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Effect of crop geometry and integrated nutrient management in influencing growth and yield of winter season baby corn

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Abstract
Baby corn cultivation can be a substitute for the *rabi* crop production in Chhattisgarh plains. Performance of baby corn variety (G5312) was evaluated under varying crop geometries and different integrated nutrient management practices in split plot design. The different crop geometry treatment proved to increase the yield of baby corn cob, with the maximum under the crop geometry of 45 x 10 cm which was followed by crop geometry of 45 x 20 cm and 60 x 20 cm. The application of 100% RDF through 50% Inorganic + 50% integration of different organic sources i.e 1/3 FYM +1/3 Vermicompost +1/3 neem cake produced maximum baby corn cob yield and fodder yield along with higher growth and yield attributes *viz.* plant height, LAI, dry mater accumulation, cob weight with and without husk. However this treatment was found statistically at par with the treatment of 100 RDF (50% I + 50% FYM) in combination with crop geometry 45 x 20 cm.

Keywords: Growth attributes, yield, baby corn, cob yield, RDF, INM, FYM, vermicompost, neem cake

Introduction
Corn (*Zea mays* L) is the most popular crop in rabi season among the farmers after wheat. Also it is the third most important cereal crop next to rice and wheat. Due to its immense production potential it can be used as young cobs particularly known as baby corn. Baby corn is dehusked immature maize ear, harvested within 2-3 days of silking but prior to fertilization (Pandey *et al*., 1998) [1]. It appends several health benefits as it is highly nutritive crop having capacity to convert more nutrients to food (Yasu, 2016) [2]. As a new crop in the region, it provides a scope for its full potential exploitation. Crop geometry is an important crop production factor for harnessing solar energy for optimum photosynthesis as well as utilization of resources *i.e.* space, light, nutrients and moisture which mainly depends on crop geometry. Plant population affects most growth parameters of crops even under optimal growth conditions and therefore, it is considered a major factor determining the degree of competition between plants (Sangakkara *et al*., 2004) [3].
Integrated nutrient management (INM) refers to judicious application of different nutrient sources in balanced proportion for sustaining soil and crop productivity (Joshi *et al.,* 2018). Beneficial effects of NPK fertilization on productivity of maize has been reported by several workers (Mehta *et al.,* 2005 and Rajanna *et al.,* 2006) [5, 4]. Vermicompost is an excellent base for establishment of free living and symbiotic microbes. FYM is considered good for improving soil health besides, it contains 0.5% Nitrogen, 0.25% Phosphorous and 0.5% Potassium likewise neem cake contains nearly 1% to 3% Nitrogen, 0.5% to 1.0% phosphorus and 1.0% to 2.0% potassium. This upcoming era needs high production and profit and thus, it creates pressure on the farmers to adopt production technologies like heavy and injudicious use of chemical fertilizers, but not only this has reduced the factor productivity, besides, eroding biodiversity and enhancing environmental pollution (Shivran *et al.,* 2014) [9]. Therefore, it's an urgent need to optimize the integrated nutrient management in baby corn.

Material and Methods
An experiment was carried out at Research cum Instructional Farm, Indira Gandhi Krishi Viswavidyalaya, Raipur, Chhattisgarh. The Research cum Instructional Farm is located at $21^0$4'N latitude, $81^0$39'E longitude and 298 m altitude from the sea level.

The region falls under the eastern plateau and hill region (Ago-climatic zone-7) of India. Raipur has a dry sub-humid to semi-dry climatic condition the source of rainfall is south-western monsoon. It receives an average annual rainfall of 1400 mm, mostly (85%) precipitated during the period of June to September. A few showers are expected during winters and occasionally during summer months. The objective of the experiment was to study the role of crop geometry and integrated nutrient management on winter season baby corn. The experiment was carried out in split plot design with three treatments of crop geometry and five treatments of INM constituting fifteen treatments. The main plot consisted of three crop geometry G1: 45 X 10 cm, G2: 45 x 20 cm and G3: 60 x 20 cm while the sub plot consisted the five INM practices *i.e* N1: 100% RDF (100: 60: 40) through inorganic source N2: 100% RDF through FYM, N3: 100% RDF through different organic sources (1/3 FYM + 1/3 Vermicompost + 1/3 neem cake), N4: 100% RDF through 50% inorganic source + 50% through FYM and N5: 100% RDF through 50% inorganic source and 50% through (1/3 FYM + 1/3 vermicompost + 1/3 neem cake).

