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Sonali Biswas

Asst. Professor, Department of
Agronomy, Bidhan Chandra
Krishi Viswavidyalaya,
Mohanpur, Nadia, West Bengal,
India

Abhijit Saha

Asst. Professor, Department of
Agronomy, College of
Agriculture, Tripura;
Lembucherra, West Tripura,
Tripura, India

SS Mondal

Former Head and Professor,
Department of Agronomy,
Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur,
Nadia, West Bengal, India

Response of integrated nutrient management and intercropping in cotton in new alluvial zone of West Bengal

Sonali Biswas, Abhijit Saha and SS Mondal

Abstract

A field experiment was carried out to evaluate the best intercropping system along with integrated nutrient management for higher productivity, soil fertility build up, nutrient utilization by crops and economies of cotton in New Alluvial zone of West Bengal. The maximum seed-cotton yield (1830.50 kg/ha) was recorded in sole cotton but the maximum net production value (3.80) and cotton equivalent yield (2346.73 kg/ha) were recorded in cotton-blackgram cropping system. The maximum uptake of nutrients (69.35, 34.25 and 72.37 kg ha⁻¹ N, P and K) by crops and the soil nutrient status after harvesting of 4th crop in system (1460, 41.51 and 199.00 kg ha⁻¹ N, P and K) were recorded in cotton-blackgram intercropping system. Among the nutritional management, treatments receiving 75% recommended dose of fertilizer of N, P and K along with 25% N through FYM recorded highest seed-cotton yield, cotton equivalent yield, net production value, nutrient uptake by crops and fertility status of soil. Based on the result, it is concluded that cotton-blackgram intercropping system with 75% recommended dose of fertilizer of N, P and K along with 25% N through FYM is a recommendable option for achieving higher yield, economic benefit, nutrient uptake and soil nutrient status by cotton in New Alluvial Zone of West Bengal, India.

Keywords: Cotton, cropping system, net return, nutrient management, yield

Introduction

Cotton is one of the most important commercial crop playing a key role in economic and social affairs of the world. Since, time immemorial, cotton has been the king of apparel fibre. Intercropping is an important means to increase the total production of cropping system as it increase the net cropped area indirectly. Cotton being a long duration and widely spaced crop having slow growth rate in the initial stages is ideally suited for intercropping with early maturing crop. Another important issue related to multiple cropping is efficient fertilizer use and maintenance of soil fertility to achieve stable production over the years. It was widely recognized that intercropping design on principles of scientific base in crop production, hold a great in increasing land productivity of Indian cotton (Mondal *et al.*, 1990). So, in cotton based intercropping system both organic and inorganic sources of nutrient are more important for maintained soil fertility and increased crop yield. Intensification of cotton based cropping system with intercrops was successful as a components in the system have different nutrient and moisture requirement, varied feeding zones in the soil profile, differential growth duration for enabling the utilization of natural resources optimally. (Sankaranarayanan *et al.*, 2012) [12]. Therefore, the present experiment was conducted to study effect of intercropping and integrated nutrient management on growth, productivity, net production value, nutrient uptake and fertility status of soil.

Materials and Methods

The experiment was carried out during *rabi* season of 2013-14 and 2014-15 at Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, West Bengal, India in sandy clay loam soil having pH 6.87, 0.07% total N, 26.66 and 179.29 kg ha⁻¹ respectively. The experiment was laid out in split plot design with three replications keeping the four cropping system treatments (A₁: cotton as sole crops, A₂: Cotton intercropped with black gram, A₃: Cotton intercropped with green gram, A₄: Cotton intercropped with soybean) in main plot and five different nutritional management treatments (T₁: 100% of the Recommended Dose of N,P & K through inorganic sources, T₂: 75% Recommended Dose of N,P & K + 25% N through Neem cake (*Azadirachta indica*), T₃: 75% Recommended Dose of N,P & K + 25% N through Karanj cake (*Pongamia pinnata*), T₄: 75% Recommended Dose of N,P & K + 25% N through Farm Yard Manure(FYM), T₆: 75% Recommended Dose of N,P & K + 25% N

Correspondence**Sonali Biswas**

Asst. Professor, Department of
Agronomy, Bidhan Chandra
Krishi Viswavidyalaya,
Mohanpur, Nadia, West Bengal,
India

