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Influence of Sources of Nitrogen and Intercropping on Pest Incidence, Yield Attributes and Yield of Cotton

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Abstract: Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India during winter (August - January) seasons of 2002 - 03 and 2003 - 04 in cotton to evaluate the effect of intercropping systems and sources of nitrogen involving organic and inorganic sources of nutrients. The experiment was laid out in a split plot design with three replications. Five intercropping systems viz., sole cotton, cotton + onion, cotton + blackgram, cotton + greengram and cotton + lucerne were included in the main plot. The subplot consisted of different nitrogen sources involving combinations of inorganic and organic manures namely, 100% recommended inorganic N, 75% inorganic N + 25% N through poultry manure, 75% inorganic N + 25% N through sunnhemp, 75% inorganic N + 25% N through farm wastes and 75% inorganic N + 25% N through weed compost. The results revealed that cotton + black gram intercropping with 75% inorganic N + 25% N through poultry manure recorded significantly lesser pest incidence, higher yield attributes and seed cotton yield in both the seasons.

Key words: Cotton, intercropping, organic, pest incidence, yield attributes, yield

INTRODUCTION

Cotton is grown in about 80 countries in the world with 33 million ha in Asia contributing about 44 per cent of world's cotton production. In India, cotton is cultivated in 9 million ha with a production of 155 lakh bales and productivity of 529 kg lint ha^{-1}[15], which is low compared to the world average of 590 kg lint ha^{-1}[9]. In Tamil Nadu, cotton occupies a total area of 2.3 lakh ha of which 65 per cent area comes under rainfed condition with a production of 4 lakh bales and productivity of 324 kg lint ha^{-1}. Despite the recent setbacks in production due to drought, cotton continues to remain the backbone of the rural economy particularly in the dry land areas.

Cotton, being a long duration and widely spaced crop having slow growth rate in the initial stages, intercropping is an option for income augmentation. This gives ample scope for growing short duration intercrops, which will make use of the potential resources of the environment, with an advantage of additional income per unit area. Intercropping also provides an efficient canopy cover over the inter row spaces of the main crop resulting in suppression of weed and conservation of soil moisture.

Application of organic manures along with inorganic fertilizers helps to regenerate the degraded soils and ensure sustainability in crop production. Integrated nutrient management is the only way to increase the production in the long run without affecting the soil health and environment.

Though the recent developments in agro-technologies have contributed immensely towards enhanced food production, it has also caused degradation in fertility and left pesticide residues in food products. Of late, there is an increasing awareness throughout the world about the sustainable agricultural practices, which largely exclude the use of pesticides and other persistent chemicals coupled with judicious use of manures and fertilizers.

The pest and disease problems are the main hindrance in cotton cultivation. Indiscriminate use of synthetic pyrethroids and mindless calendar sprays of pesticide mixture are found to be the major reasons for the reduction in cotton area and production. About 52-55 per cent of total pesticides used in India were consumed by the cotton crop alone, whereas, the cropping area was only 5 per cent[11]. More than 500 species of insects and mites have become resistant to one or the other insecticide. It is estimated that Rs.3, 400 crores is being spent on pesticides for the control of cotton bollworms.

Suitable management practices like intercropping and judicious combination of organic and inorganic manures are considered as ecologically viable, economically feasible and avoid environmental

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pollution[5,16]. In addition, combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plants[3,10]. Hence, with these ideas in view, this study was undertaken to evaluate the effect of intercropping and combined application of organic and inorganic sources of N in cotton on the incidence of major pests, yield attributes and yield of cotton in cotton based intercropping systems.

MATERIAL AND METHODS

Field experiments were conducted during winter (August - January) 2002-03 and 2003-04 at Tamil Nadu Agricultural University, Coimbatore, on sandy clay loam soil with pH of 8.0. The experiments were laid out in a split plot design replicated thrice. The treatments in the main plot consisted of sole cotton (M_1), cotton + onion (M_2), cotton + blackgram (M_3), cotton + greengram (M_4) and cotton + lucerne (M_5). The subplot consisted of combinations of inorganic and organic manures namely, 100% recommended inorganic N (S_1), 75% inorganic N + 25% N through poultry manure (S_2), 75% inorganic N + 25% N through Sunnhemp (S_3), 75% inorganic N + 25% N through farm wastes (S_4) and 75% inorganic N + 25% N through weed compost (S_5). The experimental soil was low in available N (229.8 kg ha^{-1}), low in available P (10.8 kg ha^{-1}) and high in available K (429.0 kg ha^{-1}). Cotton Cv. MCU 12 (150-155 days duration) was raised for the study.

