercial crop in India, sharing around 85% of raw material supply in textile Industry. Area under cotton cultivation in India (10.15 million ha) is the highest in the world, i.e., 25% of the world area[1]. Due to intrusion of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops have enhanced the production output per hectare in most of crops including cotton[2]. However, deterioration of the quality of soil as a natural resource is evident in the traditional cotton belt. High external input based cropping has degraded the soil water system, depleted soil organic carbon stocks and fertility. Imbalanced fertilizer application, accelerated soil loss and exclusion of organic sources, combined with overuse of nitrogen, compels the crop to exploit soil reserves for other nutrients, creating multiple nutrient deficiencies. Further there is a heavy loss of nutrients due to leaching, denitrification, volatilization and fixation in the soil. Sometimes, nutrients get leached beyond the active root zone and become no longer useful to plant[3].

Nutrient management in cotton is complex due to the overlap of vegetative and reproductive structures during the active growth phase. The nutrient demand by the fruiting parts is very high. High nutrient demand at this stage results in reduction of root growth due to less partitioning of assimilates to the root and ultimately reduced capacity to absorb nutrients[4]. An excess of nutrient applied, especially N before the crop attains the grand growth period could revert the crop to putting up more of vegetative growth. Very little absorbed nutrients go back to the soil, therefore until and unless these nutrients are replenished, soil fertility and productivity are likely to be affected adversely[5]. Judicious nutrient management is the pre-requisite to increase the productivity of cotton and to meet the industrial demand.

The 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. In this context an attempt was made to study the effect of intercropping system, nutrient management and leaf extract spray on seed cotton yield and nutrient uptake of cotton.

MATERIALS AND METHODS

Description of study area: Field trial was conducted at Agricultural College and Research Institute, Madurai, Tamil Nadu, India during Summer 2007 and Winter 2007-08. The experimental location experiences tropical climate with summer extending from March to August and winter from August to February. The soil of the experimental site was vylogam series, a member of fine loamy kaolinite, with a pH of 8.1 and 6.9 and an EC of 0.31 and 0.42 dSm^{-1}.

Experiment materials: 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 biofertilizers include *Azospirillum* +Phosphobacteria+Silicate solubilizing bacteria each at 2.6 kg ha^{-1}. For tree leaf extracts preparation fresh leaves of selected tree species viz., *Annona squamosa*, *Morinda tinctoria* and *Aegles marmellos* were collected from the trees found in the campus. The leaf extract for each of the above species were prepared by grinding fresh leaves with distilled water at 1:1 proportion and kept for 6 h and the extract was filtered, which served as a stock solution. Five percent of leaf extract prepared from stock solution was sprayed twice during the crop growth phase during the early morning hours at 60 and 80 days after sowing as per the treatment schedule. Leaf extracts were sprayed at 60 and 80 DAS.

Design and arrangement of experiment: 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 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, N_5-75% RDF+5% Vilvam leaf extract spray, N_6-75% RDF+5% Annona leaf extract spray.

Data collection: Observations on seed cotton yield and nutrient uptake was recorded. The seed cotton obtained from net plot area was shade dried, weighed at each picking and yields of all picking were pooled and computed to kg ha^{-1}. The plant samples collected for recording dry matter accumulation was used for plant analysis after drying. The samples were ground by using Wiley mill and analysed for N, P and K content. The N uptake was analyzed by the Micro kjeldahl method[6], P uptake by Colorimetry method[7] and K uptake by Flame photometry method[7]. The nutrient uptake was

calculated by multiplying the respective nutrient content with the corresponding DMP obtained per hectare for cotton and expressed in kg ha^{-1}.

Statistical analysis: Data were statistically analyzed following the procedure given by Gomez and Gomez[8]. A two-way ANOVA was used to determine significant difference among intercropping system and nutrient management. Wherever the results were significant, critical differences were worked out at 5% level and non significant results were noted as N.S.

RESULTS AND DISCUSSION

Seed cotton yield of cotton: Intercropping system, nutrient management and botanicals treatment showed significant response interms of seed cotton yield (Table 1). Higher seed cotton yield of 1619 and 1715 kg ha^{-1} was recorded under blackgram intercropping system during Summer and Winter season, respectively. The increase in seed cotton yield due to blackgram intercropping and *in situ* incorporation may be attributed to their complementary effect by way of lesser competition for nutrients and supply of nitrogen in view of better nodulation of legume intercrop and atmospheric N fixation. In addition the incorporated legume has released the nutrient at steady and balanced rate which was available to the crop at later stages[9,10]. Cotton+clusterbean cropping system reduced the seed cotton yield significantly.

