Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences
Volume 1 Number 4: 358-360, 2002

Effect of Different N Management Practices and Planting Geometries in Cotton-mungbean Intercropping System

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Abstract: The study was undertaken to determine the performance of cotton and mungbean, when grown simultaneously in different geometric proportions and fertilized by various methods. Compared to sole cropping, the yield of interplanted cotton was reduced significantly by increasing the density of recessive component of intercropping system. The reduction in seed cotton yield was accounted to be 30% in 1:1 and 40% in 1:2 cotton-mungbean planting geometry. However, statistically similar seed cotton yield to that of sole cotton was recorded from the system following 2:1 row arrangements of cotton and mungbean. Fertilizer N applied by banding alongside the rows of cotton produced significantly higher seed cotton yield as compared to broadcast applications, whereas, N applied through broadcast method over entire plot led to higher mungbean harvest when compared with the treatment receiving fertilizer N by banding technique. Cotton and mungbean interplanted according to 2:1 row arrangements surfaced as the most compatible system by producing combined yield of 4465 kg ha^{-1}, which was 18.7% higher than monoculture cotton.

Key words: Intercropping, cotton, mungbean, planting geometry

Introduction

Intercropping is a modern agronomic technique and is considered to be an effective and potential mean of increasing crop production per unit area and time (Ahmad and Anwar, 2001). It offers considerable yield advantage over sole cropping because of its efficient utilization of plant growth resources (Ahmad and Rao, 1982; Mittal *et al.*, 1985). Several crops are involved in cropping system over the world including legume and cereal combination (Ahmad *et al.*, 1990; Subedi, 1997; Itulya and Aguyoh, 1998). Apart from legume/cereal intercropping, the legume/cotton combination is also common in cotton growing areas of Pakistan. Research conducted to improve these traditional systems so far has been concentrated mostly on agronomic studies covering aspects like compatibility of different crop species, studies on plant density, inter-row and intra-row spacings and genotypes etc. (Rao *et al.*, 1987; Sarkar and Pramanik, 1992) with little emphasis on fertilizer management and geometry of interplanted crops. Some issues of fertilization that should be examined for obtaining higher efficiency of fertilizer usage include, a) how to fertilize the component species in intercropping, particularly when the species respond differently to a particular nutrient, b) whether intercropping is advantageous under high input technologies and c) whether the legumes modify the nutrient responses of associated crop.

There has been some speculation, mostly based on laboratory studies that legumes might benefit the associated crops in intercropping by transferring part of nitrogen fixed during the crops growing season (Rewari *et al.*, 1972; Ruschel *et al.*, 1979). However, very few studies have actually demonstrated the direct benefit of legumes to cotton in intercropping. In some studies, the positive effects were reported either in insufficient range of fertility situations (De *et al.*, 1978; Singh, 1981) or the legume effect was confounded with plant population because the intercrops were planted in a replacement system (Remison, 1978; Eaglesham *et al.*, 1981). Legumes when intercropped with cereals showed consistently reduced nitrogen fixation indicating that they are of less benefit to the cereals (Nambiar *et al.*, 1983; Wahua and Millar, 1978). The response of maize intercropped with soybean to nitrogen fertilization was similar to that of sole cropped maize (Ahmed and Gunasena, 1979; Ahmad and Rao, 1982). Although, the information on association of legume with cereal for nitrogen beneficiary is available in literature, but very few studies have been conducted on legume/cotton intercropping.

The study was undertaken to determine the yield response of cotton and mungbean, when planted simultaneously in different geometric proportions and fertilized by different methods.

