International Journal of Bio-resource and Stress Management 2016, 7(2):305-309 DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2016.7.2.1559

Full Research Article

Studies on the Effect of Crop Geometry and Nutrient Management on Productivity and Economics of Baby Corn and Cowpea (Fodder) Intercropping System

A. K. Barik[1], M. Karmakar[2*] and S. K. Ghorai[3]

[1,2]Dept. of ASEPAN, Institute of Agriculture, Visva-Bharati, Santiniketan, Birbhum, West Bengal (731 236), India
[3]E. I. Dupond Private Limited, Barasat, North 24 Parganas, West Bengal (700 124), India

Article History

Manuscript No. AR1559
Received in 13th March, 2016
Received in revised form 30th March, 2016
Accepted in final form 2nd April, 2016

Correspondence to

**E-mail*: karmakar.mrinmoy21@gmail.com

Keywords

Crop geometry, nutrient, baby corn, cowpea, fodder, intercropping

Abstract

A field experiment was conducted during kharif season of 2012 and 2013 at agricultural research farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal to study the effect of crop geometry and nutrient management on productivity and economics of baby corn and cowpea (fodder) intercropping system. The experiment was laid out in randomized block design having twelve treatments with each treatment replicated thrice. Higher numbers, length, girth, fresh and dry weight of baby cob as well as baby corn were recorded in various intercropping systems viz. 2:1, 2:2 row ratios with 100% NPK of base crop+75% PK of intercrop when compared with sole crop of baby corn. Higher number of corns ha^{-1}, baby corn yield and green fodder yield of baby corn and cowpea were found in sole crop of baby corn and cowpea, respectively. This was significantly higher than various intercropping systems. Total green fodder yield in different intercropping systems was higher than sole cowpea but lower than sole crop of baby corn. The treatment having 3:1 row ratio of baby corn and cowpea with 100% NPK of base crop+75% PK of intercrop exhibited significantly higher total dry fodder yield over sole crop of cowpea and at par with sole crop of baby corn. The highest gross return, net return and return rupee^{-1} investment was achieved in sole crop of baby corn which was significantly higher than all other intercropping combinations as well as sole crop of Cowpea.

1. Introduction

Intercropping is an ecological and alternative system for small-scale farmers to improve income and food production per unit area. Moreover, in farming organically managed and sustainable agricultural systems, growing crops in mixtures has become an important element (Lithourgidis et al., 2011). Cereal–legume intercropping grown for both the green fodder and seeds are valued for the important role they play in sustainableagriculture (Andersen et al., 2007). The agro industrial wastes such as pineapple waste, sugarcane molasses, the peel, husk or silk, of sweet corn and baby corn are also used as dairy feed (Sruamsiri, 2007). Baby corn, a specialized vegetable, is one of the most promoted crops in Thailand. The area planted in crop years 1983-85 was about 16,800 acres which produced about 44,000 t of fresh ears annually, of which only 20% was used as human food. The rest, mainly husk and silk, could have been used as green herbage for ruminants and pigs. It was suggested that baby corn wastages be used as supplementary roughage (Cheva-Isarakul et al., 1988). In the last one and a half decade, baby corn has emerged worldwide as one of the high value crops due to its high nutritive value and exotic taste. This can serve as fresh fodder in the region as well for which there is a high dearth. To sustain the heavy cattle population in the region baby corn can provide a valuable supplementary source of green fodder particularly for milch animals. Recently the dairy farms surrounding the urban areas have increased due to the growing need of milk and milk products for the urban people. So to sustain the dairy industries it is essential to increase fodder production. Supply of forages is inadequate in the country not only in terms of quantity but quality as well. Since the scope of area expansion under cultivated fodder (5% of cultivable area) is limited, the productivity of fodder crops is to be raised through best utilization of the resources of the prevailing production systems. Intercropping of botanically diverse crop species like cereals (baby corn as food) and legumes (fodder) appears to be one of the feasible approaches for increasing the food and herbage yield, utilization of land more efficiently, improving the forage quality and providing stability to production.

Baby corn and cowpea, the potential food and forage crops, are adaptable to wide range of environment and can provide nutritious food and fodder under rainfed conditions when grown in association. Hence, a rational approach is required on appropriate row proportion and nutrient management of baby corn and cowpea in an intercropping system. Since information on intercropping of food and forage (baby corn with cowpea) is not adequate under rainfed conditions in semi-arid regions, this study was undertaken with the objectives to study productivity and economics of baby corn and cowpea (fodder) in sole as well as intercropping system under different crop geometry and nutrient management.

