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Integrated nitrogen management on productivity and economics of baby corn

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Abstract
To study the effect of integrated nitrogen management on growth and yield of baby corn, a field experiment was conducted during *Kharif* season, 2013 in sandy clay loam soil of AC&RI, Tamil Nadu Agricultural University, Coimbatore with Syngenta baby corn hybrid G-5414 as a test variety. Experiment included twelve treatments with first three treatments as organic manures alone and rest were combinations of organic manures (pressmud, vermicompost and FYM) with different nitrogen level supplied through urea. Integrated nitrogen management practices were found to have significant influence on yield of baby corn and the economics involved. Application of pressmud @ 5 t ha^{-1} with 150 kg ha^{-1} recorded maximum in case of cob yield, yield attributes and gross and net returns.

Keywords: Baby corn, vermicompost, FYM, pressmud, nitrogen

Introduction
Maize, the Queen of cereals and the third most important cereal crop following rice and wheat in the world, recently gained potentiality as a vegetable crop, such as baby corn and sweet corn. Baby corn is the immature dehusked unfertilized maize, which can be harvested 1-2 days after silking. It is consumed as such, as a vegetable or as a value added product. The immature corn has also find its place in preparing soup, manchurian, kofta, pakodas *etc*. Besides, it serves as a good source of nutrients as it is rich in protein (15-18%), calcium (0.3-0.5%) vitamin A and vitamin C (75-80 mg/100g) (Rani *et al*., 2017) [4] and is fibre rich. The crop is free of pests and diseases, including bird pests, compared to other maize types and cereal crops. Another potential use is that, the tassels after detasseling of the crop, crop residues and cob wastes of dehusked cobs are good source of feed for cattle's. The crop being highly succulent, is palatable and digestible at every stage of crop growth, it is accepted as a good feed for livestock, especially to milch animals. This specialty corn is providing tremendous avenues for higher productivity, crop diversification, value addition and enhanced profitability. As this is harvested at immature stage before getting fertilized, the crop escapes the risk of pollen abortion, and bird pest attack, which is a threat in maize production. Even though baby corn cultivation and research is in its nascent stage of development in India, and agronomic practices are little known to the farmers; it is becoming popular among Indian farmers. At present it is mainly cultivated in Rajasthan, Meghalaya, Western U.P, Haryana, Maharashtra, Karnataka and A.P. The production potential of grain maize in the country is low (2.5 t/ha), against the world average productivity of 5.5 t/ha. Baby corn cultivation can be exploited to overcome this situation. As far as India is concerned, so far the research in baby corn was adopted mainly in varieties suited for cultivation, application of growth regulators, split application of fertilizers, irrigation regimes and intercropping. There are reports that, maize responds well to higher dose of nitrogen, even up to 200 kg/ha, which can be made use of, to increase the productivity of the crop. Since baby corn is freshly consumed, it is better to adopt organic cultivation practices. Keeping in view the scarcity in availing bulk of quality organic manures, an experiment on integrated nitrogen management was carried out.

Materials and methods
The experiment was conducted during *Kharif* 2013 in Eastern Block farm field of Tamil Nadu Agricultural University, Coimbatore. The experimental site is located at latitude of 11^0 N longitudes of 77^0 E and an altitude of 426.72 m above MSL. The average annual rainfall of Coimbatore is 674 mm received in 47 rainy days. The mean annual maximum and minimum temperature are 30.3 ^{0}C and 22.8 ^{0}C respectively.

The mean relative humidity is 86 and 59.5 percent at 0722 and 1422 hrs, respectively. The mean annual pan evaporation is 4.9 mm and the mean wind velocity is 9.0 km hr^{-1}.