Through Azospirillum+ phosphobacterium) in sub plot. The recommended fertilizer dose was 80:40:40 N, P₂O₅ and K₂O kg/ha. Half dose of nitrogen and full dose of phosphorus and potassium were applied as basal and half dose of nitrogen was applied at 40 DAS. FYM @ 10 t ha⁻¹, neem cake @ 1.0 t ha⁻¹ and karanj cake @ 1.05 t ha⁻¹ were applied at the time of final land preparation as per the subplot treatments. The spacing of cotton was 75 cm x 45 cm and the intercrops were sown in between two rows of cotton. Cotton var. was TCHH-4 sown in last week of December and intercrops were sown in first week of February. Total nitrogen in soil was estimated by modified Macro- Kjeldhal's method as directed of Jackson (1967), available phosphorus of soil was determined by Olsen's method (Jackson, 1973) with the help of photo-electric colorimeter and available potassium of soil was determined with the help of Flame photometer (Jackson, 1973). The soil EC was determined by using conductivity meter (model systronics 303) at 1:2.5 soil water ratio (Jackson, 1967). Cotton equivalent yield was determined by dividing total price of the produce to be compared with price of cotton kg ha⁻¹. The statistical analysis was done as per procedure suggested by Gomez and Gomez (1984).

Results and Discussions

Yield and cotton equivalent yield

Effect of cropping system

The pooled data of 2 years on crop yields in different cotton based intercropping system revealed that the seed cotton yield (Table 1) of cotton as sole crop was significantly higher (1830.50 kg/ha) than respective intercrop cotton yield. It may be due to the fact that it enhanced growth without intercrop competition resulted in better development of yield attributes such as number of bolls per plant and boll weight ultimately leading to increased seed-cotton yield. This result is corroborated with findings of Jayakumar *et al.*, (2007) [3]. Yield reduction of seed cotton due to intercropping was higher with soybean (28.29 %), followed by greengram (16.68 %), blackgram (11.58%).

The maximum cotton equivalent yield (2346.73 kg/ha) was obtained in cotton+blackgram intercropping system, followed by the yield recorded in cotton+greengram intercropping system (Table 1). Minimum cotton equivalent yield (1761.50 kg/ha) was recorded when cotton grown as sole crop as compared with other intercropping system. The maximum cotton equivalent yield was obtained in cotton-blackgram intercropping system may be due to the fact that the yield of blackgram as intercrop was higher and lesser reduction in seed cotton yield compare with greengram and soybean intercrops. This result an agreement with the finding of Giri *et al.* (2006) [2], Kote *et al.* (2005) [5].

Effect of Nutrient Management

The maximum seed-cotton and cotton equivalent yield (1911.82 and 1582.50 kg ha⁻¹) was obtained When the crops in system were treated with 75% RD of N, P & K along with 25% N through FYM followed by the yield (1742.00 kg ha⁻¹) in the treatment receiving 75% RD of N, P and K along with 25% N through neemcake (Table 1). The minimum yield was also observed when the treatment receiving 100% RD of N, P and K through inorganic sources. Application of 75% RD of N, P and K along with 25% N through FYM registered

maximum seed cotton yield may be due to the fact that FYM in conjunction with mineral fertilizer not only provide additional nutrients other than N,P, K & S but also causes improvement in the physical properties of soil. This result is agreement with the findings of Abroal and Katyal (1990), Jaya Kumar *et al.* (2007) [3] and Venkateswarlu *et al.* (2007) [14]. Marimuthu *et al.* (2013) [9] stated that crop productivity can be sustained with integrated plant nutrient management practices.

Table 1: Effect of cropping system and integrated nutrient management on seed cotton yield and cotton equivalent yield (2 years pooled data)

Treatment	Yield in Kg ha ⁻¹	
	Seed Cotton	Cotton Equivalent
Cropping system (A)		
A ₁ (Sole cotton)	1830.50	1761.50
A ₂ (cotton + blackgram)	2518.36	2346.73
A ₃ (cotton + green gram)	1525.10	2112.56
A ₄ (cotton + soybean)	1312.50	1841.96
SEm ±	12.67	30.5
CD (P = 0.05)	56.84	136
Nutrient Management (T)		
T ₁ (100% RD)	1215.25	1605.68
T ₂ (75% RD+25% N as Neem cake)	1742.00	2178.88
T ₃ (75% RD +25% N as Karanj cake)	1584.37	1975.60
T ₄ (75% RD +25% N as FYM)	1911.82	2429.43
T ₅ (75% RD + Bio fertilizers)	1411.62	1766.33
SEm ±	15.13	23.8
CD (P = 0.05)	59.22	93.15

Note- RD- Recommended Dose.

