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Light Interception and Productivity of Baby Corn as Influenced by Crop Geometry, Intercropping Systems and INM Practices*

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Abstract: Field experiments were conducted during kharif (June-September) 2002 and summer (March-May) 2003 seasons at Eastern Block farm, Tamil Nadu Agricultural University, Coimbatore. The experiments were laid out in split plot design with two factors in main plots viz., crop geometry (45×25 cm (S_1) and 60×19 cm (S_2)) and intercropping systems [(sole baby corn (C_1), baby corn + *Amaranthus* (C_2) and baby corn + green gram (C_3)] and four INM practices [(100% recommended NPK (150:60:40 kg ha^{-1}) alone (N_1); 50% NPK + FYM + *Azospirillum* + phosphobacteria (N_2); 50% NPK of baby corn + Poultry manure + *Azospirillum* + phosphobacteria (N_3) and 50% NPK of baby corn + Goat manure + *Azospirillum* + phosphobacteria (N_4)] were allotted in sub plots. The results revealed that barring at 25 DAS, S_2 registered higher light interception than S_1. Intercropped baby corn recorded greater light interception than sole baby corn at 25 DAS and 45 DAS. The results at later stages were comparable. The treatments N_3 and N_4 recorded higher light interception than N_1 and N_2. Similarly, higher green cob yield and Baby corn Equivalent Yield (BEY) registered at S_2 than S_1. Under intercropping situation, baby corn yield was not varied but BEY was significantly higher in C_2 and C_3 than C_1. Similar to light interception, baby corn yield and BEY were significantly higher with N_3 and N_4 than the rest. Strong positive and significant correlation between light interception and baby corn yield was noticed at all the stages except at 25 DAS during summer 2003 season. Whereas, the correlation between BEY and light interception was significant at 25 DAS during kharif 2002 and at 25 and 45 DAS during summer 2003 season.

Key words: Baby corn, baby corn equivalent yield, light interception, green cob yield, correlation analysis

INTRODUCTION

Living standard of people and shift in food habit from non-vegetarian to vegetarian in the world evolved several vegetables. One such vegetable is called baby corn i.e., the immature cobs are harvested and used. Since baby corn is a short duration (65-75 days) and new plant type, standardization of agro-techniques is needed to ensure the income of farmers (Thavaprakaash *et al*., 2006).

Space availability to the individual plant is necessary to use the soil resources effectively and to harvest the maximum possible solar radiation to attain higher yield. Though the spacing requirement of grain and fodder corn has been standardized, the information on the influence of spacing on yield and light interception behavior of baby corn that too under intercropping situation is lacking. Baby corn enters into the reproductive phase from 45-55 DAS and ends its life cycle within 65-75 days. Until that the space, light, moisture and nutrients in soil are under utilized. Such resources could

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effectively be utilized by introducing short duration intercrops, which complete their life cycle within 50-55 days. Vegetable like *Amaranthus* and short duration pulse (Green gram) are better option, as they would not compete much to baby corn. Suitability of *Amaranthus* (Amma and Ramdas, 1991) and green gram (Shivey and Singh, 2000) was already proved with other crops. These two crops are compatible with baby corn too. Introduction of organic manures along with inorganic fertilizers not only increase the yields but also quality of produce (Suri *et al*., 1997; Nanjundappa *et al*., 2000). *Azospirillum*, a bio-fertilizer could supply 25% of N requirement (Rai and Gaur, 1982) whereas, phosphobacteria a phosphate solubilizing bacteria will make available the phosphate source (Datta *et al*., 1992). Information on these factors on light interception and baby corn yield is lacking and so the present study was undertaken.

MATERIALS AND METHODS

The field experiments were conducted during kharif (June to September) 2002 and summer 2003 (February to May) seasons at Eastern Block farm, Tamil Nadu Agricultural University, Coimbatore. The experimental site is located at 11°N latitude, 77°E longitude with an altitude of 426.7 m above MSL. The soil of the experimental area was sandy clay loam (*Typic Ustropept*) with alkaline pH; low in organic carbon (0.31 and 0.30%) and available N (246.5 and 239.7 kg ha^{-1}), medium in available P (11.9 and 13.0 kg ha^{-1}) and high in available K (400.8 kg ha^{-1} each) during kharif 2002 and summer 2003 seasons, respectively. The baby corn composite COBC1, *Amaranthus* cv. CO 5 and green gram cv. Pusa bold were chosen for the study.

