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Response of Crop Geometry, Intercropping Systems and INM Practices on Yield and Fodder Quality of Baby Corn

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Abstract: Field experiments were conducted during late rabi 2002 and 2003 seasons at Eastern Block farm of Tamil Nadu Agricultural University, Coimbatore, India. The texture of the experimental fields is sandy clay loam. The experiments were laid out in split plot design. Two factors viz., crop geometry (45×25 cm (S_1) and 60×19 cm (S_2)) and intercropping systems (Baby corn alone (C_1), Baby corn + radish (C_2), Baby corn + coriander (C_3)) were taken in main plots and four INM practices (100% recommended NPK alone (N_1); 50% NPK + FYM + *Azospirillum* + phosphobacteria (N_2); 50% NPK + poultry manure + *Azospirillum* + phosphobacteria (N_3) and 50% NPK + goat manure + *Azospirillum* + phosphobacteria (N_4)) were assigned to sub plots. The experimental results revealed that baby corn and fodder yields were higher at 60×19 cm spacing level as compared with S_1. Intercropping systems did not influence on baby corn and fodder yields. The treatments N_3 and N_4 registered higher baby corn and fodder yields than N_1 and N_2. Neither crop geometry nor intercropping systems did influence on fodder quality of baby corn. All the three INM practices (N_2, N_3 and N_4) recorded higher values of quality parameters than N_1. However, N_3 and N_4 values were significantly higher than N_2.

Key words: Baby corn, intercropping systems, INM practices, fodder yield, fodder quality

INTRODUCTION

Maize is the third most important cereal crop in India as well as in the world. It is used as food for human and feed for livestock especially poultry industry. It late 1970s people in USA and western countries started to consume the young raw cobs called baby corn. Change in food habit from non-vegetarian to vegetarian aggravated the consumption of vegetables especially baby corn (Thavaprakaash *et al*., 2006). Though the baby corn is much popular worldwide, agro-techniques to achieve higher production is the need of the day.

Space available to the individual plant is important which decides the utilization of soil resources and also harvest of solar radiation, both together, in turn decides the yield of baby corn. Though the spacing requirement of grain and fodder maize has been standardized, the information on the influence of spacing on fodder yield and quality of baby corn composite that too under intercropping situation is lacking.

Though baby corn is a short duration crop (65-75 days) and enters into the reproductive phase 55 Days After Sowing (DAS), until that the resources such as light, space, moisture and nutrients are under utilized. Such less utilized resources could be used effectively by introducing short duration vegetables like radish and coriander which end their life cycle before 45 DAS and not having much effect on main crop are selected to grow with baby corn.

A very large number of evidences (Suri *et al*., 1997; Nanjundappa *et al*., 2000; Ramamoorthy and Lourduraj, 2002) confirm the fact that judicious combination of inorganic fertilizers and organic

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manures brings about favorable as well as desirable results in terms of yield, quality of crop produces and fertility built up of soils. Bio-fertilizers in combination with inorganic fertilizers and organic manures are the way to sustain in crop production. *Azospirillum* is used for maize and satisfy 20-25% of nitrogen requirement (Rai and Gaur, 1982) whereas phosphobacteria, a phosphate solubilizing micro-organisms will make available of phosphate sources from the un and/or less available form (Datta *et al*., 1992).

Information on the optimum crop geometry to explore the available resources, suitable intercrops for higher income per unit area and effect of organic manures in combination with inorganic and bio-fertilizers on baby corn fodder yield and fodder quality is meagre. Hence, this study has been contemplated.

MATERIALS AND METHODS

The field experiments were conducted during late rabi (January-March) 2002 and 2003 (December-March) 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 0.32%) and available N (223.6 and 229.7 kg ha^{-1}), medium in available P (12.9 and 13.1 kg ha^{-1}) and high in available K (421.6 and 436.7 kg ha^{-1}) during late rabi 2002 and 2003 seasons, respectively. The baby corn composite CoBC1 and radish cv. Pusa chetki and coriander cv. CO 4 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 cm and 60×19 cm) and intercropping systems (sole baby corn, baby corn+radish and baby corn+ coriander) and integrated nutrient management practices with four levels (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; N_4-50% NPK of baby corn + Goat manure + *Azospirillum* + phosphobacteria) were assigned in sub plots. 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. Furrows were formed in-between the two baby corn rows and the intercrops were sown. Radish seeds were hand dibbled at a spacing of 8 cm. Coriander seeds were rubbed against hard surface and split well into two and sown in lines. Organic manures were applied as per the treatment (on equal N basis) and incorporated in to the soil uniformly. Bio-fertilizers (*Azospirillum* and phosphobacteria) at the rate of 2 kg ha^{-1} were mixed with well-powdered FYM and spread uniformly as per the treatment. Recommended dose of nitrogen (150 kg ha^{-1}) as urea, 60 kg ha^{-1} of phosphorus as single superphosphate and 40 kg ha^{-1} of potassium as muriate of potash were applied as per the treatment schedule. Fifty percent 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.

