Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
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Asian Journal of Plant Sciences
Volume 1 Number 1, 34-36, 2002

Effect of Placement and Broadcast Application of N and P in Cotton-Mungbean Intercropping System

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Abstract: Effect of surface broadcast and band placement of N and P fertilizers was evaluated in cotton-mungbean Intercropping system with respect to yield and crop productivity under field conditions. Response of interplanted crops to both elements varied with their mode of application. Significantly higher crop harvests were recorded from the placement of nutrients than broadcast application. Nutritional choice of both crops was different since cotton preferred N over P whereas reverse was true for mungbean. More over, highest return from cotton-mungbean Intercropping system was obtained with the band placement of fertilizer N along with the cotton and fertilizer P along with the mungbean.

Key words: Intercropping, surface broadcast, band placement, *Gossypium hirsutum* L., *Vigna radiata*

Introduction

Intercropping is well known for increasing the productivity of land (Wahua, 1983; Altieri and Liebman, 1986). It has a long and established history in most of the under developed world (Rajat, 1980; Barrada, 1980; Maqbool and Silva, 1999), viz-a-viz there are indications that such systems will continue to be a principal feature of small farm agriculture for foreseeable future (McCollum, 1980). Choice of the crops and their proper management can play a determinant role in making such systems efficient. Growing crops of dissimilar growth habit such that the peak periods of their growth do not coincide would ensure optimum productivity of the two crops growing in association (Rajat, 1980). For long duration and initially slow growing crop like cotton, short duration and fast maturing grain legumes would appear to be most compatible companion crops. However, there are variable reports on intercropping cotton with such legumes. (Rao and Murthy, 1965; Kairon *et al*., 1975). Fertilizer requirements of intercropping systems are altogether different from the sole cropping and it becomes operationally difficult to meet the demand of the interplanted crops simultaneously since heavy N fertilization of dominant component may often not be conducive for the growth of recessive associate of the system (Rajat, 1980). The present investigations were, therefore, undertaken to evaluate the relative efficacy of broadcast and band placement of fertilizer N and P in cotton-mungbean intercropping system and to suggest fertilization schedule for best meeting their demand for maximization of land productivity.

Materials and Methods

A field study was conducted at the experimental farm of NIA, Tandojam to evaluate the performance of N and P with respect to yield and crop productivity when applied through broadcast and band placement in cotton-mungbean intercropping system. The experimental site was silty clay in texture, non-saline in nature (EC 0.76 dS m^{-1}), low in O. M (0.82%), Kjeldahl N (0.04%) and Olsen's P (6.2 mg kg^{-1}). Seven treatments as per under mentioned detail were arranged according to randomized complete design with four repeats in 5.5 x 6m^2 sub plots.

T_1 = Control (N0 P0)
T_2 = N by broadcast method over entire plot
T_3 = N by placement method alongside cotton
T_4 = P by broadcast method over entire plot
T_5 = P by placement method alongside mungbean
T_6 = N + P by broadcast method over entire plot
T_7 = N alongside cotton and P alongside mungbean by placement method

Cotton (cv: AENS-10/87) was cropped at an inter-row spacing of 80 cm whereas mungbean (cv: AEM-96) was centered in between cotton rows as a supplementary crop. Each plot was having 8 rows of cotton and 7 rows of mungbean. Fertilizer N as urea was applied at 120 kg ha^{-1} in two equal splits i.e., half at sowing and the other half at first irrigation, whereas fertilizer P at the rate of 75 kg ha^{-1} in the form of single super phosphate was applied to their respective treatments in a single dose through broadcast method at sowing and through band placement after crop emergence. Cotton leaves were sampled at squaring, flowering and initial boll formation stages and assayed for N and P contents using standard methods (Jackson, 1962). Competition between cotton and mungbean was continued for 68 days. Yield data on seedcotton was recorded and completed in three consecutive pickings. The results were compiled and statistically analyzed using standard method of analysis (Steel and Torrie, 1986). The differences among treatment means were compared by employing Duncan's multiple range test (Duncan, 1970).

Results and Discussion

Concentration of N in cotton leaves: N status of leaves collected at various growth stages of cotton was significantly affected by different treatments (Table 1). Concentration of N in leaves sampled from control was 2.76% at squaring, 2.60% at flowering and 2.36% at boll formation stage. Application of N at 120 kg ha^{-1} induced significant improvement in leaf N content as compared to control treatment with particular reference to band placement, which showed relatively higher leaf N than broadcast application. Addition of P to N showed a tendency of higher N assimilation when applied by either method. Significantly highest N figures of 3.46, 3.39 and 3.04% recorded with band placement were statistically identical to 3.43, 3.36 and 2.95% obtained from broadcast application at squaring, flowering and boll formation stages respectively. Compared to broadcast application, higher leaf N content with banded fertilizer may be due to its placement in closer proximity to cotton roots and increased susceptibility of broadcast N to volatilization losses and immobilization by surface organic residues (Locke and Hons, 1988).