Among the nutrient management and botanicals spray treatment, application of 75% RDF along with biofertilizers viz., *Azospirillum*, phosphobacteria and silica solubilizing bacteria recorded higher seed cotton yield (1742 and 1852 kg ha^{-1}) during Summer and Winter season. The yield increase might be due to the growth, multiplication and unfailing colonization of biofertilizer around rhizosphere region, which supplied the nutrients continuously. Integrated nutrient management has considerable importance as to take remedial measures in fertility management and boosting the production[11]. The positive outcomes of integrated nutrient management on improving soil fertility and increasing the yield were found by various researchers in many areas[12,13]. Seed cotton yield was low from the treatment receiving 75% RDF alone. Low availability of nutrients reduced the growth and led to low N, P and K uptake which in turn finally resulted in poor yield.

Nitrogen uptake of cotton: Intercropping system had a discernible influence on N uptake (Table 2) during both the seasons of experimentation. Cotton+blackgram intercropping (C_2) recorded higher N uptake of cotton (82.82 and 84.90 kg ha^{-1} at 120 DAS during Summer and Winter season respectively). The decomposed residue had released N in a steady state and it would have paved way for more absorption of N. Similar views were reported by Kulandaivel *et al.*[14].

Nutrient management and botanicals spray exhibited significant influence on N uptake of cotton. Application of 75% RDF along with biofertilizers (*Azospirillum*, phosphobacteria and silica solubilizing bacteria) recorded higher N uptake by cotton (89.95 kg ha^{-1} at 120 DAS during Summer and Winter season respectively). Higher N uptake might be due to N fixation by applied *Azospirillum* becomes available to cotton at steady rate and were absorbed at a faster rate. The organic matter of blackgram residue has created a favourable base and organic substrate for biofertilizers for its growth, multiplication and unfailing colonization which might have increased the availability of N and its steady supply to cotton

Table 1: Effect of intercropping system, nutrient management and tree leaf extract sprays on seed cotton yield (kg ha^{-1}) of cotton

	Summer 2007						Winter 2007-08				
Treatments	C_1	C_2	C_3	C_4	Mean	Treatments	C_1	C_2	C_3	C_4	Mean
N_1	1595	1723	1690	1565	1643	N_1	1675	1861	1803	1645	1746
N_2	1445	1480	1475	1290	1423	N_2	1525	1570	1560	1495	1538
N_3	1650	1910	1782	1625	1742	N_3	1732	1998	1954	1724	1852
N_4	1480	1525	1495	1295	1449	N_4	1560	1614	1585	1455	1554
N_5	1485	1535	1505	1310	1459	N_5	1564	1620	1601	1459	1561
N_6	1490	1540	1510	1315	1464	N_6	1580	1627	1604	1462	1568
Mean	1524	1619	1576	1400		Mean	1606	1715	1685	1540	
	Summer 2007						Winter 2007-08				
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	49	71	138	142		S.Ed	45	55	110	110	
CD (p = 0.05)	120	143	NS	NS		CD (p = 0.05)	110	111	NS	NS	

Table 2: Effect of intercropping system, nutrient management and tree leaf extract sprays on nitrogen uptake (kg ha^{-1}) of cotton (120 DAS)

	Summer 2007						Winter 2007-08				
Treatments	C_I	C_2	C_3	C_4	Mean	Treatments	C_I	C_2	C_3	C_4	Mean
N_1	82.97	89.14	81.97	82.17	84.06	N_1	85.01	91.17	90.81	83.21	87.55
N_2	72.20	78.01	77.96	71.60	74.94	N_2	74.17	80.11	79.91	73.67	76.97
N_3	86.21	92.12	91.14	82.28	87.94	N_3	88.24	94.26	93.17	84.11	89.95
N_4	72.31	79.01	78.01	71.67	75.25	N_4	74.21	81.04	80.07	73.59	77.23
N_5	72.67	79.21	78.47	72.01	75.59	N_5	74.71	81.30	80.57	74.11	77.67
N_6	72.99	79.41	78.67	72.21	75.82	N_6	75.01	81.51	80.77	74.11	77.85
Mean	76.56	82.82	81.04	75.32		Mean	78.56	84.90	84.22	77.13	
	Summer 2007						Winter 2007-08				
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	0.48	0.70	1.37	1.40		S.Ed	2.27	2.74	5.48	5.47	
CD (p = 0.05)	1.17	1.42	2.83	2.83		CD (p = 0.05)	5.55	5.53	NS	NS	

Table 3: Effect of intercropping system, nutrient management and tree leaf extract sprays on phosphorus uptake (kg ha^{-1}) of cotton (120 DAS)

