International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(3): 1945-1948

Received: 10-03-2020
Accepted: 12-04-2020

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Influence of integrated nutrient management practices and foliar application on yield and economics of babycorn (*Zea mays* L.)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i3aa.9489

Abstract
Field experiments were conducted at the experimental farm Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2017 to study the productivity and yield maximization of baby corn (*Zea mays* L.) as influenced by integrated nutrient management practices and foliar application. The experiment was laid out in randomized block design with three replication and twelve treatments. Among the twelve treatments, T_{12} (100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya) exerted significant influence on yield and economics, the higher net return of Rs. 98287 was obtained with conjoint application of 100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya. The higher return per rupee was also recorded in the same treatment (T_{12}) as 3.00 while the lower (1.5) was recorded in the control (T_1).

Keywords: INM, foliar spray, babycorn, economics.

Introduction
Baby corn (also known as young corn, mini corn or candle corn) is the ear of maize (*Zea mays* L.) plant harvested young especially when the silks have either not emerged or just emerged and no fertilization has taken place. Baby corn can be grown under a wide range of agro climatic conditions but the plants grow well and exhibit maximum potential biomass at a temperature range of 25 to 35^0C. Deep, fertile, rich in organic matter and well drained soils are the most preferred ones for the crop; however, baby corn can be grown on a variety of soil types. The soil should be medium textured with good water holding capacity. The crop is very sensitive to water logging. Thus, the ideal soil is the one which is neither clayey nor sandy having pH between 6.5 and 7.5. In India, baby corn is being cultivated in Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka and Andhra Pradesh. Rajasthan state was first in respect of area, where in this baby corn crop occupies 10.5 lakh ha area (12.9 per cent) with production of 19.5 lakh tones and productivity of 18.6 q ha^{-1} (Government of India). In Tamil Nadu, maize is cultivated in an area of 0.22 million hectares with production of 0.81 million tonnes and a productivity of 4.5 t ha^{-1} and also it occupies fourth position in India (Gangaiya, 2013). [2]

Baby corn cultivation provides tremendous avenue for diversification, value addition and revenue generation. In the light of recently liberalized policy of government to boost export trade and food industry development, baby corn production on maize belts of India stands better promise for export trade, high income generation and for creation of employment in agriculture sector through canning and dairy industries. Nitrogen, phosphorus and potassium are the key nutrients which greatly influence the yield of crops. In addition, integration of organic with inorganic fertilizers improves the physiological system of the crop, and modifies soil physico-chemical behaviour and results in augmented crop yields. Foliar fertilization is simple and effective method of providing nutrients to crops. Foliar application will be more efficient than soil applications at the late growth stage when there is preferential assimilate translocation into seeds (or) fruits and root activity for nutrient uptake is limited. Also, at this late growth stage, the quality of fodder (or) human food products can be specifically improved by foliar fertilization.

The organic fertilizers in addition to nutrients contain microbial load and growth promoting substances which help in improving the plant growth, metabolic activity and resistance to pest and diseases thereby, increased net return of the crop.

Materials and methods

The field experiment was carried out at the Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar during the year 2017 to study the effect of integrated nutrient management practices and foliar application on yield maximization and economics of baby corn (G-5414). The experimental soil is clay loam in texture with pH of 7.6. The soil was medium in available nitrogen (263 kg ha^{-1}), medium in available phosphorus (17.2 kg ha^{-1}) and high in available potassium (280.1 kg ha^{-1}). The experiment was laid out in Randomized Block Design and replicated thrice. There twelve treatments *viz.*, T_1 – Control, T_2 – 100% RDN + 3 sprays of 3% panchagavya, T_3 – 75% RDN + poultry manure @ 5t ha^{-1} + 4 sprays of 4% panchagavya, T_4 – 100% RDN +poultry manure @ 5t ha^{-1} + 3 sprays of 3% panchagavya, T_5 – 75% RDN + FYM @ 10 t ha^{-1} + 4 sprays of 4% panchagavya,T_6 – 100% RDN + FYM @ 10 t ha^{-1} + 3 sprays of 3% panchagavya,T_7 – 75% RDN + EFYM @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya, T_8 – 100% RDN + EFYM @ 750 kg ha^{-1} + 3 sprays of 3% panchagavya, T_9 – 75% RDN + EPC @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya, T_{10} – 100% RDN + EPC @ 750 kg ha^{-1} + 3sprays of 3% panchagavya, T_{11} – 75% RDN + vermicompost @ 5 t ha^{-1} + 4 sprays of 4% panchagavya, T_{12} – 100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya. The Ncontent of organic manures was estimated by the method suggested by Yoshida *et al.*(1972) on dry weight basis of the organic sources. Organic manures *viz.*, FYM, Vermicompost, EFYM, EPC, Poultry manure, were applied as basal one week before sowing as per treatment schedule and incorporated in the soil. Recommended seed rate of baby corn @ 25 kg $ha^{-1}$with spacing of 60 cm x 20 cm was adopted. The fertilizer recommendation for baby corn is 150:60:40 kg of N, P_2O_5 and k_2O ha^{-1} respectively. Panchagavya was prepared and applied as a foliar spray as per the treatment schedule at 15, 25, 35 and 45 DAS (4sprays) and 15, 25, 35 DAS (3 sprays). The tassels were removed manually and immediately after their emergence and before the tassels turned to pink colour to avoid fertilization of the cob. Detasseling was done as and when emergence of tassel i.e., normally at 52-55 DAS. Topping refers to nipping or the removal of terminal portion from the uppermost node to induce better cob development and to avoid fertilization of cob. Topping beyond 9^{th}, 10^{th} and 11^{th} internodes was done at 47, 50, and 53 DAS, respectively. The observations on growth attributes and yield were recorded. The economics were worked out based on the prevailing market price.