Leaf P concentration: Response to applied P was significantly expressed in cotton leaves as indicated in Table 2. Phosphorus concentration was maximum at squaring but declined gradually at subsequent growth stages. Phosphorus applied through broadcast method over the entire plot was efficiently utilized by cotton whereas P drilled alongside mungbean was accessible to the neighboring cotton in minor quantities since leaf P with broadcast application was 0.252% at squaring,

Table 1: Leaf N status at various stages of crop growth

Treatments	N Concentration (%)		
	Squaring	Flowering	Boll formation
T_1 = Control	2.67d	2.60c	2.36d
T_2 = N (broadcast)	3.11bc	3.14b	2.76bc
T_3 = N (Placement)	3.32ab	3.24ab	2.81ab
T_4 = P (Broadcast)	2.89cb	2.74c	2.55cd
T_5 = P (Placement)	2.76d	2.57c	2.40d
T_6 = N + P (Broadcast)	3.43a	3.36ab	2.95a
T_7 = N + P (Placement)	3.46a	3.39a	3.04a

Means followed by similar letters do not differ significantly from each other at 5% level by DMR test.

Table 2: Leaf P concentration at different stages of crop growth

Treatments	P Concentration (%)		
	Squaring	Flowering	Boll formation
T_1 = Control	0.202d	0.168c	0.163e
T_2 = N (broadcast)	0.211d	0.177c	0.172de
T_3 = N (Placement)	0.216cd	0.181c	0.179cd
T_4 = P (Broadcast)	0.252a	0.217a	0.203b
T_5 = P (Placement)	0.227bc	0.197b	0.187c
T_6 = N + P (Broadcast)	0.258a	0.222a	0.215a
T_7 = N + P (Placement)	0.233b	0.202b	0.197b

Means followed by similar letters do not differ significantly from each other at 5% level by DMR test.

Table 3: Crop yields as affected by placement and broadcast application of N and P

Treatments	Crop yield (kg ha^{-1})		
	Seedcotton	Mungbean	Combined
T_1 = Control	733.4e	409.1e	1142.4d
T_2 = N (broadcast)	1272.7c	787.8b	2060.6b
T_3 = N (Placement)	1469.7a	672.7c	2142.4b
T_4 = P (Broadcast)	860.6d	566.7d	1427.3c
T_5 = P (Placement)	787.8e	706.1c	1493.9c
T_6 = N + P (Broadcast)	1363.6b	803.1b	2166.7b
T_7 = N + P (Placement)	1481.8a	921.2a	2403.0a

Means followed by similar letters do not differ significantly from each other at 5% level by DMR test.

Table 4: Agronomic efficiencies of cotton and mungbean as affected by placement of N and P

Treatments	Kg yield kg^{-1} of nutrient applied	
	Seedcotton	Mungbean
T_1 = Control	0.00g	0.00e
T_2 = N (broadcast)	4.50b	3.29b
T_3 = N (Placement)	6.12a	2.22cd
T_4 = P (Broadcast)	1.69e	2.10d
T_5 = P (Placement)	0.70f	3.99a
T_6 = N + P (Broadcast)	3.23d	1.95d
T_7 = N + P (Placement)	3.85c	2.64c

Means followed by similar letters do not differ significantly from each other at 5% level by DMR test.

0.217% at flowering and 0.203% at boll formation against leaf P status of 0.227, 0.197 and 0.187% recorded with the placement of fertilizer P at corresponding growth stages of cotton respectively. Moreover, assimilation of P was catalyzed by the addition of N indicating positive synergistic relationship between the two elements. Significant differences in between broadcast and band placement for P levels of interplanted cotton leaves however, do not coincide with those reported by Shere *et al*. (1975), where the difference in the P content of monoculture cotton leaves was statistically similar for broadcast and band placement of labelled superphosphate.