The experiments were laid out in split plot design with three replications on a gross plot size of 5.4×4.0 m and a net plot size of 4.5×3.0 m. Two factors viz., crop geometry at two levels (45×25 and 60×19 cm) and intercropping systems (sole baby corn, baby corn + *Amaranthus* and baby corn + green gram) in main plots and four levels of integrated nutrient management practices [(N_1 - 100% of the recommended dose of NPK (150:60:40 kg ha^{-1}) of baby corn; N_2 - 50% NPK of baby corn + FYM + *Azospirillum* + phosphobacteria; N_3 - 50% NPK of baby corn + Poultry manure + *Azospirillum* + phosphobacteria; and N_4 - 50% NPK of baby corn + Goat manure + *Azospirillum* + phosphobacteria)] in sub plots were assigned. Before sowing, furrows were formed in the beds as per the spacing treatments. The baby corn seeds were pre-treated with fungicide (Carbendazim at the rate of 2 g kg^{-1} of seeds) sown in the furrows and covered with soil. Before sowing, furrows were formed in the beds as per the spacing treatments. Green gram seeds were hand dibbled at a spacing of 10 cm. *Amaranthus* seeds were mixed with sand at 1:5 ratio and sown in furrows as solid sowing. Organic manures were applied as per the treatment (on equal N basis) and incorporated in the soil uniformly. Bio-fertilizers (*Azospirillum* and phosphobacteria) at the rate of 2 kg ha^{-1} were mixed along with well-powdered FYM and spread uniformly as per the treatment. Recommended dose of nitrogen (150 kg ha^{-1}) as Urea, phosphorus (60 kg ha^{-1}) as Single super phosphate and potassium (40 kg ha^{-1}) as Muriate of potash were applied as per the treatment schedule. Fifty per cent of N and K fertilizers along with full dose of P were applied as basal. Remaining half of the N and K were applied as top dressing at 25 DAS. All the agronomic practices were carried out uniformly to raise the crop.

The measurement of light was done between 1200 and 1300 h of the day using a quantum meter (LI-COR model LI-185 A) with 1.0 m line quantum sensor. In each plot, the light incident above the canopy was measured by holding the sensor above the crop canopy. Light transmitted through the crop canopy was measured by holding the sensor below the crop canopy. For transmitted light, two observations were taken, one holding the sensor along the row and other across the rows and the mean was taken. The percentage of light intercepted by the crop canopies of the cropping systems was calculated as under.

$$PLI = \frac{(LI - LT)}{LI} \times 100$$

Where:

- PLI-Percentage of light intercepted,
- LI- Light incident above the crop canopies and
- LT-Light transmitted below the crop canopies.

Light interception pattern was studied at 25, 45 and 60 DAS and at harvest of baby corn.

Harvested cobs from the net plot were weighed and cob yield was recorded from individual plots and expressed in kg ha^{-1}. Baby corn equivalent yield was worked out based on the formulae evolved by Verma and Modgal (1983). The data subjected to statistical analysis as suggested by Gomez and Gomez (1984). The data on light interception of baby corn were correlated with baby corn yield and BEY and their significant relationship was tested by using t-test and indicated * or ** based on their significance.

RESULTS AND DISCUSSION

Light Interception

Data on light interception during both the seasons was significant. Light interception steadily increased up to 60 DAS and decreased at harvest. Between two seasons, the values were higher during kharif 2002 than summer 2003 season (Table 1).

Two crop geometry levels did exhibit a perceptible difference on light interception over seasons. During kharif 2002 season, 60×19 cm (S_2) intercepted more light (29.7, 47.9, 66.0 and 45.7%) at 25, 45 and 60 DAS and at harvest respectively than 45×25 cm (S_1). The results were repetitive during summer 2003 season also. The improved light interception was due to the increased growth parameters of baby corn and intercrops.

Intercropping systems had an appreciable influence on light interception during both the seasons. In general, intercropped baby corn intercepted more light than sole baby corn. Baby corn + *Amaranthus* (C_2) intercropping system harvested the increased light (29.9 and 37.7% at 25 DAS during kharif 2002 and summer 2003 seasons as compared with baby corn + green gram (C_3) intercropping system (28.0 to 36.8%). Whereas, the reverse trend was noticed at 45 DAS during kharif 2002 season and on par during summer 2003 season. The minimum light interception was noted under sole baby corn (C_1). At later stages (60 DAS and at harvest) light interception did not vary significantly. The increased light interception was due to better growth of intercrops. Kailasam (1994) obtained similar results in sugarcane.