The recommended dose of fertilizers (80: 40: 40 N, P_2O_5 and K_2O kg ha^{-1}) were applied as urea, single super phosphate and muriate of potash. The seeds of cotton were sown at a spacing of 75 X 30 cm with two seeds per hill. The intercrops were sown in between the rows of cotton at recommended spacing. Other cultivation practices normally recommended for the cotton crop were followed. Fertilizer nitrogen was applied in the form of prilled urea (46%N) in two splits at seedling (20-25 DAS) and vegetative stage (40-45 DAS) as per the treatment schedule. The entire phosphorus fertilizer was applied as basal in the form of single super phosphate (16% P_2O_5). The potassium fertilizer was applied in the form of muriate of potash (60% K_2O) in two splits at seedling and vegetative stage.

Different sources of organic manures *viz.,* poultry manure, sunnhemp, weed compost and farm wastes were applied as per the treatments to meet the recommended 25 per cent 'N' level. Poultry manure was applied as well decomposed deep litter manure. Sunnhemp was grown as intercrop in cotton up to pre flowering stage and then incorporated into the field. Weeds and farm wastes were collected from farm and the surrounding field, composed by pit method and then applied. Well decomposed manures were analyzed for the nutrient content. The nutrient content and the quantity of manures applied are given in Table 1.

The yield attributes viz., number of monopodial and sympodial branches and total numbers of fruiting points per plant were recorded on 120th day. Boll setting percentage was calculated from the total number of bolls and number of fruiting points per plant recorded at 120 DAS. Bolls from the tagged plants was counted at every picking and total number of bolls per plant was computed and expressed as number per plant. The boll weight of five fully opened bolls at random was recorded at each picking and the mean was worked out and expressed in gram per boll.

Pest count viz., number of aphids, thrips, leafhopper, whitefly and bollworms were recorded at boll formation to boll development stages at top, middle and bottom in five randomly selected plants. Seed cotton from each picking was shade dried and weighed for each treatment separately and yield as sum of all pickings was computed.

RESULTS AND DISCUSSIONS

Yield Attributes: The yield attributes of cotton were significantly influenced by both intercropping systems and nitrogen sources (Table 2). Cotton sole crop recorded higher monopodial (1.90) and sympodial (27.13) branches, more bolls (35.6), fruiting points per plant (61.0) and higher boll weight (3.78 g). The better yield attributes in sole crop of cotton was due to the increased plant spread which added more number of nodes and more number of sympodial branches. Moreover, cotton under sole crop situation enjoyed all benefits from environmental and below ground resources without any competition to produce more number of bolls and greater boll weight. This is in agreement with the findings of Abdel – Aal[1] and Krishnasamy[12]. There was a reduction in the yield attributes due to intercropping and the least reduction in yield attributes was recorded with blackgram (M_3) and the highest reduction with lucerne (M_5).

Application of 75% N through inorganic + 25% N through poultry manure resulted in higher number of monopodial (1.93) and sympodial branches (26.35), bolls per plant (31.6), fruiting points per plant (59.6) and boll weight (3.79 g) in both the years. This nutrient management practice has resulted in better plant height, LAI and presumably chlorophyll content of the leaves. These might have resulted in better interception, absorption and utilization of radiation energy leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants. The overall improvement in crop growth was reflected

Table 1: Nutrient content and quantity of organic manures applied in both the years

Sl. No.	Organic manures	Nutrient content (%) on dry weight basis						Quantity applied (kg ha^{-1})	
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
		N		P_2O_5		K_2O			
1.	Poultry manure	2.85	2.70	1.41	1.22	1.54	1.34	720	741
2.	Sunnhemp	2.38	2.30	0.59	0.50	1.88	1.80	840	870
3.	Weed compost	0.40	0.44	0.48	0.50	0.48	0.53	5000	4546
4.	Farm waste	0.63	0.85	0.53	0.40	0.66	0.68	3175	2353