Net Production Value

The maximum net production value was registered (3.80) when cotton intercropped with blackgram intercropped with blackgram and treated with 75% RD of N, P and K along with 25% N through FYM in the system (Table 2). The second highest net production value (3.51) was obtained when cotton was intercropped with green gram and received 75% RD of N, P and K along with 25% N through FYM. Higher net production value was also obtained in the treatment where cotton intercropped with any legume crops along with 75% RD of N, P and K in addition with 25% N through Neem cake or karanj cake or bio fertilizers. The lower net production value (1.42) was obtained when cotton intercropped with soybean received 100% recommended N, P and K through inorganic sources. Though there was a reduction in seed-cotton yield under intercrop situation, it well compensated by additional yield from intercropped with integrated nutrient management there by registering higher economic return. Higher net return besides a higher benefit: cost ratio 3.80 was recorded under planting of blackgram in between cotton rows with integrated nutrient management may be due to the fact that though there was a reduction in seed-cotton yield under intercropped situation, it was compensated by addition yield from intercrop. This result was corroborated with the findings of Krishnasamy *et al.* (1995) [6]. They reported that there was a reduction in seed-cotton yield under intercrop situation, but it was well compensated by addition yield from intercrops (blackgram). Reddy *et al.* (2009) [11] stated that the intercropping of cowpea, blackgram or green gram was significantly superior than sole cropping.

Table 2: Net production value in cotton based cropping system under integrated nutrient management

Treatments	Yield in kg ha ⁻¹ (mean)			Cost of cultivation (Excluding fertilizer) (Rs.)	Cost of fertilizer and manure (x) Rs.	Total cost (A) × Rs.	Value of produce ha ⁻¹ (Rs.)	Net profit t ha ⁻¹ (Rs.)(B – A) = C	NPV (C/A)
	Seed-cotton	Stalk yield	Intercrops						
A ₁ T ₁	1460	2225	--	9350.00	1970.00	11320.00	30312.5	18992.5	1.68
A ₁ T ₂	2030	3155	--	9350.00	5328.00	14678.00	42177.5	27499.5	1.88
A ₁ T ₃	1850	2850	--	9350.00	4556.00	13908.00	38425.00	24517.00	1.77
A ₁ T ₄	2140	3475	--	9350.00	2598.00	11948.00	46275.0	34327.00	2.88
A ₁ T ₅	1672.5	2530	--	9350.00	1508.00	10858.00	33815.0	22957	2.11
A ₂ T ₁	1285	1825	624.5	9550.00	1970.00	11520.00	39092.5	27572.5	2.39
A ₂ T ₂	1837.5	2705	802.5	9550.00	5328.00	14878.00	53152.5	38274.5	2.57
A ₂ T ₃	1655.0	2400	755.0	9550.00	4556.00	14106.00	49400.00	35294.0	2.50
A ₂ T ₄	1962.5	3185	879.0	9550.00	2598.00	12148.00	58422.5	46274.5	3.80
A ₂ T ₅	1473.5	2200	703.5	9550.00	1508.00	11058.00	44690.5	33582.5	3.03
A ₃ T ₁	1152.5	2455	504.0	9650.00	1970.00	11620.00	34357.5	22737.0	1.95
A ₃ T ₂	1695	1660	704.5	9650.00	5328.00	14978.00	48820.0	33842.0	2.25
A ₃ T ₃	1560	2265	643.5	9650.00	4556.00	14206.00	45022.5	30816.5	2.16
A ₃ T ₄	1845	2750	855.5	9650.00	2598.00	12248.00	55305.00	43057	3.51
A ₃ T ₅	1350	1960	564.0	9650.00	1508.00	1158.00	39260.00	28102	2.51
A ₄ T ₁	905.5	1280	882.5	9550.00	1970.00	11520.00	27965.00	16445	1.42
A ₄ T ₂	1528	2150	1139.5	9550.00	5328.00	14878.00	43038.00	28160	1.89
A ₄ T ₃	1302.5	2060	1065.0	9550.00	4556.00	14106.00	37730	23624	1.67
A ₄ T ₄	1659	2585	1233.5	9550.00	2598.00	12148	47327.5	35179	2.89
A ₄ T ₅	1110	1760	975.0	9550.00	1508.00	11058	32830.0	21772	1.96

Price of fertilizer and manure Price of Produce
 Urea- Rs. 5.00 kg ha⁻¹, SSP- Rs. 3.20 kg⁻¹, MOP- Rs. 4.50 kg⁻¹
 Seed cotton - Rs. 20/kg, Cotton stalk- Rs. 0.50/kg, Black gram
 – Rs. 20/kg, Green gram – Rs. 20/kg, Soybean – Rs. 10 per kg
 Neemcake- Rs 10.00 kg ha⁻¹, Karanjcake- Rs. 6.00 kg⁻¹,
 FYM- Rs,0.50 per kg, Biofertilizer- Rs. 6 per packet.