Seed cotton yield: The data presented in Table 3 indicated that the yield of interplanted cotton was influenced significantly by both methods of N and P application. With the exception of T_5 where P at 75 kg ha^{-1} was drilled alongside mungbean; the control producing 733.4 kg ha^{-1} was out yielded by rest of the fertilizer treatments. Nitrogen supplemented at 120 kg ha^{-1} through placement method produced 1469.7 kg ha^{-1} of seedcotton, which was significantly higher than 1272.7 kg ha^{-1} recorded from the same rate of broadcast nitrogen. Seedcotton yield was also affected significantly by P application. Phosphorus applied alone through broadcast method produced significantly higher yield as compared to control whereas P banded alongside mungbean was expressed insignificantly by yielding 787.7 kg ha^{-1} of seedcotton. The data further revealed that simultaneous application of N and P by either method resulted into significantly higher seedcotton harvests as compared to their respective single application. Highest yield to the tune of 1481.8 kg ha^{-1} was harvested with the simultaneous placement of N alongside cotton and P alongside mungbean. These results corroborate with the finding of Shah *et al.*, 1994, who reported that fertilization of N and P by deep placement method produced significantly higher seedcotton harvests as compared to broadcast application of N + P at sowing for two consecutive years. Higher yield response of banded fertilizer P may be attributed to increased P availability owing to less P fixation and conversion of applied phosphates to slowly available compounds as compared to broadcast phosphorus. Since P sorption maxima depends on the ratio of soil to applied phosphates, fixation of broadcast P is much greater than the fertilizer P applied in bands because of the narrow soil to fertilizer ratio in the latter situation (Rashid and Din, 1993; Mahmood-ul- Hassan *et al.*, 1993).

Mungbean yield: Mungbean harvests were significantly affected by N and P when applied by either method (Table 3). Nitrogen applied by broadcast over the entire plot produced 787.8 kg ha^{-1} of mungbean, which was significantly higher than 672.7 kg ha^{-1} recorded from the same rate of N applied through placement alongside cotton rows. Phosphorus applied by band placement alongside mungbean yielded 706.1 kg ha^{-1} of mungbean against 566.7 kg ha^{-1} recorded from the same rate of broadcast phosphorus. Moreover, yield response of mungbean intercrop to N + P application was significantly different as compared to their respective single or alone applications. Highest yield to the tune of 921.2 kg ha^{-1} recorded in the treatment receiving N + P through placement was significantly higher than 803.1 kg ha^{-1} obtained from the treatment receiving N + P through broadcast method. Likely response of mungbean to different methods of P fertilization was observed by Din and Rashid (1994), who reported that drilling of fertilizer P resulted in 72% saving of fertilizer without affecting plant growth and crop yield since fertilizer requirement for near maximum grain yield was 18 kg P ha^{-1} by placement and 66 kg P ha^{-1} by broadcast method. These results also corroborate with the findings of Rashid *et al*. (1990) who reported that band placed fertilizer P was 33% more efficiently utilized by chickpeas as compared to corresponding broadcast P application.

Combined yield: Performance of broadcast and band placement of N and P in cotton-mungbean intercropping system has been expressed in terms of combined yield (Table 3). The data showed that control (N0 P0) was out yielded by all the treatments. Fertilizer N applied alone at 120 kg ha^{-1} produced significantly higher combined harvests as compared to P applied at 75 kg ha^{-1} irrespective of method of fertilizer application. The yield differences between broadcast and band placement for N or P application were statistically non significant. Significantly highest combined yield of 2403 kg ha^{-1} was recorded from N + P placement and lowest harvests of 1142.4 kg ha^{-1} were obtained from the control treatment. These results are in close conformity to those reported by Rajat (1980), where combined harvests recorded from Maize + mungbean, maize + blackgram and maize + cowpea when grown at 120 kg N ha^{-1} were increased over their respective controls by 44.4, 33.5 and 43.8%, respectively.

Agronomic efficiency: It is one way of expressing the fertilizer use efficiency in quantitative terms. According to Tandon (1987), this parameter determines the vehemence of certain input on per unit basis. The data showed that choice of cotton and mungbean for N and P when grown in an intercropping system was altogether different (Table 4). Cotton preferred N over P whereas reverse was true for mungbeans. Significantly highest return per kg of applied N when supplemented through placement method was 6.12 kg for cotton whereas highest yield per kg of applied P was 3.99 kg for mungbean.

Despite consistent efforts of the researchers, we are lagging behind the

target of attaining self-sufficiency for feeding the rapidly increasing population. The land resources of the country though limited would be enough to meet future challenges for sustainable crop production provided that they are efficiently utilized. The present investigations suggest that intercropping system involving legumes as recessive associates is one of such options, which may help to address this issue by improving per acre crop harvests without additional inputs.

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