Table 2: Effect of intercropping systems and nitrogen sources on yield attributes of cotton (Mean of two years)

Treatments	Monopodial branches (No. plant^{-1})	Sympodial branches (No. plant^{-1})	Boll weight (g)	Boll setting (%)	Bolls (No. plant^{-1})	Fruiting points (No.plant^{-1})
			Intercropping systems			
M_1 - Cotton alone	1.90	27.13	3.78	36.78	35.6	61.0
M_2 - Cotton + onion	1.82	24.79	3.56	39.58	27.4	52.8
M_3 - Cotton + blackgram	1.86	26.02	3.67	38.47	30.4	57.4
M_4 - Cotton + greengram	1.78	24.32	3.54	40.57	25.5	50.9
M_5 - Cotton + lucerne	1.66	23.71	3.50	42.80	23.4	48.4
SEd	0.048	0.508	0.088	0.916	0.9	1.9
CD (P=0.05)	0.118	1.166	NS	2.113	2.1	4.3
			Nitrogen sources			
S_1- 100% recommended inorganic N	1.75	24.69	3.55	43.10	27.1	52.1
S_2- 75% inorganic N + 25% N through poultry manure	1.93	26.35	3.79	37.39	31.6	59.6
S_3- 75% inorganic N + 25% N through sunnhemp	1.79	25.15	3.58	38.31	28.4	53.4
S_4- 75% inorganic N + 25% N through farm waste	1.78	25.04	3.56	39.11	27.9	53.4
S_5- 75% inorganic N + 25% N through weed compost	1.77	24.73	3.56	40.33	27.4	53.1
SEd	0.052	0.533	0.366	0.897	0.8	1.7
CD (P=0.05)	0.115	1.06	NS	1.805	1.6	3.4
Interaction	NS	NS	NS	NS	NS	NS

in better source - sink relationship, which in turn enhanced the yield attributes. Similar findings were reported by Madhavi *et al.,*[14] and Cooperband *et al.*[6].

Pest Incidences: Both intercropping systems and nitrogen sources significantly influenced the pest incidences, namely aphids, thrips, leafhopper, whitefly and boll worm (Table 3). Among the intercropping systems, all the treatments involving intercropping recorded lesser pest incidence than sole cotton and the least incidence was recorded under cotton + blackgram intercropping. The decreased pest incidences observed under intercropping treatments might be due to the fact that intercropping is one of the important cultural practices in pest management, could have resulted in reduced pest incidence and increased natural enemies activity. In addition, intercropping of pulses also improved the soil fertility by N fixation in the soil. The modification of the microenvironment and differences in the nutrient uptake by the intercrops might have reduced the pest infestation and the development and movement of insect pests. This is in agreement with the findings of Rao and Reddy[17]. Similarly, Chakravarthy *et al.*,[5] also reported increased parasitism might be due to the availability of nectar, pollen and existence of favourable microclimate in intercropped zones of agro - ecosystem and increased natural enemies viz., coccinellids and chrysopids by conservation.

Table 3: Effect of intercropping systems and nitrogen sources on pest population (000's ha^{-1}) in cotton. (Mean of two years)*

Treatments	Aphids	Thrips	Leaf hopper	Whitefly	Boll worm
Intercropping systems					
M_1	281.40	248.71	372.60	338.00	52.80
M_2	260.60	223.60	240.60	286.60	43.00
M_3	252.80	108.00	311.60	270.60	35.80
M_4	255.20	207.60	317.60	274.00	41.20
M_5	271.40	236.00	347.80	315.00	45.80
Mean	264.28	204.78	318.04	296.84	43.73
Nitrogen sources					
S_1	280.40	229.31	357.60	312.40	53.00
S_2	245.60	184.60	315.80	278.40	39.40
S_3	255.20	196.80	330.20	292.80	53.20
S_4	266.00	202.20	337.20	298.00	44.00
S_5	274.20	211.00	349.40	302.60	49.00
Mean	260.28	200.78	334.04	292.84	46.72

*Data not analyzed

Table 4: Effect of intercropping systems and nitrogen sources on seed cotton yield (kg ha^{-1})