Harvested cobs from the net plot were weighed and cob yield was recorded from individual plots and expressed in kg ha^{-1}. After harvest of cobs, the baby corn stalks were harvested from the net plot area, weighed and expressed as green fodder yield (t ha^{-1}). Crude protein content of baby corn fodder was computed by multiplying the N content (estimated from the di-acid digest by micro-kjeldahl method) with the factor 6.25 and expressed in percent. Crude fibre was estimated gravimetrically by successive digestion and washing a weighed plant sample with dilute acid and alkali. The material left un-dissolved was considered as crude fibre and expressed in percentage (Goering and Vansoest, 1970). Ether extract (an estimate of crude fats and oils) was estimated gravimetrically by subjecting a weighed, powdered plant sample to continuous extraction with petroleum ether at 40 to 50°C in a Soxhlet extraction apparatus and expressed in percentage (AOAC, 1975). Mineral content was estimated gravimetrically by using the powdered sample and expressed the values in percentage. Nitrogen Free Extract (NFE) was calculated by subtracting the percentage content of moisture, ether extract, crude protein, crude fibre and ash from 100 (Pathak and Jakhmola, 1983). The data subjected to statistical analysis as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Green Cob Yield

Irrespective of the treatments, green cob yields were higher (6801 to 7707 kg ha^{-1}) during late rabi 2002 season as compared with 2003 (5167 to 5608 kg ha^{-1}). Both the seasons, crop geometry led substantial increase in green cob yield (Table 1). 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 11.5 and 3.6 during late rabi 2002 and 2003 seasons, respectively. The results of pooled analysis also indicate the same trend where the increase was 7.9%. The increase might be 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 bajra under wider spacing. Similar results were obtained with the fodder yield also.

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 were also reported by Tiwari *et al.* (2002).

Table 1: Effect of crop geometry, intercropping systems and INM practices on green cob and green fodder yields of baby corn

	Green cob yield (kg ha^{-1})			Green fodder yield (t ha^{-1})	
Treatments	1	2	3	1	2
Crop geometry					
S_1	6877	5340	6104	26.60	20.60
S_2	7666	5533	6584	29.20	22.10
SEd	218	57	121	0.48	0.23
CD (p = 0.05)	485	127	250	1.07	0.51
Intercropping					
C_1	7124	5384	6250	28.10	21.50
C_2	7348	5372	6361	27.90	21.20
C_3	7349	5402	6374	27.80	21.30
SEd	266	70	145	0.59	0.28
CD (p = 0.05)	NS	NS	NS	NS	NS
INM					
N_1	6801	5173	5986	25.90	19.80
N_2	7012	5167	6090	26.20	20.20
N_3	7707	5598	6651	29.80	22.90
N_4	7668	5608	6588	29.80	22.40
SEd	298	110	186	0.74	0.44
CD (p = 0.05)	604	222	376	1.49	0.89

Interaction absent

1-Late rabi 2002	2-Late rabi 2003	3-Pooled mean of both the seasons
Crop Geometry	Intercropping systems	Integrated Nutrient Management practices
S_1-45×25 cm	C_1-Baby corn alone	N_1-Recommended inorganic fertilizers to baby corn
S_2-60×19 cm	C_2-Baby corn + Radish	N_2-50% NPK of baby corn + FYM + *Azospirillum* + phosphobacteria
	C_3-Baby corn + Coriander	N_3-50% NPK of baby corn + Poultry manure + *Azospirillum* + phosphobacteria
		N_4-50% NPK of baby corn + Goat manure + *Azospirillum* + phosphobacteria

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 (7707 and 7668 kg ha^{-1}) and (5598 and 5608 kg ha^{-1}) as compared with FYM (N_2) incorporated with inorganic and bio-fertilizers (7012 and 5167 kg ha^{-1}) and inorganic fertilizers (N_1) alone (6801 and 5173 kg ha^{-1}) during late rabi 2002 and 2003 seasons, respectively. Similar trend also noticed with pooled mean data. Application of poultry manure increased the P availability (More and Ghonshikar, 1988) through the formation of soluble complex with organic legends increased the P uptake (Das *et al*., 1991a). Transformation from existing solid phase of K to a soluble metal complex increased the K uptake (Das *et al*., 1991b). 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. The response of INM treatments on fodder yields was similar to cob yield.