	Summer 2007						Winter 2007-08				
Treatments	C_I	C_2	C_3	C_4	Mean	Treatments	C_I	C_2	C_3	C_4	Mean
N_1	17.52	18.71	18.21	15.71	17.54	N_1	19.92	21.31	21.20	18.10	20.13
N_2	14.10	16.82	16.10	13.37	15.10	N_2	17.19	18.98	18.47	16.32	17.74
N_3	17.91	18.91	18.81	15.95	17.90	N_3	20.31	21.42	21.31	18.39	20.36
N_4	15.01	16.60	15.97	13.92	15.38	N_4	17.31	19.09	18.51	16.41	17.83
N_5	15.21	16.71	16.01	14.04	15.49	N_5	17.42	19.21	18.46	16.51	17.90
N_6	14.97	16.42	18.81	14.02	16.06	N_6	17.09	20.71	18.84	16.19	18.21
Mean	15.79	17.36	17.32	14.50		Mean	18.21	20.12	19.47	16.99	
	Summer 2007						Winter 2007-08				
For	C	N	C at N	N at C		For	C	N	C at N	N at C	
S.Ed	0.20	0.18	0.39	0.36		S.Ed	0.23	0.21	0.44	0.41	
CD (p = 0.05)	0.48	0.37	0.82	0.73		CD (p = 0.05)	0.55	0.42	0.94	0.83	

throughout cropping period resulting in higher N uptake. Similar results of higher N uptake under integrated nutrient management was reported by Dendi Damodar Reddy *et al.*[15].

Phosphorus uptake of cotton: Phosphorus uptake also followed the similar trend as like that of N uptake by cotton. Cotton under blackgram intercropping system registered higher P uptake (Table 3) at 120 DAS (17.36 and 20.12 kg ha^{-1} during Summer and Winter, respectively). The increased uptake of phosphorus might be due to build up of available phosphorus in soil as a result of incorporation of intercrop residue though solvent action of organic acids produced during decomposition.

Nutrient management and botanicals spray also exerted a distinct influence on the uptake of P. Application of 75% RDF along with *Azospirillum*, phosphobacteria and silica solubilizing bacteria to cotton registered higher P uptake (17.90 and 20.36 kg ha^{-1} during Summer and Winter season, respectively. Inoculation of phosphobacteria might have enhanced the phosphorus compounds fixed in the soil by their secretion of aliphatic and aromatic acids coupled with enzymes such as phytase and phospholipase. Silica solubilizing bacteria was also reported to release the phosphorus from soil as well as it reduces P fixation in soil resulting in higher P uptake[16]. The combination of cotton+blackgram intercropping receiving 75% RDF along with biofertilizers recorded the highest P uptake of 18.91 and 21.42 kg ha^{-1} at 120 DAS during Summer and Winter season, respectively.

Potassium uptake of cotton: Cropping system had greatly influenced the K uptake (Table 4) of cotton. Cotton under blackgram intercropping system registered higher K uptake at 120 DAS (77.85 and 80.75 kg ha^{-1} during Summer and Winter season, respectively). Higher uptake of K under cotton+blackgram intercropping system might be due to vigorous growth, higher LAI resulting in greater photosynthate accumulated as high dry matter due to steady availability of nutrients would have facilitated in higher absorption of K. Integrated application of inorganics and biofertilizers increased K uptake. Inclusion of silica solubilizing bacteria might have increased K uptake by release of K from

Table 4: Effect of intercropping system, nutrient management and tree leaf extract sprays on potassium uptake (kg ha^{-1}) of cotton (120 DAS)

	Summer 2007						Winter 2007-08				
Treatments	C_1	C_2	C_3	C_4	Mean	Treatments	C_1	C_2	C_3	C_4	Mean
N_1	78.31	79.04	78.91	78.22	78.62	N_1	81.02	81.92	81.82	81.22	81.50
N_2	75.06	75.72	75.64	74.61	75.26	N_2	77.52	78.61	78.53	74.97	77.41
N_3	78.69	80.92	80.01	78.51	79.53	N_3	81.42	83.83	82.92	81.58	82.44
N_4	75.12	77.04	75.81	74.73	75.68	N_4	77.63	79.96	78.72	78.00	78.58
N_5	75.21	77.11	75.92	74.82	75.77	N_5	77.71	80.02	78.81	78.12	78.67
N_6	75.41	77.24	76.01	74.91	75.89	N_6	77.82	80.13	78.92	78.32	78.80
Mean	76.30	77.85	77.05	75.97		Mean	78.85	80.75	79.95	78.70	

	Summer 2007					Winter 2007-08				
For	C	N	C at N	N at C	For	C	N	C at N	N at C
S.Ed	0.46	0.68	1.32	1.35	S.Ed	0.47	0.70	1.36	1.40
CD (p = 0.05)	1.13	1.37	NS	NS	CD (p = 0.05)	1.16	1.41	NS	NS

the soil colloids. Higher microbial population as evidenced from the results favoured high release of K from soil. The importance of K fertilization and K uptake by cotton were reported by Hezhong Dong *et al*.[17]. Similar K fertilization was extremely important for maintaining high yield. Shorter plant and low dry matter yield of cotton due to competitive and suppressive effect of clusterbean led to low K uptake.