Table 1: Effect of INM practices on cob yield and Stover yield (kg ha^{-1}) of Baby corn

Treatments		cob yield (kg ha^{-1})	Stover yield (t ha^{-1})
T_1	Control	12.17	2640
T_2	100% RDN + 3 sprays of 3% panchagavya	18.41	5071
T_3	75% RDN + poultry manure @ 5t ha^{-1} + 4 sprays of 4% panchagavya	16.43	4448
T_4	100% RDN +poultry manure @ 5t ha^{-1} + 3 sprays of 3% panchagavya	19.13	5693
T_5	75% RDN + FYM @ 10 t ha^{-1} + 4 sprays of 4% panchagavya	13.28	3582
T_6	100% RDN + FYM @ 10 t ha^{-1} + 3 sprays of 3% panchagavya	18.86	5402
T_7	75% RDN + EFYM @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	14.37	3868
T_8	100% RDN + EFYM @750 kg ha^{-1} + 3 sprays of 3% panchagavya	20.20	6493
T_9	75% RDN + EPC @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	15.52	4163
T_{10}	100% RDN + EPC @ 750 kg ha^{-1} + 3sprays of 3% panchagavya	20.06	6341
T_{11}	75% RDN + vermicompost @ 5 t ha^{-1} + 4 sprays of 4% panchagavya	18.12	4751
T_{12}	100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya	21.00	6845
S.Ed		125.36	135.00
CD (p=0.05)		260	280

Results and discussion

Cob yield, stover yield (kg ha^{-1}) and harvest index (Table 1and 2)

Among the various integrated nutrient management practices evaluated, application of 100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya (T_{12}) significantly registered the higher cob yield, stover yield and harvest index of 6845 kg ha^{-1}, 21.00 t ha^{-1} and 24.58 per cent, respectively. The abundant supply of mineral nutrients and organic manure were directly involved in the protoplasmic constituents and accelerate the process of cell division and elongation which in turn resulted in increased productive plants, cob diameter, cob length and cob weight with these integrated nutrient management treatments. Addition of mineral nitrogen along with the vermicompost influenced the stalk thickness of the plants more positively than just a standalone application of vermicompost. This effect could be attributed to the fact that the addition of mineral fertilizer accelerated mineralization processes in the soil and, therefore, was able to release enough and easily available nutrients of vermicompost. (Maria Kmetova, 2014) [4]. The hormonal substances present in panchagavya especially cytokinin which plays a vital role in vegetative plant parts with nutrient partitioning while in reproductive parts, high levels of nutrient mobilization. Increase in yield was also be due to fact that cow dung in panchagavya act as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth (De Britto and Girija, 2006; Patil *et al.*, 2012) [1, 5].

The application of integrated nutrient management practices and foliar application on babycorn markedly influenced the higher green fodder yield due to higher nutrient supply sources along the organic inputs. These findings are in close conformity with those of Kar *et al.* (2006) [3] and Singh *et al.* (2007) [7] on sweet corn while Verma *et al.* (2012) [9] on maize. Thakur *et al.* (1997) [8] demonstrated that baby corn weight with and without husk was found to increase significantly with successive increase in N levels up to 100 kg N ha^{-1}.The control (T_1) resulted in the least values of cob yield, stover yield and harvest index 2640 kg ha^{-1}, 12.17 t ha^{-1}

and 17.82 per cent, respectively. Due to unavailable nutrient to crop due to combination of leaching, fixation. These results are accordance with the findings of Satish *et al.* (2011) [6].