Fodder Quality

Improved fodder quality parameters *viz*., crude protein, crude fibre, ether extract, mineral content and NFE recorded during late rabi 2002 over 2003 season (Table 2-4).

Crude protein, Ether extract and NFE of fodder decreased towards maturity whereas crude fibre and mineral content increased. Crude Protein (CP) content was higher at 45 DAS and declined afterwards. The present results could be attributed to increased accumulation of carbohydrates and other structural materials such as lignin and silica with maturity of the crop and reduction of leaf to stem ratio (leaf fractions generally have higher CP than stem). Rakkiyappan and Krishnamoorthy

Table 2: Crude protein content (%) and crude fibre (%) content of baby corn fodder as influenced by of crop geometry, intercropping systems and INM practices

	Crude protein content (%)						Crude fibre content (%)					
	Late rabi 2002			Late rabi 2003			Late rabi 2002			Late rabi 2003		
Treatments	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest
Crop geometry												
S_1	8.51	7.24	6.59	7.60	6.72	5.91	31.98	34.73	35.80	36.08	35.92	36.53
S_2	8.59	7.21	6.59	7.51	6.74	5.90	32.11	34.73	35.49	35.83	36.13	36.68
SED	0.06	0.06	0.05	0.06	0.05	0.46	0.20	0.27	0.25	0.21	0.21	0.21
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intercropping												
C_1	8.55	7.23	6.56	7.59	6.75	5.90	32.31	34.86	35.50	35.98	36.00	36.44
C_2	8.46	7.23	6.62	7.60	6.75	5.90	31.96	34.88	35.91	35.76	36.04	36.84
C_3	8.44	7.21	6.58	7.48	6.69	5.91	31.87	34.45	35.52	36.13	36.03	36.74
SEd	0.07	0.07	0.07	0.12	0.07	0.57	0.25	0.33	0.30	0.25	0.25	0.26
CD (p = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
INM												
N_1	8.22	6.56	5.86	6.93	6.09	5.26	36.02	38.78	40.77	40.22	40.43	41.53
N_2	8.56	7.04	6.39	7.41	6.63	5.86	32.67	35.62	36.32	36.62	36.40	39.23
N_3	9.01	7.66	7.05	7.94	7.10	6.24	30.03	32.22	32.82	33.43	33.70	33.85
N_4	9.10	7.64	7.08	7.94	7.12	6.25	29.47	32.30	32.67	33.55	33.55	33.80
SEd	0.12	0.01	0.11	0.14	0.11	0.10	0.47	0.57	0.55	0.47	0.47	0.48
CD (p = 0.05)	0.25	0.24	0.23	0.28	0.23	0.20	0.95	1.16	1.10	0.95	0.95	0.97

Interaction Absent, NS: Non significant

Table 3: Effect of crop geometry, intercropping systems and INM practices on ether extract (%) and nitrogen free extract (%) content of baby corn fodder

	Crnde protein content (%)						Crnde fibre content (%)					
	Late rabi 2002			Late rabi 2003			Late rabi 2002			Late rabi 2003		
Treatments	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest
Crop geometry												
S_1	3.56	3.40	3.20	3.51	3.34	3.29	47.22	45.36	37.93	46.41	40.04	37.84
S_2	3.54	3.45	3.20	3.58	3.38	3.28	47.48	46.37	40.29	46.19	40.18	38.01
SED	0.02	0.02	0.01	0.02	0.02	0.02	0.28	0.27	0.29	0.27	0.24	0.24
CD (p = 0.05)	NS	0.05	NS	0.05	NS	NS	NS	0.60	0.63	NS	NS	NS
Intercropping												
C_1	3.53	3.40	3.20	3.60	3.49	3.25	47.59	45.66	40.68	46.18	40.39	38.02
C_2	3.53	3.45	3.21	3.54	3.41	3.30	47.75	45.78	40.74	46.44	40.00	38.09
C_3	3.58	3.43	3.17	3.51	3.44	3.27	46.90	46.15	40.91	46.29	39.94	38.15
SED	0.03	0.03	0.02	0.03	0.03	0.02	0.34	0.33	0.86	0.34	0.29	0.35
CD (P = 0.05)	NS	NS	NS	0.06	NS	NS	NS	NS	NS	NS	NS	NS
INM												
N_1	3.25	3.19	2.92	3.24	3.15	2.94	41.28	41.37	36.28	42.27	35.65	36.91
N_2	3.50	3.42	3.15	3.47	3.38	3.24	46.48	45.33	40.05	45.82	39.02	41.09
N_3	3.72	3.56	3.37	3.70	3.56	3.47	49.60	48.45	43.77	48.75	42.87	43.25
N_4	3.73	3.55	3.36	3.79	3.56	3.47	50.02	48.30	43.33	48.37	42.90	43.35
SED	0.05	0.05	0.04	0.05	0.05	0.04	0.62	0.60	0.97	0.61	0.53	0.52
CD (p = 0.05)	0.10	0.09	0.09	0.10	0.09	0.09	1.26	1.22	2.01	1.23	1.07	1.07