CONCLUSION

Based on the result of the field study cotton+blackgram intercropping with application of 75% RDF+combined application of *Azospirillum*, phosphobacteria and Silica solubilizing bacteria could be recommended for higher seed cotton yield and increased nutrient uptake.

SIGNIFICANCE STATEMENT

This study discovered that cotton+blackgram as significant intercropping system and application of 75% RDF+combined application of *Azospirillum*, phosphobacteria and Silica solubilizing bacteria biointegrated nutrient management strategies for higher seed cotton yield and soil fertility. This study will help the researchers to uncover the critical areas of intercropping system and integrated management that many researchers were not able to explore. Thus a new theory on cotton based intercropping system and integrated nutrient management may be arrived at.

REFERENCES

1. Muthukrishnan, P., N. Thavaprakaash and K. Srinivasan, 2017. Effect of organic nutrient management practices in comparison with conventional method on performance of cotton in Tamil Nadu. Madras Agric. J., 104: 15-22.
2. Ramesh, P., M. Singh and A.S. Rao, 2005. Organic farming: Its relevance to the Indian context. Curr. Sci., 88: 561-568.
3. Hadole, S.S., G.J. Bhagat, A.H. Nagone and V.R. Thakur, 2012. Nutrient management through drip system of irrigation in Cotton. PKV Res. J., 36: 52-55.
4. Singh, J. and D. Blaise, 2000. Nutrient management i rainfed cotton. CICR Technical Bulletin No: 6 pp:3. http://www.cicr.org.in/pdf/nutrient_rainfed.pdf.
5. Rawal, S. and A. Kumar, 2016. Nutrient Management in Cotton: Problem and Prospects: Optimization Techniques. LAP Lambert Academic Publishing, Germany, ISBN-13: 978-3659904059.
6. Hymphries, E.C., 1956. Mineral Components and Ash Analysis. In: Modern Methods of Plant Analysis, Peach, K. and M.V. Tracey (Eds.). Springer-Verlag, Berlin, pp: 468-502.
7. Jackson, M.L., 1973. Soil Chemical Analysis. 1st Edn., Prentice Hall Ltd., New Delhi, India, Pages: 498.
8. Gomez, K.A. and A.A. Gomez, 2010. Statistical Procedures for Agricultural Research. Wiley India Pvt. Ltd., New Delhi.
9. Pacharne, D.P., 2017. Production potential and energy dynamics of efficient cropping systems under diverse nutrient management practices. Indian J. Agron. 62: 280-286.
10. Chellamuthu, V. and C. Ramaswami, 2000. Studies on intercropping in winter irrigated cotton. Madras Agric. J., 87: 95-98.
11. Vora, V.D., K.D. Rakholiya, K.V. Rupapara, G.S. Sutaria and K.N. Akbari, 2015. Effect of integrated nutrient management on Bt cotton and post harvest soil fertility under dry farming agriculture. Asian J. Agric. Res., 9: 350-356.
12. Laekemariam, F. and G. Gidago, 2012. Response of maize (*Zea mays* L.) to integrated fertilizer application in Wolaita, South Ethiopia. Adv. Life Sci. Technol., 5: 21-30.
13. Islam, M.K., Khalequzzaman, M.K. Hassan and M. Kaikobad, 2014. Annual research report. Cotton Development Board, Ministry of Agriculture, Bangladesh, pp: 131-142.

14. Kulandaivel, S., R. Bhoopathi Prabhukumar and S. Gurumurthy, 2001. Effect of planting pattern on cotton based intercropping system. Ann. Agric. Res., 22: 64-66.
15. Reddy, D.D., D. Blaise, B. Kumrawat and A.K. Singh, 2017. Evaluation of integrated nutrient management interventions for Cotton (*Gossypium hirsutum*) on a vertisol in central India. Commun. Soil Sci. Plant Anal., 48: 469-475.
16. Muralikannan, M., 1996. Biodissolution of silicate, phosphate and potassium by silicate solubilizing bacteria in rice ecosystem. M.Sc. Thesis, Agricultural College and Research Institute, Madurai.
17. Dong, H.Z., X.Q. Kong, W.J. Li, W. Tang and D.M. Zhang, 2010. Effects of plant density and nitrogen and potassium fertilization on cotton yield and uptake of major nutrients in two fields with varying fertility. Field Crop Res., 119: 106-113.