Materials and Methods

A field study was conducted at the Experimental Farm of Nuclear Institute of Agriculture (NIA), Tandojam during 1999-2000 to determine the suitability of different planting geometries and mode of N fertilizer application in cotton-mungbean intercropping system for higher efficiency of crop production. The experimental site was silty clay in texture with ECe ranging from 0.72 to 0.76 mS cm^{-1}. The soil was deficient in organic matter (0.82%), total N (0.04%) and available P (6.2 mg kg^{-1}). The experiment was laid out according to split plot design with cropping geometries forming the main plot and method of fertilizer application, the sub plots. Fertilizer nitrogen was applied @ 120 kg N ha^{-1} in single or split doses either through broadcast method over entire plots at sowing or through banding technique alongside cotton rows after crop emergence. The details of planting geometries involved in intercropping system were as follows:

- PG 0 Sole crop of cotton, having 7 rows at 80 cm apart
- PG 1 Intercrop, one row of cotton alternating with one row of mungbean each at 40 cm apart with 7 rows of cotton and 6 rows of mungbean.
- PG 2 Intercrop, one row of cotton alternating with two rows of mungbean each at 30 cm apart with 6 rows of cotton and 10 rows of mungbean.
- PG 3 Intercrop, two rows of cotton at 60 cm apart alternating with one row of mungbean each at 30 cm apart with 9 rows of cotton and 4 rows of mungbean.

The cotton cultivar CV., NIAB-78 and mungbean, AEM-96 were sown simultaneously according to their respective cropping densities in the subplots each measuring 5 x 3m^2. The treatments were fertilized with triple superphosphate applied at 75 kg P ha^{-1} as a blanket dose at the time of sowing. Mungbean planted in between cotton rows took up its growth very quickly and was harvested after 68 days of sowing thus terminating its competition for all resources with the associated cotton at the early stage of its growth and development. Yield data on seed cotton were recorded and completed in three consecutive pickings. Standard laboratory procedures were adopted for analysis of soil (Jackson, 1962). The results obtained were subjected to statistical analysis using methods prescribed by Steel and Torrie, 1986. The differences among the treatment means were compared by using DMR test (Duncan, 1970).

Results and Discussion

Seed cotton yield: Irrespective of methods or mode of N application, seed cotton yield was highest in sole cropping with an overall average yield of 3760 kg ha^{-1} (Table 1). Mungbean interplanted within cotton rows led to significant reduction in seed cotton harvest. The magnitude of depression was accounted to be 30% in 1:1 and 40% in 1:2 cotton-mungbean planting geometry. However, 2:1 geometry of cotton-mungbean produced statistically similar yield to that recorded from the sole cotton crop. Nitrogen banded alongside the cotton rows exhibited significantly higher yield responses as compared with broadcast N irrespective of their mode of application. Fertilizer N supplemented by banding in single dose produced 263 kg ha^{-1} of additional seed cotton harvest, which was 8% higher than corresponding split application method. The results indicate that early maturing mungbean may likely to be less competitive with dominant crop and thus more suitable for interplanting in cotton provided that the interplanted species are managed in such a way that their interspecific competition for all resources is decreased as compared to intraspecific competition (Horwith, 1985).

Table 1: Seed cotton yield (kg ha^{-1}) as affected by different cropping densities in cotton-mungbean intercropping system

Cropping system	Broadcast Single	Broadcast Split	Banding Single	Banding Split	System mean
Sole	3600	3413	4167	3860	3760a
1:1	2587	2360	2880	2667	2624b
1:2	2087	2033	2393	2207	2180c
2:1	3587	3353	4153	3807	3725a
Mean	2965d	2790c	3398a	3135b	-

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

Table 2: Grain yield of mungbean (kg ha^{-1}) as affected by different cropping densities in cotton-mungbean intercropping system

Cropping system	Broadcast Single	Broadcast Split	Banding Single	Banding Split	System mean
Sole	-	-	-	-	-
1:1	1047	967	920	867	950b
1:2	1320	1447	1280	1233	1320a
2:1	813	773	713	660	740c
Mean	1060a	1062a	971b	920b	-

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

Table 3: Combined yield (kg ha^{-1}) as affected by different cropping densities in cotton-mungbean intercropping system

Cropping system	Broadcast Single	Broadcast Split	Banding Single	Banding Split	System mean
Sole	3600	3413	4167	3860	3760b
1:1	3633	3327	3800	3533	3573c
1:2	3407	3480	3673	3440	3500c
2:1	4400	4127	4867	4467	4465a
Mean	3760b	3587c	4127a	3825b	-

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

Sole = (cotton alone)
1:1 = (one row of cotton: one row of mungbean)
1:2 = (one row of cotton: two rows of mungbean)
2:1 = (two rows of cotton: one row of mungbean)