Nitrogen Sources	Intercropping systems											
	2002 - 2003						2003 - 2004					
	M_1 - Cotton alone	M_2 - Cotton + onion	M_3 - Cotton + black gram	M_4 - Cotton + greengram	M_5 - Cotton + lucerne	Mean	M_1- Cotton alone	M_2 - Cotton + onion	M_3 - Cotton + black gram	M_4 - Cotton + greengram	M_5 - Cotton + lucerne	Mean
S_1- 100% recommended inorganic N	1800	1650	1745	1560	1450	1641	1710	1590	1665	1500	1410	1575
S_2- 75% inorganic N+ 25% N through poultry manure	2553	1970	2100	1850	1750	2045	2377	1880	2020	1782	1680	1948
S_3- 75% inorganic N+ 25% N through sunnhemp	2020	1840	1965	1740	1635	1840	1900	1765	1860	1690	1580	1759
S_4- 75% inorganic N+ 25% N through farm waste	1950	1770	1890	1680	1580	1774	1820	1700	1790	1618	1517	1689
S_5- 75% inorganic N+ 25% N through weed compost	1875	1710	1800	1605	1515	1701	1765	1650	1715	1560	1470	1632
Mean	2040	1783	1900	1687	1586		1914	1717	1810	1630	1531	
		SEd		CD (P=0.05)				SEd		CD (P=0.05)		
M		39.6		91.2				37.5		86.4		
S		33.9		68.7				34.4		69.6		
M at S		78.6		164.6				78.4		163.5		
S at M		76.0		153.6				76.9		155.5		

Application of 75% inorganic N + 25% N through poultry manure resulted in lower number of aphids (245.60 in 000's ha^{-1}), thrips (184.60 in 000's ha^{-1}), leaf hopper (315.80 in 000's ha^{-1}), whitefly (278.40 in 000's ha^{-1}) and boll worm (39.40 in 000's ha^{-1}) in both the years. In addition, organic manures also supply macro and micronutrients to the crop plants and improve the physical properties of the soil. Organic manures were reported to work like slow release fertilizers facilitating balanced growth, finally making plants less prone to pest incidence. This is in agreement with the findings of Bhawalkar and Bhawalkar[3]. Similar findings were also by Lyashenko *et al.,*[13] who reported that increased levels of leucoanthocyanins, catachins, flavanol, glycosides and phenol carboxylic acids in plants, which were received from organic manures.

Seed Cotton Yield: Yield of seed cotton was significantly influenced by the intercropping systems and nitrogen sources (Table 4). Sole crop of cotton

recorded higher seed cotton yield (2040 and 1914 Kg ha-1) than intercropped cotton. Enhanced growth without intercrop competition resulted in better development of yield attributes such as sympodial branches, fruiting points and number of bolls ultimately leading to increased seed cotton yield. Further uptake of NPK was also significantly higher in sole cropping of cotton at all crop stages, which might have also contributed to higher production efficiency. Similar findings were reported by Balasubramanian[2] and Deshpande *et al.,*[7]. Intercropping led to reduction in yield of cotton by 6.9 to 22.2 per cent depending on intercrop species. Yield reduction was higher with lucerne (20.0 - 22.2%) followed by green gram (14.8 - 17.3), onion (10.3 - 12.5%) and blackgram (5.4 - 6.9%).

The seed cotton yield was greatly influenced by the nitrogen sources. Substitution of 25% N through organic sources resulted in increase in yield (3.6 - 24.6%) over application of entire N through inorganic sources. Largest increase in yield (23.7 - 24.6%) was achieved with integration of poultry manure to substitute 25% N. It was followed by the incorporation of sunnhemp to supply 25% N (11.7 - 12.1%). The increased yields achieved with poultry manure might be due its high N content and its narrow C: N ratio, which accelerated the release of nitrogen. Similar findings were reported by Bishnoi and Bajwa[4]. Ghosh *et al,*[8] also reported that poultry manure as a rich source of nitrogen and phosphorus had positive influence on seed cotton yield.

Among the treatment combinations, sole cotton applied with 75 per cent inorganic N through poultry manure resulted in higher seed cotton yield in both the years of study. This was followed by cotton + blackgram with 75 per cent inorganic N + 25 per cent N through poultry manure.

Conclusion: It can be concluded that cotton + black gram intercropping with 75% inorganic N + 25% N through poultry manure recorded significantly lesser pest incidence, higher yield attributes and seed cotton yield in both the years of study.

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