Results and Discussion

Growth Attributes

Significant variation in plant population, plant height, Leaf Area Index (LAI) and dry matter accumulation plant^{-1} was observed due to different treatments of crop geometries. Significantly higher plant population, plant height and LAI was found under the crop geometry of G1: 45 x 10 cm than those of G2: 45 x 20 cm and G3: 60 x 20 cm. The maximum plant height and maximum LAI exhibited under crop geometry of G1: 45 x 10 cm, but it was found at par with the crop geometry of G2: 45 x 20 cm. While, the lowest plant height and LAI was observed under the crop geometry of G3: 60 x 20 cm. Dry matter accumulation plant^{-1} was recorded highest under the crop geometry of G3: 60 x 20 cm which was statistically similar to the crop geometry of G2: 45 x 20 cm.

Significant difference in plant population was not observed among the treatments with respect to integrated nutrient management. At harvest, significantly tallest plants, maximum LAI and greater dry matter accumulation were produced under the treatment of N5: 100% RDF, where 50% nutrient applied through inorganic and 50% through different organic sources (1/3 FYM + 1/3 vermicompost + 1/3 neem cake). This treatment was found significantly superior than others, but was comparable with N4: 100% RDF (50% inorganic source + 50% through FYM) and N1: 100% RDF applied through inorganic source during both the years and on mean basis. The least plant height was observed under the treatment of N4: 100% RDF applied through FYM during both the years. The combination of inorganic and organic fertilizers was applied under said treatment, which improved the physical and chemical properties of soil, reduced nutrient losses and provides favourable condition for nutrient absorption, translocation and manufacturing of photosynthates and their utilization. Thus, enhanced plant height, which in turn led to prolific production of leaves and leaf area index. The increased plant height due to integrated nutrient management in baby corn was also observed by Jinjila *et al.* (2016) and Mahapatra *et al.* (2018) [8].

Yield attributes and yield

The highest cob weight with and without husk of baby corn was recorded under the crop geometry G3: 60 x 20 cm, which was significantly different than other treatments of crop geometries, but it was comparable to the crop geometry G2: 45 x 20 cm during both the years. The lowest cob weight with and without husk was obtained under the crop geometry of G1: 45 x 10 cm. Whereas the significantly higher baby corn cob yield and green fodder yield was obtained under the crop geometry of G1: 45 x 10 cm as compared to G2: 45 x 20 cm and G3: 60 x 20 cm during both the years. The increase in cob yield was mainly attributed due to increased plant population under closer spacing i.e. 45 x 10 cm. The plant population at this geometry was 54% higher than G3: 60 x 20 cm and 14% higher than G2: 45 x 20 cm. Closer spacing could have increased the baby corn yield to 10% at a spacing of 45 x10 cm reported by Thakur *et al.* (1997) [10]. Similar results of increased cob yield were obtained by Dar *et al.* (2014) [11].

As regards to different integrated nutrient management, the application of N5: 100% RDF, where 50% nutrient applied through inorganic source and 50% through different organic sources (1/3 FYM + 1/3 vermicompost + 1/3 neem cake) produced significantly the highest cob weight with and without husk of baby corn and similarly baby corn cob yield and fodder yield, which was comparable with the treatment of N4: 100% RDF (50% inorganic source + 50% through FYM and N1: 100% RDF applied through inorganic source during both the years. Whereas, the least cob weight without husk was observed under the treatment of N2: 100% RDF applied through FYM during both the years. Improvement in baby corn cob yield and related yield attributes due to incorporation of organic and inorganic nutrient sources can be attributed to balanced carbon nitrogen ratio. These might have Lead to better assimilation of photosynthates and their efficient translocation from source to sink.