It was observed that wherever, the mungbean density was increased in between cotton lines, the yield of seed cotton was badly affected due to competitive affect of the crop (Adetiloye, 1980). Although mungbean, a legume, has the ability to fix nitrogen and was sown right with the sowing of cotton crop. It could be assumed that mungbean will have lower competitive affect for cotton. But the competition for the available resources between two crops was observed, when mungbean density was increased between the cotton rows. Due to this competitive effect the seed cotton yield was reduced. The findings were in close agreement to those reported by Natarajan and Naik (1992), where cowpea, being strongly competitive, reduced cotton yield, when grown as an intercrop to an extent depending on growing condition and time of its planting relative to cotton. The observation was further strengthened by the higher yield obtained by banding of fertilizer in vicinity of cotton roots. When fertilizer was applied through broadcast method, roots of both crops were having equal opportunity to absorb and assimilate nitrogen from the soil, which affected the cotton yield adversely. But when the fertilizer was banded near the cotton roots, cotton crop fulfilled its requirement from the applied N and mungbean by fixing it, thus the yield of cotton was increased. The findings implied that mungbean did not compete with cotton, when it was interplanted in 2:1 geometry. In this planting pattern, the population of legume crop was maintained at a lower level as compared to dominant component of intercropping system. The nitrogen fixed by legume may be sufficient for recessive crop itself and cotton benefited from applied N and produced higher harvest. Thus the early maturing legume was less competitive and required greater plant density for adversely affecting the yield of dominant crop (Ntare, 1990).

Mungbean: Mungbean yield was significantly affected by planting geometries (Table 2). The highest yield of 1320 kg ha^{-1} accrued from 1:2 planting ratios, was followed by 950 and 740 kg ha^{-1} harvested from 1:1 and 2:1 cotton-mungbean pattern, respectively. Moreover, different N management practices induced significant impact on mungbean. The broadcast application of fertilizer N in entire plot yielded significantly higher mungbean compared to banding of N alongside cotton rows. Nitrogen applied through broadcast method either in single or in split doses gave statistically similar grain yield of 1060 and 1062 kg ha^{-1}. The lower grain yield by either way of banding was 971 and 920 kg ha^{-1}.

Differential yield response of mungbean at various planting proportions commensurate with the fluctuation in mungbean planting density within the cropping system. Mungbean competed with cotton for available resources in 1:2 geometry, which led to increased mungbean harvest at the cost of yield losses in associated cotton crop. The other probable reason for higher yield in 1:2 planting pattern could be the increased plant population of mungbean per unit area. The higher number of plants per unit area produced the higher yield. However, having lower population in 1:1 and 2:1 planting pattern, mungbean could not compete with companion cotton, which affected its yield adversely. Likely findings were reported by Natarajan and Naik (1992), while working with intercropping of cotton and cowpeas in Zimbabwe.

Combined harvest: The performance of cotton and mungbean in terms of total production when grown in different geometrical pattern has been depicted in Table 3. The results showed that productivity was significantly affected by various cropping systems. Simultaneous cropping of cotton and mungbean in 2:1 ratio proved to be the most effective system by producing combined harvests of 4465 kg ha^{-1}, which were 18.7% higher than monoculture cotton (3760 kg ha^{-1}). However, cotton and mungbean arranged according to 1:1 and 1:2 ratios produced significantly lower composite yield than sole cotton, which may be due to effective competition between two crops for available resources.

The results are in close conformity to those reported by Rajat (1980), where combined harvests recorded for 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. On further exploration of data it was found that banding and broadcast methods for N application were different from each other with respect to crop yield. The banding of N fertilizer depicted its superiority over broadcast method by producing significantly higher yield of 4127 kg ha^{-1}. However, single dose application of fertilizer N in either case was prone to be more profitable by gearing up the crop harvests as compared to their respective split applications.

It may be inferred from the present investigation that yield advantages in an intercropping system could only be achieved by manipulating planting ratio of intercrops in such a way that the recessive component may thrive without affecting the yield of dominant associate of the intercropping system.

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