Table 2: Effect of INM practices on Harvest index of baby corn

Treatments		Harvest index
T_1	Control	17.82
T_2	100% RDN + 3 sprays of 3% panchagavya	21.59
T_3	75% RDN + poultry manure @ 5t ha^{-1} + 4 sprays of 4% panchagavya	21.30
T_4	100% RDN +poultry manure @ 5t ha^{-1} + 3 sprays of 3% panchagavya	22.93
T_5	75% RDN + FYM @ 10 t ha^{-1} + 4 sprays of 4% panchagavya	21.14
T_6	100% RDN + FYM @ 10 t ha^{-1} + 3 sprays of 3% panchagavya	22.24
T_7	75% RDN + EFYM @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	21.15
T_8	100% RDN + EFYM @ 750 kg ha^{-1} + 3 sprays of 3% panchagavya	24.32
T_9	75% RDN + EPC @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	21.20
T_{10}	100% RDN + EPC @ 750 kg ha^{-1} + 3sprays of 3% panchagavya	24.10
T_{11}	75% RDN + vermicompost @ 5 t ha^{-1} + 4 sprays of 4% panchagavya	21.77
T_{12}	100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya	24.58

Economics (Table 3)

The maximum gross return, net return and return per rupee invested was Rs.147400, Rs.98287 and 3.00, respectively were associated with the treatment T_{12} (100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya. The treatment (T_1) control registered the least gross return of Rs.58885, net return of Rs.26845 and the return per rupee invested of 1.5.

Table 3. Economics of cultivation on Baby corn

	Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Return rupee^{-1} invested
T_1	Control	30345	58885	26845	1.5
T_2	100% RDN + 3 sprays of 3% panchagavya	47005	110625	63619	2.35
T_3	75% RDN + poultry manure @ 5t ha^{-1} + 4 sprays of 4% panchagavya	48250	97175	48925	2.01
T_4	100% RDN +poultry manure @ 5t ha^{-1} + 3 sprays of 3% panchagavya	48571	123425	74854	2.54
T_5	75% RDN + FYM @ 10 t ha^{-1} + 4 sprays of 4% panchagavya	48966	79280	30313	1.61
T_6	100% RDN + FYM @ 10 t ha^{-1} + 3 sprays of 3% panchagavya	49378	117470	68091	2.37
T_7	75% RDN + EFYM @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	45432	84545	39112	1.86
T_8	100% RDN + EFYM @ 750 kg ha^{-1} + 3 sprays of 3% panchagavya	48954	139960	91005	2.85
T_9	75% RDN + EPC @ 750 kg ha^{-1} + 4 sprays of 4% panchagavya	47845	91020	43175	1.90
T_{10}	100% RDN + EPC @ 750 kg ha^{-1} + 3sprays of 3% panchagavya	48510	136850	88340	2.82
T_{11}	75% RDN + vermicompost @ 5 t ha^{-1} + 4 sprays of 4% panchagavya	104080	48742	55337	2.13
T_{12}	100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya	49112	147400	98287	3.00

Partial Budgeting (Table 4)

The Partial budget analysis was undertaken to conform the financial viability of the referred best treatment (100% RDN + verrmicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya) at field level. The Credits and Debits involved with the best treatment was compared with the existing practice (Recommended dose of fertilizer alone) which is presently adopted in the field by the farmers. The Net gain estimated vide, partial budgeting, when the best treatment is adopted instead of existing practice was Rs. 12165 /- ha^{-1}. From the Partial budgeting it is inferred that adoption of the best treatment T_{12} (100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya) would certainly enhance the income level of farmers ultimately.

Table 4: Partial budgeting analysis on the INM recommended package of practices for baby corn

S.NO	CREDIT (A)	Amt (Rs ha^{-1})	S.NO	DEBIT (B)	Amt (Rs ha^{-1})
	Added Returns (ha^{-1})			Added cost (ha^{-1})	
i.	1774 kg of cob yield @ 20 Rs/kg	25900	i.	Urea 326.08 kg @ 5.42 Rs/kg	1767.35
ii.	2.59 ton Stover yield @ 0.5 Rs/kg	1295	ii.	SSP 375 kg @ 7.24 Rs/kg	2715.00
			iii.	MOP 66.66 kg @ 12 Rs/kg	799.92
			iv.	Vermicompost 5000 kg @ 3.00 Rs/kg	15000
			v.	Panchagavya 15 litre @ 50 Rs/lit	750
	Sub Total	27195		Sub Total	20312.27
	Reduced Cost (ha^{-1})			Reduced Returns	
i.	Urea 326.08 kg @ 5.42 Rs/kg	1767.35		NIL	----
ii.	Ssp 375 kg @ 7.24 Rs/kg	2715.00			
iii.	MOP 66.66 kg @ 12 Rs/kg	799.92			
	Sub Total	5282.27		Sub Total	----
	TOTAL (A)	32477.27		TOTAL (B)	20312.27

Conclusion

The best combination of organic and inorganic fertilizers (T_{12}) for increasing productivity of baby corn with sustainability. This treatment is also responsible for improving physico-chemical properties and nutrient status of soil as well as higher net return. Thus the combined use of organic manure and chemical fertilizer holds great promise in meeting the growing nutrient demands of intensive agriculture and maintaining the crop productivity, yield maximization and economics at higher levels with overall improvement of soil fertility in baby corn.

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