Interaction absent, NS: Non Significant

Table 4: Mineral content (%) of baby corn fodder as influenced by crop geometry, intercropping systems and INM practices

	Late rabi 2002			Late rabi 2003		
Treatments	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest
Crop geometry						
S_1	4.51	5.71	6.65	4.35	5.51	6.41
S_2	4.56	5.69	6.71	4.39	5.57	6.49
SED	0.07	0.08	0.09	0.08	0.09	0.10
CD (p = 0.05)	NS	NS	NS	NS	NS	NS
Intercropping						
C_1	4.51	5.71	6.69	4.40	5.60	6.47
C_2	4.57	5.73	6.73	4.38	5.57	6.45
C_3	4.54	5.69	6.75	4.36	5.58	6.46
SED	0.08	0.09	0.10	0.09	0.10	0.11
CD (p = 0.05)	NS	NS	NS	NS	NS	NS
INM						
N_1	4.53	5.68	6.71	4.37	5.59	6.47
N_2	4.75	5.90	6.95	4.61	5.85	6.79
N_3	4.74	5.95	6.99	4.63	5.86	6.71
N_4	4.74	5.88	6.95	4.60	5.89	6.73
SED	0.09	0.10	0.11	0.10	0.10	0.11
CD (p = 0.05)	0.19	0.20	0.23	0.21	0.21	0.23

Interaction absent, Non Significant

(1982) also observed decrease in CP content with the age of the crop. Whereas, CF content was in reverse trend. These results are in close conformity with the findings of Gill and Patil (1983) in sorghum. The decrease in EE content in advanced stages might be attributed to the translocation of fatty materials to the growing portion. The results are in agreement with the findings of Raja (1996) in fodder maize. Higher mineral content at 45 DAS than 60 DAS and at harvest was due to more accumulation of minerals at the early stages. The present findings are in accordance with the observations made by Rakkiyappan and Krishnamoorthy (1982) and Raja (1996) in fodder maize. Nitrogen Free Extract (NFE) showed similar trend. This was due to the increased production of protein resulting in lower NFE. Raja (1996) also reported similar results.

In both the seasons, all the quality parameters of baby corn fodder were not affected by either crop geometry or intercropping systems at any of the stages. However, during late rabi 2002 season (60 DAS) and 2003 season (45 DAS) ether extract content was significantly higher in S_2 than S_1. Sole baby corn recorded higher ether extract content than intercropped baby corn at 45 DAS during 2003 season. Similarly during late rabi 2002 season, NFE content varied significantly at 60 DAS and at harvest where S_2 recorded higher value than S_1. Since there was no change in growth nature of baby corn fodder, the quality parameters did not vary significantly. Similarly, Chen *et al*. (1990) did not find any variation on quality characters of maize by the spacing levels.

The INM practices have an augmentative effect on the quality parameters of baby corn fodder. All the three INM practices registered significantly higher values than inorganic fertilizer alone applied (N_1) plots. During late rabi 2002 season, at harvest, 50% NPK + poultry manure + bio-fertilizers (*Azospirillum* + phosphobacteria) recorded higher (7.08, 3.37, 6.19 and 43.77) crude protein, ether extract, mineral content and NFE respectively when compared to N_2 and N_1. However, the results are on par with N_4. Between N_1 and N_2, FYM applied with inorganic and bio-fertilizers (*Azospirillum* + phosphobacteria) recorded greater values than N_1. The results are repetitive during rest of the stages and also during 2003 season. However, the reverse trend was recorded with crude fiber where the highest values (40.77) recorded with N_1. Application of poultry and goat manures improved the soil fertility environment, which led to enhanced physiological and biochemical reaction in plants ultimately improved the fodder quality of baby corn. The increment of quality characters due to organic manures (Addy *et al*., 1987; Reddy *et al*., 1990) and bio-fertilizers (Singh *et al*., 1993; Mehta *et al*., 1996) was also documented earlier.

CONCLUSIONS

In the light of the results obtained, it can be concluded that baby corn raised at 60×19 cm spacing level, along with short duration intercrops like radish and coriander increased the yield without reducing the quality of fodder. Compensation of 50% of NPK through organic manures (Poultry manure/goat manure) and biofertilizers (*Azospirillum* and phosphobacteria) not ouly improved the yield but also the quality of fodder.

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