2. Materials and Methods

A field experiment was carried out at Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketansituated at 23°39´ N latitude and 87°42´ E longitude with an average altitude of 58.90 m above mean sea level under sub-humid and semi arid region of West Bengal during *kharif* season (May-June to Sepetember-October) of 2012 and 2013 to study the productivity and economics of baby corn and cowpea (fodder) intercropping system under different crop geometry and nutrient management practices in lateritic soilof West Bengal. The experimental soil was Sandy loam in texture, low level of organic carbon, available nitrogen and potash content, medium in available phosphorus and slightly acidic in p_H (5.65). Sand, silt and clay percentage were 72.6, 17.8 and 9.6, respectively (calculated through Bouyoucos Hydrometer method). The experiment, consisted of twelve treatments each with three replications, was laid out in randomized block design (RBD). The treatments were: T_1: Sole baby corn with 100% NPK (100:50:50; N:P2O5:K2O in kg ha^{-1}); T_2: Sole cowpea with 100% NPK (20:40:20; N:P2O5:K2O in kg ha^{-1}); T_3: Baby Corn+Cowpea (2:2) with 100% NPK of base crop+75% PK of intercrop; T_4: Baby Corn+Cowpea (2:2) with 100% NPK of base crop+50% PK of intercrop; T_5: Baby Corn+Cowpea (2:2) with 100% NPK of base crop+25% PK of intercrop; T_6: Baby Corn+Cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop; T_7: Baby Corn+Cowpea (3:1) with 100% NPK of base crop+50% PK of intercrop; T_8: Baby Corn+Cowpea (3:1) with 100% NPK of base crop+25% PK of intercrop; T_9: Baby Corn+Cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop; T_{10}: Baby Corn+Cowpea (2:1) with 100% NPK of base crop+50% PK of intercrop; T_{11}: Baby Corn+Cowpea (2:1) with 100% NPK of base crop+25% PK of intercrop; T_{12}: Baby Corn+Cowpea (50:50) mixture with 100% NPK of baby corn. The crops were sown on 18th July of both 2012 and 2013, respectively and raised following the recommended package of practices. The baby corn and cowpea were sown with a seed rate of 40 kg ha^{-1} and 30 kg ha, with uniform row to row spacing of 30 cm and plant to plant spacing of 20 cm in baby corn and continuous sowing within the row in cowpea (fodder) at a soil depth of 5.0 cm. The cost of cultivation, gross return, net return and return rupee^{-1} invested (gross return/cost of cultivation) were calculated on the basis of prevailing market price of different inputs and outputs. The experimental data were analysed following the standard statistical method (Panse and Sukhatme, 1985; Gomez and Gomez,1984).

3. Results and Discussion

3.1. Yield attributes and yield

Higher number of cobs plant^{-1} (2.30) as well as cob girth (7.40 cm)of baby corn were recorded in the treatment having Baby Corn+Cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop which were higher than sole crop of baby corn (1.85 and 7.03 cm., respectively). Baby Corn+Cowpea (2:2 row ratio) with 100% NPK of base crop+75% PK of intercrop exhibited higher cob fresh (51.74 g.) and dry weight (4.65 g.) in comparison to sole crop of baby corn. Similarly higher corn length (8.37 cm.) and (3.51 cm.) corn girth were found inBaby Corn+Cowpea (2:1 row ratio) with 100% NPK of base crop+75% PK of intercrop when compared with sole crop of baby corn (8.26 cm. and 3.30 cm., respectively).Though higher corn fresh weight was obtained in Baby Corn+Cowpea (2:2 row ratio) with 100% NPK of base crop+75% PK of intercrop, it was at par with sole crop of baby corn.Corn dry weight in sole baby corn with 100% NPK (100:50:50) and Baby Corn+Cowpea (2:2 row ratio) with 100% NPK of base crop+75% PK of intercrop was at par with each other.