During the experimental period, total rainfall received was 176.6 mm in 26 days. The mean maximum and minimum temperatures were 31.6 ^{0}C and 22.4 ^{0}C respectively. The mean relative humidity was 86% and 56%. The mean pan evaporation was 5.8 mm and the wind velocity was 7.8 km hr^{-1}. The soil of the experimental field was sandy clay loam with a bulk density of 1.42 Mg m^{-3}. The nutrient status of experimental field was found to be low in available nitrogen, medium in available phosphorus and high in available potassium during the start of the experiment. Soil pH was 8.7 with EC 0.6 dS m^{-1}. Organic carbon content of the soil was 0.86%. The baby corn Syngenta hybrid G-5414 was chosen as the test crop. The crop was raised during *kharif* season (July-October) 2013. The total duration of the crop was 85 days. The treatments were, T_1: FYM 12.5 t ha^{-1}, T_2: Vermicompost 5 t ha^{-1}, T_3: Pressmud 5 t ha^{-1}, T_4: FYM 12.5 t ha^{-1} +125 kg N ha^{-1}, T_5: Vermicompost 5 t ha^{-1} +125 kg N ha^{-1}, T_6: Pressmud 5 t ha^{-1} +125 kg N ha^{-1}, T_7: FYM 12.5 t ha^{-1} + 150 kg N ha^{-1} (Control), T_8: Vermicompost 5 t ha^{-1} +150 kg N ha^{-1}, T_9: Pressmud 5 t ha^{-1} +150 kg N ha^{-1}, T_{10}: FYM 12.5 t ha^{-1} +175 kg N ha^{-1}, T_{11}: Vermicompost 5 t ha^{-1} +175 kg N ha^{-1}, T_{12}: Pressmud 5 t ha^{-1} +175 kg N ha^{-1}. Recommended P & K is common to all treatments (60 & 40 kg ha^{-1} respectively). Experiment was laid out in Randomized Block Design and replicated thrice. Organic manures *viz.* FYM, pressmud and vermicompost were applied as per the treatments based on the recommendations. Inorganic fertilizers used for the supply of nitrogen, phosphorus and potassium includes urea (46% N), single superphosphate (16% P_2O_5) and muriate of potash (60% K_2O) respectively. Azospirillum was applied as per the recommendation given in CPG (2012). Seeds were pretreated with thiram at 2 g/kg of seed and seed rate of 25 kg/ha was adopted. After field preparation the baby corn seeds were dibbled in the sides of the ridges at the rate of two seeds per hole adopting a spacing of 45 x 25 cm. The organic manures were applied to the respective treatments prior to sowing and incorporated into the soil uniformly. Simultaneously the recommended biofertilizer azospirillum @ 2 kg/ha was applied by mixing with sand and mixed well into the soil to all the treatments uniformly. The N fertilizer was applied as split doses i.e. 50 percent as basal and remaining 50 percent in two equal splits at 30 and 45 DAS as per treatment schedule. Recommended doses of phosphorous (60 kg/ha) as SSP and potassium (40 kg/ha) as MOP were applied as basal application to all the treatments.

Detasseling is an important and necessary operation in baby corn cultivation, in order to prevent cob fertilization. Tassels were removed immediately on their emergence and before changing its color to pink. From each plot, immature cobs were harvested as soon as the silk emerged (1-3 cm). Six harvests were carried out with an interval of one to two days. The cobs were sampled randomly and observations on yield parameters were taken. The cobs were weighed per plot and cob yield was expressed in kg/ha. Observations on yield attributes were recorded and economic analysis was done. The parameters obtained were subjected to statistical scrutiny.

Results and Discussion

Yield and yield parameters

Number of cobs per plant

Data pertaining to the number of cobs $plant^{-1}$ and ha^{-1} under varied nitrogen management practices clearly revealed that there was no significant influence of treatments over the number of cobs per plant. This might be for the reason that cobs per plant must be a genetic character and hence cannot be manipulated or improved by agronomic practices. Whereas, in case of number of cobs per hectare, there is a significant influence among varied treatments. This might be due to variation in plant population.

Cob: corn ratio

It has been observed a significant difference in case of Cob to corn ratio of baby corn with different treatments imposed. The treatments with 150 kg N ha^{-1} along with pressmud 5 t ha^{-1} or vermicompost 5 t ha^{-1} or FYM 12.5 t ha^{-1} maintained a parity with each other and higher cob: corn ratio was obtained with the application of pressmud 5 t ha^{-1} along with 150 kg N ha^{-1} treatment.

Cob yield

Appreciable variation was observed in the green cob yield of baby corn under integrated nitrogen management. Among the different treatments tried, maximum yield was obtained in the treatment with the application of pressmud 5 t ha^{-1} +150 kg N ha^{-1}, which was in on par with FYM 12.5 t ha^{-1} + 150 kg N ha^{-1} and vermicompost 5 t ha^{-1} +150 kg N ha^{-1}. The significant improvement in yield components might have significantly responded to the different levels of manures and integrated use of nitrogen with their combined effect leading to the increased yield. These findings are in close conformity with Neupane and Mahajan (2013) [3]. The increase in yield might be also due to continuous supply of N to the soil solution, which match the absorption pattern of baby corn plant and enables to meet the required nutrients for physiological processes, which in turn improved the cob yield. All these might have helped to enhance the nutrient use efficiency and thus directly or indirectly contributed to higher cob yield.

Organic manures, the reservoirs of nutrients produces various organic acids on decomposition; thereby slowly releases absorbed ions by producing plant growth promoting substances for the entire period of crop growth. The higher yield was observed with the application of pressmud, might be ascribed partly to its higher nutrient content; as well as partly due to its ability to release N synchronously with the demand of baby corn, compared to vermicompost and FYM. This might be the reason for higher growth attributes and more translocation to sink leading to higher yield of the crop. Dadarwal *et al*., 2009 [1]has reported that application of 75% NPK+2.25 t ha^{-1} vermicompost + biofertilizers significantly yielded highest dehusked cob (baby corn).