The INM practices exerted a positive effect on light interception of baby corn based intercropping systems. At 25 DAS, 100% NPK alone (N_1) did record the highest light harvest (31.2 to 36.8%) during both the seasons. During kharif 2002, combined application of inorganic fertilizers along with organic manures (poultry manure or goat manure) and bio-fertilizers (*Azospirillum* + phosphobacteria) (N_3 and N_4) registered higher (49.2, 66.4 and 46.1% at 45 and 60 DAS and at harvest respectively) than N_2 and N_1. A close parallel was evident at summer 2003 season too. Higher light interception might be due the increased mineralization of organic manures which released the nutrients including micronutrients would have enhanced the growth of the crops and in turn intercepted more light than the rest of the treatments.

Green Cob Yield

Irrespective of the treatments, green cob yields were higher (7243 to 8037 kg ha^{-1}) during kharif 2002 season as compared with summer 2003 (7109 to 7521 kg ha^{-1}) season (Table 1).

Table 1: Yield and light interception of baby corn as influenced by crop geometry, intercropping systems and INM practices under baby corn based intercropping systems

	Light interception							
	Kharif 2002				Summer 2003			
Treatments	1	2	3	4	1	2	3	4
Crop geometry								
S1	26.1	46.3	62.2	42.3	32.4	48.6	58.1	37.2
S2	29.7	47.9	66.0	45.7	35.8	50.7	63.2	39.4
SEd	0.2	0.5	0.5	0.4	0.3	0.4	0.5	0.3
CD (p = 0.05)	0.5	1.0	1.0	0.8	0.6	0.9	1.0	0.7
Intercropping								
C1	25.8	45.4	64.2	43.9	30.8	50.3	60.4	38.2
C2	29.9	46.5	64.2	44.0	37.7	49.5	60.6	38.2
C3	28.0	49.5	64.0	44.1	33.8	49.2	60.9	38.4
SEd	0.3	0.6	0.6	0.5	0.3	0.5	0.6	0.4
CD (p = 0.05)	0.6	1.3	NS	NS	0.7	NS	NS	NS
INM								
N1	31.2	45.1	61.6	41.8	36.8	48.0	58.3	36.6
N2	26.6	45.0	61.7	41.9	33.2	48.2	58.5	37.0
N3	27.1	49.2	66.4	46.1	33.5	51.0	62.7	39.7
N4	26.8	49.2	66.9	46.3	32.9	51.4	63.1	39.7
SEd	0.4	0.9	1.0	0.8	0.6	0.9	1.0	0.7
CD (p = 0.05)	0.9	1.8	2.0	1.5	1.1	1.7	2.0	1.4

Table 1: Continued

	Yield			BEY		
	Kharif 2002	Summer 2003	Pooled	Kharif 2002	Summer 2003	Pooled
Crop geometry						
S1	7333	7116	7222	8870	8183	8526
S2	7976	7519	7747	9507	8450	8979
SEd	107	83	91	52	49	55
CD (p = 0.05)	239	185	190	115	109	121
Intercropping						
C1	7749	7306	7527	8049	7306	7677
C2	7559	7317	7437	9805	8817	9310
C3	7656	7331	7493	9712	8827	9269
SEd	132	102	110	63	60	64
CD (p = 0.05)	NS	NS	NS	141	133	151
INM						
N1	7335	7109	7221	8690	8097	8393
N2	7243	7126	7184	9380	8129	8752
N3	8037	7516	7777	9248	8525	8885
N4	8004	7521	7760	9436	8515	8980
SEd	202	130	151	121	109	127
CD (p = 0.05)	409	263	309	246	222	255

1-25 DAS, 2-45 DAS, 3-60 DAS, 4-At Harvest

Both the seasons, crop geometry led substantial increase in green cob yield of baby corn. Baby corn raised at 60×19 cm (S_2) produced higher cob yields over S_1 (45×25 cm). The percentage of increase of S_2 over S_1 was 10.9 and 10.6 during kharif 2002 and summer 2003 seasons, respectively. The results of pooled analysis also in the same trend where the increase was 10.7%. The increase was due to the effective utilization of applied nutrients increased sink capacity and higher nutrient uptake of crop. The yield potential of baby corn is decided by the growth and yield components. This was reflected in the present study. Khafi *et al.* (2000) also reported higher yields of pearl millet under wider spacing.

No significant response was observed on green cob yield due to the intercropping systems during the study. Non-significant results obtained in growth and yield characters ultimately reflected in the green cob yield of baby corn also. The similar results on yield of maize were also reported by Tiwari *et al.* (2002).