Nutrient Uptake and Nutrient Status of Soil Effect of Cropping System

The maximum uptake of nutrients (N, P and K) was observed in intercropping system (Table 3). The uptake of nutrients (N, P and K) by the crops was maximum under cotton +black gram cropping system (69.35 kg ha⁻¹ N, 34.25 kg ha⁻¹ P and 72.37kg ha⁻¹ K). The uptake of nutrients by crops was lowest in sole cotton. The higher N uptake by intercropping system as compared to the N uptake by sole cropping of cotton was observed which ultimately brought about greater yield potentiality of intercropping system than sole cropping of cotton. These results are in conformity with the findings of Pasalawar *et al.* (2004) [10] who showed that the N uptake by intercropping was more than that of sole cotton. After harvest of the 4th crop in system, the nutrients (N, P and K) status of soil was improved due to different inter cropping system. Maximum nutrients status (N, P and K) of soil was recorded when cotton was intercropped with blackgram (1460 kg ha⁻¹ N, 41.51 kg ha⁻¹ P and 199.00 kg ha⁻¹ K). It might be due to the fact that in this system legume crop (black gram) was include with cotton which has an inherent capacity to fix

atmospheric nitrogen biologically and are found to be able to increase total N status of soil, available P and available K also (Jayakumar *et al.* 2017) [4]. Venkateswarlu *et al.* (2007) [14] observed that the annual incorporation of legume improved the soil properties and fertility status of the soil.

Effect of Nutrient Management

The maximum uptake of nutrients (58.67 kg N ha⁻¹, 25.05 P kg ha⁻¹ and 68.65 K kg ha⁻¹, respectively) were observed when the crops were treated with 75% RD of N, P and K along with 25% N through FYM (Table 3). Considerably higher uptake of nutrients (N, P and K) was also observed when crops were received 75% RD of N, P and K along with 25% N through neem cake or karanj cake or addition of bio fertilizer. The nutrient status of soil was found when crop management was done with 75% RD of N, P and K along with 25% N through FYM. Lowest or depletion nutrient status of soil after harvesting of 4th crop was observed when crop received only inorganic fertilizers. The improvement of soil nutrient status might be due to fact that combined application of organic and inorganic sources of nutrients increase the availability of plant nutrients. This result is supported by Suresh and Kumar (2005) [13]. They reported that the addition of organic manure maintained the highest organic C status and highest available N and K. Marimuthu *et al.* (2013) [9] and Jayakumar *et al.* (2017) [4] stated that soil fertility status can be sustained with integrated plant nutrient management practices.

Table 3: Effect of intercropping and nutrient management on nutrient uptake (Kg ha⁻¹) by crops and nutrient status of soil (kg ha⁻¹) (2 years pooled data)

Treatments	N Uptake	P Uptake	K Uptake	Total N	Available p	Available K
Cropping System (A)						
A ₁	58.02	26.90	66.27	1370.00	24.66	177
A ₂	69.35	34.25	72.37	1460.00	41.51	199
A ₃	67.10	33.10	70.12	1430.00	37.77	195
A ₄	63.25	29.25	68.10	1400	33.24	178
SEm ±	0.48	0.07	0.40	0.73	0.39	0.66
CD at 5%	2.15	0.33	1.79	3.30	1.77	3.00
Nutrient management (T)						
T ₁	39.50	16.04	45.28	1363.00	27.79	178.77
T ₂	52.52	22.76	60.46	1433.00	36.19	191.06
T ₃	49.27	20.53	57.21	1429.41	35.12	191.03

T ₄	58.67	25.05	68.65	1459.08	39.96	196.28
T ₅	45.84	18.77	51.52	1398.00	32.42	182.07
SEm ±	0.59	0.11	0.55	0.811	0.25	0.83
CD at 5%	2.30	0.43	2.1	3.17	0.69	3.25

NB: A₁ = Sole cotton) A₂ = cotton + blackgram) A₃ = cotton + green gram) A₄ = cotton + soybean) T₁ = 100% RD, T₂ = 75% RD+25% N as Neem cake, T₃ = 75% RD +25% N as Karanj cake T₄ = 75% RD +25% N as FYM & T₅ = 75% RD + Bio fertilizers

Conclusion

Utilization of different organic resources for partial substitution of chemical fertilizers not only offers higher crop yields but also augments the soil health as a whole for sustainability in agricultural production. Inclusion of different legumes to intercropping system increase the net return, improved the soil health and productivity of the system. Cotton-blackgram cropping system receiving 75% RD of N, P and K along with 25% N through FYM recorded highest net return, productivity of system, nutrient uptake and fertility status of soil.

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