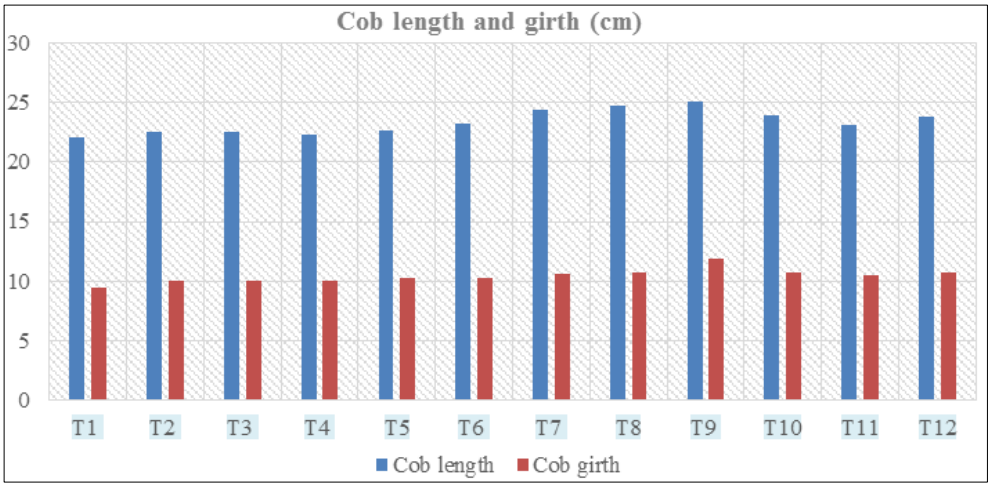
Regarding the treatment combinations, highest level of nitrogen i.e., 175 kg N ha^{-1} along with varied organic manures resulted in the low yield compared to the treatments with nitrogen 150 kg N ha^{-1} + varied organic manures. This might be due to over N dose. Nitrogen, which is proved to enhance vegetative growth, might have extended the growth during vegetative phase up to reproductive phase and hence there might be delay in initiation of reproductive phase resulting in lower yield in baby corn.

Table 1: Effect of integrated nitrogen management on yield and yield parameters

Treatments	No. of cobs/plant	Cob : corn ratio	Cob weight	Green cob yield (kg/ha)
T_1 : FYM 12.5 t ha^{-1}	1.9	4.83	68.4	7891
T_2 : Vermicompost 5 t ha^{-1}	1.9	4.89	67.4	7752
T_3 : Pressmud 5 t ha^{-1}	2.1	4.90	62.9	7650
T_4 : FYM 12.5 t ha^{-1} +125 kg N ha^{-1}	1.9	4.94	76.3	8135
T_5 : Vermicompost 5 t ha^{-1} +125 kg N ha^{-1}	2.0	5.45	77.1	8182
T_6 : Pressmud 5 t ha^{-1} +125 kg N ha^{-1}	2.1	5.65	79.2	8205
T_7 : FYM 12.5 t ha^{-1} + 150 kg N ha^{-1}	2.0	8.27	88.7	9195
T_8 : Vermicompost 5 t ha^{-1} +150 kg N ha^{-1}	2.1	8.41	97.6	9147
T_9 : Pressmud 5 t ha^{-1} +150 kg N ha^{-1}	2.2	8.63	107.3	10097
T_{10} : FYM 12.5 t ha^{-1} +175 kg N ha^{-1}	2.1	6.06	81.2	8641
T_{11} : Vermicompost 5 t ha^{-1} +175 kg N ha^{-1}	2.1	6.37	81.5	8706
T_{12} : Pressmud 5 t ha^{-1} +175 kg N ha^{-1}	2.1	6.86	81.5	8890
SEd	0.1	0.34	4.2	640
CD (P=0.05)	NS	0.70	8.7	1327

Weight, length and girth (cm) of cob and corn

Regarding, cob and corn weight, cob and corn length and cob girth the treatment imposed as pressmud 5 t ha^{-1} + 150 kg N ha^{-1} recorded higher values compared to rest of the treatments. However, the highest corn weight was comparable to that obtained with the supply of vermicompost 5 t ha^{-1} with 150 kg N ha^{-1} and FYM 12.5 t ha^{-1} along with 150 kg N ha^{-1}. Higher yield attributes in baby corn might be due to the increased vigor, photosynthetic rate and translocation of assimilates with the application of integrated nitrogen management. Availability of adequate amount of N during the entire growth period also might have promoted assimilates, from source to sink which increased the weight, length and girth of both cob and corn. Ranjeet *et al*. (2012) [5] reported the availability of NPK in balanced proportion in integrated nutrient management. He also opined that vermicompost 5 t ha^{-1} and biofertilizers helps in better growth and development of corn which ultimately lead to higher yield of maize.