The highest number of corns ha^{-1} (284806 ha^{-1}) as well as baby corn yield (2734 kg ha^{-1}) were obtained from sole crop of baby corn.These were significantly higher than all other inter cropping combinations. Lemlem (2013) reported that intercrop forage legumes with maize significantly affected the growth and grain yield of maize ($^{**}p<0.01$) where the sole maize yielded the highest 3056 kg ha^{-1} and lower 2305 kg for maize cowpea integration. However in another citation, (Banik et al., 2009) reported that total productivity in terms of baby corn yield equivalent was highest under the baby corn-groundnut intercropping system. Among the different intercropping combinations treatment having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop showed the highest number of corns ha^{-1} (261145 ha^{-1}) and baby corn yield (2505 kg ha^{-1}). One of the explanations for this improvement is thatthe maize canopy is not able to intercept all the solar radiation during the growth period. Hence, the remaining radiation is captured by the culture growing under the maize, resulting in better use of this resource (Prasad and Brook, 2005) and blocking the light from reaching the undesirable plants (weeds).This was statistically at par with the treatment

Table 1: Effect of crop geometry and nutrient management on yield components of baby corn in baby corn+cowpea (fodder) intercropping system. (Pooled data of 2012 and 2013)

Treatment	Number of cobs plant^{-1}	Cob length (cm)	Cob girth (cm)	Cob fresh wt. (g)	Cob dry wt. (g)	Corn length (cm)	Corn girth (cm)	Corn fresh wt. (g)	Corn dry wt. (g)
T_1	1.85	22.51	7.03	51.38	4.62	8.26	3.30	9.60	0.77
T_3	2.24	21.97	7.33	51.74	4.65	8.14	3.47	9.62	0.75
T_4	2.15	21.83	7.20	51.41	4.48	8.11	3.39	9.57	0.74
T_5	2.09	21.64	7.21	50.91	4.39	8.13	3.30	9.40	0.67
T_6	2.16	21.30	6.95	51.34	4.67	8.28	3.48	9.60	0.72
T_7	2.07	21.18	7.22	51.34	4.53	8.24	3.31	9.54	0.69
T_8	2.09	22.11	7.22	51.19	4.40	8.24	3.27	9.57	0.64
T_9	2.30	22.14	7.40	51.54	4.54	8.37	3.51	9.52	0.68
T_{10}	2.20	22.25	7.01	51.35	4.09	8.32	3.50	9.56	0.66
T_{11}	2.13	21.52	7.17	51.28	4.20	8.22	3.39	9.49	0.62
T_{12}	1.83	20.91	6.97	50.80	3.88	7.85	3.27	9.30	0.63
SEm±	0.02	0.35	0.16	0.20	0.09	0.43	0.04	0.07	0.02
CD (p=0.05)	0.05	1.01	0.46	0.26	0.29	0.19	0.13	0.19	0.05

T_1: Sole baby corn with 100% NPK (100:50:50; N:P_2O_5:K_2O in kg ha^{-1}); T_2: Sole cowpea with 100% NPK (20:40:20; N:P_2O_5:K_2O in kg ha^{-1}); T_3: Baby corn+cowpea (2:2) with 100% NPK of base crop+75% PK of intercrop; T_4: Baby corn+cowpea (2:2) with 100% NPK of base crop+50% PK of intercrop; T_5: Baby corn+cowpea (2:2) with 100% NPK of base crop+25% PK of intercrop; T_6: Baby corn+cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop; T_7: Baby corn+cowpea (3:1) with 100% NPK of base crop +50% PK of intercrop; T_8: Baby corn+cowpea (3:1) with 100% NPK of base crop+25% PK of intercrop; T_9: Baby corn+cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop; T_{10}: Baby corn+cowpea (2:1) with 100% NPK of base crop+50% PK of intercrop; T_{11}: Baby corn+cowpea (2:1) with 100% NPK of base crop+25% PK of intercrop; T_{12}: Baby corn+cowpea (50:50) mixture with 100% NPK of baby corn.

Table 2: Effect of crop geometry and nutrient management on corn, green fodder and dry fodder yield of baby corn and cowpea in baby corn+cowpea (fodder) intercropping system. (Pooled data of 2012 and 2013)