Table 1: Effect of crop geometry and integrated nutrient management on plant population, plant height, LAI and dry matter accumulation at harvest

Treatment	Plant population (000 ha^{-1})		Plant height (cm)		Leaf Area Index (LAI)		Dry matter accumulation plant^{-1} (g)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Crop geometry								
G1	220	220	190.1	195.2	11.01	10.94	157.24	170.41
G2	109	109	189.5	193.5	4.88	4.90	167.90	174.11
G3	83	83	184.3	188.2	4.21	4.24	170.95	180.72
S.Em ±	0.23	0.19	0.8	1.8	0.06	0.04	0.78	1.53
CD (P=0.05)	0.90	0.76	3.3	5.4	0.23	0.17	3.05	6.00
Integrated nutrient management								
N1	135	135	203.0	212.7	6.70	6.91	183.8	187.35
N2	135	135	171.8	182.1	6.15	6.22	140.32	157.36
N3	135	135	175.6	190.0	6.18	6.32	143.65	161.32
N4	135	135	201.2	210.7	6.68	6.54	181.74	188.83
N5	135	134	204.3	213.6	7.77	7.61	185.41	190.52

S.Em±	0.33	0.37	1.6	2.01	0.08	0.12	0.71	1.69
CD (P=0.05)	NS	NS	3.8	5.8	0.24	0.36	2.08	4.93

G1: 45 X 10 cm, G2: 45 X 20 cm, G3: 60 x 20 cm, N1: 100% RDF (Inorganic), N2: 100% RDF (FYM), N3: 100%RDF (1/3 FYM + 1/3 VC + 1/3 NC), N4: 100% RDF (50% Inorganic + 50% FYM), N5: 100% RDF (50% Inorganic + 50% (1/3 FYM + 1/3 VC + 1/3 NC))

Table 2: Effect of crop geometry and integrated nutrient management on cob weight with husk, cob weight without husk, cob yield and fodder yield

Treatment	Cob weight without husk (g)		Cob weight with husk (g)		Cob yield (t ha^{-1})		Fodder yield (t ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Crop geometry								
G1	81.73	84.45	12.84	16.51	2.27	2.38	37.23	39.72
G2	89.66	87.94	14.60	18.48	1.94	2.02	32.27	35.09
G3	91.68	89.63	15.40	18.58	1.39	1.56	30.91	32.27
S.Em ±	0.64	0.63	0.20	0.47	0.07	0.05	0.78	0.66
CD (P=0.05)	2.54	2.76	0.82	1.86	0.31	0.24	3.09	2.62
Integrated nutrient management								
N1	97.80	94.84	16.66	20.39	2.01	2.28	37.82	39.52
N2	71.12	72.55	11.69	14.42	1.54	1.64	29.72	31.05
N3	74.79	79.66	11.81	15.30	1.71	1.81	31.53	33.16
N4	94.27	93.27	16.44	19.27	1.89	2.11	37.71	36.42
N5	98.80	96.49	16.81	20.73	2.14	2.31	40.57	41.72
S.Em±	1.64	1.13	0.40	0.57	0.09	0.08	2.51	2.12
CD (P=0.05)	4.79	3.25	1.19	1.68	0.27	0.25	7.25	6.26

G1: 45 X 10 cm, G2: 45 X 20 cm, G3: 60 x 20 cm, N1: 100% RDF (Inorganic), N2: 100% RDF (FYM), N3: 100%RDF (1/3 FYM + 1/3 VC + 1/3 NC), N4: 100% RDF (50% Inorganic + 50% FYM), N5: 100% RDF (50% Inorganic + 50% (1/3 FYM + 1/3 VC + 1/3 NC))

Conclusion

The crop geometry 45 x 10 cm produced the maximum baby corn cob and baby corn fodder yield as compared to crop geometry of 45 x 20 cm and 60 x 20 cm. To achieve a higher yield the use of 100% RDF through a combination of 50% inorganic and 50% (1/3FYM +1/3vermicompost + 1/3 neem cake) proved to be reliable in baby corn crop production.

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