In respect of INM treatments, it had synergistic effect on green cob yield of baby corn during both the seasons. Combined application of inorganic and bio-fertilizers (*Azospirillum* and phosphobacteria) along with either poultry manure or goat manure (N_3 and N_4) produced higher cob yield (8037 and 8004 kg ha^{-1}) and (7516 and 7521 kg ha^{-1}) when compared to FYM (N_2) incorporated with inorganic and bio-fertilizers (7243 and 7126 kg ha^{-1}) and inorganic fertilizers (N_1) alone (7335 and 7109 kg ha^{-1}) during kharif 2002 and summer 2003 seasons, respectively. Same trend also noticed with pooled mean data. Application of poultry manure increased the P availability (More and Ghonshikar, 1988) through the formation soluble complex with organic legends increased the P uptake. Transformation from existing solid phase of K to a soluble metal complex increased the K uptake (Das *et al*., 1991). Fixation of atmospheric N and secretion of growth promoting substances of *Azospirillum* and increased bacterial efficiency by phosphobacteria (Datta and Banik, 1997) combined together might have increased the growth and yield parameters and ultimately yield of baby corn. Yield increase due to poultry manure (Reddy and Reddy, 1999), sheep/goat manure (Ramesh, 1998), bio-fertilizers (Mishra *et al*., 1998) were reported earlier.

Baby corn Equivalent Yield

In general, the Baby corn Equivalent Yield (BEY) was higher during kharif 2002 season than summer 2003 season (Table 1).

During kharif 2002 season, wider (60×19 cm) crop geometry (S_2) registered higher BEY (9507 kg ha^{-1}) than at 45×25 cm (8870 kg ha^{-1}). This was true with summer 2003 season also. The pooled mean was also in similar trend where the yield increase was 9.5%. Increased BEY was solely due to higher yield of baby corn recorded under S_2. Singh (2000) also reported higher maize equivalent yield at 60 cm row spacing.

The effect of intercropping systems on BEY was significant during both the seasons. Sole baby corn (S_1) registered lower BEY (8049 and 7306 during kharif 2002 and summer 2003 season, respectively) as compared to intercropped baby corn (C_2 and C_3). Pooled data also follow the same trend where 21.3 and 20.7% increase over C_1 was recorded in C_2 and C_3, respectively. Additional yield obtained from the intercrops without reducing the main crop yield improved the BEY. Similarly, increased equivalent yield of main crop by addition of intercrops viz., *Amaranthus* (Anitha *et al*., 1999) and green gram (Paradkar *et al*., 1993) under varied component crops was reported earlier. Tiwari *et al*. (2002) reported that leafy vegetables did not show any adverse effect on growth and development of main crop, which may be attributed to the fact that *Amaranthus* is shallow rooted and short-statured with short duration. This is true with the present investigation, where both the intercrops are shallow rooted and did not compete with baby corn.

The INM practice exhibited a positive response on BEY during the course of investigation. During kharif 2002 season, compensation of 50% NPK by organic manure (poultry manure or goat manure) and bio-fertilizers (*Azospirillum* + phosphobacteria) (N_3 and N_4) recorded significantly superior BEY (9248 and 9436 kg ha^{-1}, respectively) over N_2 (50% NPK + FYM + *Azospirillum* + phosphobacteria) and N_1 (100% NPK alone). N_1 and N_2 remained at par. The similar trend was also noted in summer 2003 season and also pooled mean data. Higher yields of baby corn and non-reduction of intercrop yields under these treatments had influenced on the improvement of BEY. Singh *et al*. (1997) reported similar findings of increased Maize Equivalent Yield (MEY) due to the addition of organic manures to inorganic fertilizers.

Correlation Analysis

Correlation between light interception at different stages and baby corn yield during both the seasons was significant (Table 2). Whereas, the correlation between BEY and light interception was significant at all the stages during Kharif 2002 and ouly at 25 and 45 DAS during summer 2003 season. It explained the positive relationship of light interception on productivity of baby corn.

Table 2: Correlation analysis between light interception and green cob yield and BEY of baby corn

	Yield		BEY	
Parameters	Kharif 2002	Summer 2003	Kharif 2002	Summer 2003
Light interception (25 DAS)	-0.604**	0.150	0.243	0.668**
Light interception (45 DAS)	0.681**	0.975**	0.649**	0.567**
Light interception (60 DAS)	0.973**	0.959**	0.281	0.392
Light interception (Harvest)	0.962**	0.913**	0.309	0.348

**Significant at 1% level

CONCLUSION

From the above investigation, it can be concluded that raising baby corn at 60 cm row spacing with coriander and radish as intercrops by following INM practices (50% NPK + poultry/goat manure + *Azospirillum* + Phosphobacteria) intercepted more light which in turn produced higher baby corn and BEY than the rest.

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