Treatment	No. of corns ha^{-1}	Baby corn yield (kg ha^{-1})	Green fodder yield (t ha^{-1})			Dry fodder yield (t ha^{-1})		
			Baby corn (fodder)	Cowpea (fodder)	Total	Baby corn (fodder)	Cow pea (fodder)	Total
T_1	284806	2734	38.62	-	38.62	5.48	-	5.48
T_2	-	-	-	25.49	25.49	-	2.57	2.57
T_3	181988	1752	23.55	14.25	37.80	3.86	1.66	5.51
T_4	173784	1663	23.81	13.00	36.81	3.65	1.40	5.04
T_5	168971	1590	22.79	11.95	34.74	3.33	1.28	4.59
T_6	261145	2506	31.49	6.15	37.64	5.10	0.71	5.81
T_7	256972	2419	31.04	5.11	36.15	4.71	0.57	5.28
T_8	257834	2457	31.53	4.45	35.98	4.58	0.48	5.06
T_9	252713	2404	27.07	9.02	36.10	4.49	1.09	5.58
T_{10}	243601	2333	26.48	8.88	35.36	4.18	1.00	5.18
T_{11}	234357	2235	26.95	7.77	34.72	3.97	0.84	4.80
T_{12}	148799	1386	17.29	13.06	30.36	2.31	1.33	3.64
SEm±	1950.03	18.51	0.67	0.55	0.82	0.11	0.06	0.13
CD (p=0.05)	5737.21	54.41	1.98	1.60	2.41	0.34	0.19	0.37

having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+50% PK of intercrop and the treatment having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+25% PK of intercrop and significantly higher than the treatment having Baby Corn+Cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop with respect to number of baby corns ha^{-1}. On the other hand with respect to baby corn yield this was at par with the treatment having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+25% PK of intercrop and significantly higher than the treatment having Baby Corn+Cowpea (3:1) with 100% NPK of 2 base crop+50% PK of intercrop and treatment having Baby Corn+Cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop.

Among the several reasons that have been advanced for the low productivity of cowpea in intercropping systems is shading (Mortimore et al., 1997; Terao et al., 1997). The morphologically shorter component, usually cowpea, suffers greater yield reduction as a result of the shading effect of the taller cereal plants. In a review, Olufajo and Singh (2002) reported reduction in cowpea yields without any significant negative effect on maize yields in maize–cowpea intercrops. Though the highest total green fodder yield (38.62 ton ha^{-1}) was obtained from sole crop of baby corn, this was at par with the treatment having Baby Corn+Cowpea (2:2) with 100% NPK of base crop+50% PK of intercrop and treatment having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop. Similar findings were also reported by (Sharma et al., 2009) where green and dry fodder yield of both the component crops were substantially reduced under intercropping system compared with their sole crop yield. In another citation, (Sarkar et al., 2011) also reported that higher values of dehusked ear (cob) yield and fodder yield of baby corn were obtained from sole cropping rather than intercropping with rapeseed. Whereas (Kumar et al., 2005) reported that intercropping of maize and cowpea in the row proportion of 2:2 recorded significantly higher total green fodder over other treatments. The highest total dry fodder yield was achieved from the treatment Baby Corn+Cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop (5.81 t ha^{-1}). However this was at par with the treatment having Baby Corn+Cowpea (2:1) with 100% NPK of base crop+75% PK of intercrop and the treatment having sole baby corn with 100% NPK (100:50:50; $N:P_2O_5:K_2O$ in kg ha^{-1}).

3.2. Economics

The highest gross return, net return and return rupee^{-1} investment was recorded in sole crop of baby corn which was significantly higher than all other intercropping combinations. Among the intercropping combinations of baby corn and cowpea, the treatment having Baby Corn+Cowpea (3:1) with 100% NPK of base crop+75% PK of intercrop exhibited the highest gross return (₹ 150623 ha^{-1}), net return (₹ 98407 ha^{-1}), and return rupee^{-1} investment (₹ 2.88). However these two intercropping combinations are at par with each other.

Table 3: Effect of crop geometry and nutrient management on economics of baby corn and cowpea in baby corn+cowpea (fodder) intercropping system. (Pooled data of 2012 and 2013)

Treatment	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	Return rupee^{-1} investment (₹)
T_1	157745	50960	106780	3.09
T_2	37738	34645	3093	1.09
T_3	117186	51525	65661	2.27
T_4	112055	50940	61115	2.19
T_5	107699	50405	57294	2.13
T_6	150632	52225	98407	2.88
T_7	147012	27410	95347	2.83
T_8	147213	51105	96108	2.87
T_9	147478	52125	95353	2.81
T_{10}	142506	51565	90796	2.80
T_{11}	137274	51005	86269	2.68
T_{12}	96687	48865	47822	1.97
SEm±	1393		1366	0.03
CD (p=0.05)	4086		4006	0.08