Economics

The present study shown that the treatment with pressmud application @ 5 t ha^{-1} along with urea @ 150 kg N ha^{-1} obtained maximum gross and net return compared to all the other treatments imposed. Maximum cost of cultivation was however obtained in application of pressmud @ 5 t ha^{-1} along with urea @ 175 kg N ha^{-1}.

Table 2: Economics involved in integrated nitrogen management

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1 : FYM 12.5 t ha^{-1}	60371	92910	32539	1.5
T_2 : Vermicompost 5 t ha^{-1}	61621	90895	29274	1.5
T_3 : Pressmud 5 t ha^{-1}	61621	90000	28379	1.5
T_4 : FYM 12.5 t ha^{-1} +125 kg N ha^{-1}	61866	94600	32734	1.5
T_5 : Vermicompost 5 t ha^{-1} +125 kg N ha^{-1}	63116	96945	33829	1.5
T_6 : Pressmud 5 t ha^{-1} +125 kg N ha^{-1}	63116	96425	33309	1.5
T_7 : FYM 12.5 t ha^{-1} + 150 kg N ha^{-1}	62165	1,07,450	45285	1.7
T_8 : Vermicompost 5 t ha^{-1} +150 kg N ha^{-1}	63415	1,07345	43930	1.7
T_9 : Pressmud 5 t ha^{-1} +150 kg N ha^{-1}	63415	1,17,095	53680	1.8
T_{10} : FYM 12.5 t ha^{-1} +175 kg N ha^{-1}	62463	1,03,535	41072	1.7
T_{11} : Vermicompost 5 t ha^{-1} +175 kg N ha^{-1}	63713	1,03,685	39972	1.6
T_{12} : Pressmud 5 t ha^{-1} +175 kg N ha^{-1}	63713	1,05,150	41437	1.7

Partial budgeting was also calculated to know the viability of the tested treatments. In this tool, economic advantages of different treatments is to be worked out and the benefits or losses are expressed in ₹ ha^{-1}**.** It is suggested by Gonales and Van Der Veen (1986) [2]. From partial budgeting (Table:3), it is very clear that, application of pressmud 5 t ha^{-1} with 150 kg N ha^{-1} has been obtained as best technology, both in terms of yield and BC ratio, is economically viable.

Table 3: Partial budgeting of baby corn cultivation as influenced by imposed treatments

Treatments	Total change in benefit (₹ha^{-1})		Total change in cost (₹ha^{-1})		Net change in income (₹ha^{-1}) (A+B) - (C+D)
	Added return (₹) (A)	Reduced cost (₹) (B)	Added cost (₹) (C)	Reduced return (₹) (D)	
T_1 : FYM 12.5 t ha^{-1}	---	1794	---	12746	-10952
T_2 : Vermicompost 5 t ha^{-1}	---	544	---	16011	-15467
T_3 : Pressmud 5 t ha^{-1}	---	544	---	16906	-16362
T_4 : FYM 12.5 t ha^{-1} +125 kg N ha^{-1}	---	299	---	12551	-12252
T_5 : Vermicompost 5 t ha^{-1} +125 kg N ha^{-1}	---	---	951	11456	-12407
T_6 : Pressmud 5 t ha^{-1} +125 kg N ha^{-1}	---	---	951	11976	-12927
T_7 : FYM 12.5 t ha^{-1} + 150 kg N ha^{-1}	---	---	---	---	---
T_8 : Vermicompost 5 t ha^{-1} +150 kg N ha^{-1}	---	---	1250	1355	-2605
T_9 : Pressmud 5 t ha^{-1} +150 kg N ha^{-1}	8395	---	1250	---	7145
T_{10} : FYM 12.5 t ha^{-1} +175 kg N ha^{-1}	---	---	298	4213	-4511
T_{11} : Vermicompost 5 t ha^{-1} +175 kg N ha^{-1}	---	---	1548	5313	-6861
T_{12} : Pressmud 5 t ha^{-1} +175 kg N ha^{-1}	---	---	1548	3848	-5396

Conclusion

It can be concluded that integration of different organic sources of nutrients with inorganic sources have been proven to attain success in baby corn production than use of either organic manures or chemical fertilizers alone. This management strategy is improving the total crop productivity as well as maintaining soil health for future generation. Also, it can assure economic stability to farmers.

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