Labour cost @ ₹ 120 and ₹ 150 during 2012 and 2013, respectively, Urea @ ₹ 8 kg^{-1}, SSP @ ₹ 14 kg^{-1}, MOP @ ₹ 12 kg^{-1}, Selling price of baby corn @ ₹ 0.5 piece^{-1}, Baby corn plant fodder @ ₹ 800 t^{-1}, Cowpea fodder @ ₹ 1500 t^{-1}

1 US $ = ₹ 55.60 and ₹ 66.13 during September of both 2012 and 2013, respectively.

4. Conclusion

Baby Corn when grown as sole crop produced significantly higher numbers of corns ha^{-1} and baby corn yield as well as gross return and return rupee^{-1} investment in comparison to other intercropping systems with various row proportions. However, total green and dry fodder yield achieved from 2:2 and 3:1 row proportions of Baby Corn+Cowpea (fodder) with 100% NPK of base crop (Baby Corn) and 75% PK of intercrop (cowpea) were at par with sole crop of baby corn.

5. References

Andersen, M.K., Hauggaard-Nielsen, H., Hogh-Jensen, H., Jensen, E.S., 2007. Competition for and utilisation of sulfur in sole and intercrops of peas and barley. Nutrient

Cycling Agroecosystems 77, 143–153. DOI:10.1007/s10705-006-9053-7.

Banik, P., Sharma, R.C., 2009. Yield and resource utilization efficiency in baby corn-legume-intercropping system in the Eastern Plateau of India. Journal of Sustainable Agriculture 33(4), 379−395.

Bouyoucos, G.H., 1951. A recalibration of the Hydrometer Method for making mechanical analysis of soils. Agronomy Journal 43, 434−438.

Cheva-Isarakul, B., Paripattananont, T., 1988. The nutritive value of fresh baby corn waste. Ruminant feeding systems utilizing fibrous agricultural residues, 151−156.

Gomez, K.A., Gomez, A.A., 1984. Statistical procedures for agricultural research. Second Edition. John Wiley and Sons, New York, USA.

Kumar, S., Rawat, C.R., Melkenia, N.P., 2005. Forage production potential and economics of maize (*Zea mays*) and cowpea (*Vigna unguiculata*) intercropping under rainfed conditions. Indian Journal of Agronomy 50(3), 184−186.

Lemlem, A., 2013. The effect of intercropping maize with cowpea and lablab on crop yield. Herald Journal of Agriculture and Food Science Research 2(5), 156−170.

Lithourgidis, A.S., Dordas, C.A., Damalas, C.A., Vlachostergios, D.N., 2011. Annual intercrops: an alternative pathway for sustainable agriculture. Australian Journal of Crop Science 5, 396–410.

Mortimore, M.J., Singh, B.B., Harris F, Blade S.F., 1997. Cowpea in traditional cropping systems. Advances in cowpea research. Copublication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS), 99−113.

Olufajo, O.O., Singh, B.B., 2002. Advances in cowpea cropping research. Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World Cowpea Conference, 2000, Sep 4–8. Ibadan, IITA.

Panse, V.G., Sukhatme, P.V., 1985. Statistical method of Agricultural workers. ICAR, New Delhi, 152−159.

Prasad, R.B., Brook, R.M., 2005. Effect of varying maize densities on intercropped maize and soybean in Nepal. Experimental Agriculture 41, 365–382. DOI:10.1017/S0014479705002693.

Sarkar, S., Sarkar, A., Mandal, B.K., 2011. Response of baby corn (*Zea mays*)+rapeseed (*Brassica campestris*) intercropping system under different moisture regimes and mulch. Indian Journal of Agriculture Rsearch 45(4), 314−319.

Sharma, R.P., Raman, K.R., Singh, A.K., Poddar, B.K., Kumar, R., 2009. Production potential and economics of multi-cut forage sorghum (*Sorghum sudanense*) with legumes intercropping under various row proportions, Range-Management-and-Agroforestry 30(1), 67−71.

Sruamsiri, S., 2007. Agricultural wastes as dairy feed in Chiang Mai. Animal Science Journal 78(4), 335−341.

Terao, T., Watanabe, I., Matsunaga, R., Hakoyama, S., Singh, B.B.,1997. Agro-physiological constraints in intercropped cowpea: an analysis, Advances in cowpea research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS), 129–140