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Influence of Fertility Levels, Nitrogen Levels and Organic Sources on Growth Pre-*kharif* Baby Corn under Irrigated Condition of Varanasi

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Abstract An agronomic trial was conducted with high yielding hybrid variety of baby corn (HM-4) during *kharif* season of 2014 and 2015 to find out the influence of fertility, nitrogen levels and organic sources on baby corn growth parameters at Varanasi, Uttar Pradesh in India. Higher growth attributes were observed with the application of 100% RDF over 75% and 50% RDF, respectively. Similarly, application of 50 kg N ha^{-1} through organic sources resulted in significantly highest growth attributes during the course of study. Whereas, application of vermicompost recorded significantly highest values of growth attributes as compared to FYM. However, difference between vermicompost and sewage sludge failed to touch the level of significance.

Keywords Baby corn, Fertility levels, Growth attributes, Nitrogen, Organic sources.

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Introduction

Maize is the third most important cereal crop next to rice and wheat in India. Baby corn is dehusked young cob of maize harvested within 2-3 days of silk emergence. Being a C_4 plant, it is an efficient converter of absorbed nutrients into food. Baby corn has high contents of vitamin B and is a good source of numerous nutrients. It starts the reporductive phase after 45 days and ends its life span within 60-70 DAS normally in the *kharif* season [1]. Rice-wheat is the predominant cropping system in India, covering an area of 10.4 M ha and has been practiced for more than 40 years, mostly in the entire Indo-Gangetic alluvial belt [2]. Because both crops are exhaustive in nature owing to their similar rooting pattern and foraging and fertilizers are applied unbalanced and excessively, this system is inconvenient with respect to sustainability and productivity. Therefore, this system needs to be diversified without yield loss both in rice and in wheat [2]. Baby corn seems to be a suitable pre-*kharif* crop between rice and wheat [3]. Because this system will be introduced in eastern Uttar Pradesh [3], an efficient production technology for baby corn needs to be developed to achieve high and remunerative yield of baby corn. Nutrient supply is key to ensuring higher productivity of baby corn. Three major nutrients-nitrogen, phosphorus and potassium must be applied adequately. The importance of sufficient nutrient supply in maize is further increased because of the extremely short duration of baby corn. In addition to NPK, sulfur deficiency has been reported over the past few years and hence this nutrient in plant nutrition needs to be prioritized in studies [4]. Whereas, it is well established that the improvement of quality and productivity of crops could be made possible with combined application of organic manures and balanced chemical fertilizers. Therefore, organic manure can be integrated with chemical fertilizers.The concept of integrated nutrient management seeks to sustain soil fertility through an integration of different sources of nutrition that will produce maximum crop yield per unit input use. In view of these facts, an experiment was undertaken at BHU, Varanasi during pre-*kharif* season of 2014 and 2015 to determine the effect of fertility levels, nitrogen levels and organic sources on the growth rate of baby corn.

Materials and Methods

Experimental site and treatment combination

A field experiment was conducted during pre-*kharif* season of 2014 and 2015 at Agricultural Research Farm, Varanasi, under irrigated condition. The experimental location is situated at $25^0$18` N latitude, $83^0$03` E longitude and at an altitude of 128.93 m above mean sea level. The experiment was carried out at the same site during both the years in the split plot design and replicated thrice with NPKS (100%, 75% and 50% RDF recommended dose of fertilizer) in the main plots and nitrogen application through organic sources (25 and 50 kg N ha^{-1}) and organic sources (FYM, vermicompost and sewage sludge) in the subplots. Each replication was divided into three main plots and every main plot into six subplots. Thus, in all there were 18 (3 main plots × 6 subplots) treatment combinations and 54 experimental units in the experiment. Baby corn hybrid HM-4 was sown in a line at a depth of 5 cm with a spacing of 40 cm × 20 cm on 5th May and 16th April during 2014 and 2015, respectively. Nitrogen was applied in three splits per treatment, i.e., half of basal, 25% at knee high and 25% at tassel emergence stages. The entire doses of P, K and S were applied as di-ammonium phosphate (DAP), muriate of potash (MOP) and elemental sulfur at the time of last ploughing. Organic manures were incorporated in plots 10 days before the sowing of baby corn. The quantities of organic manures were calculated on the basis of nitrogen present in them. Sewage sludge was air dried and grounded before applied in the field. FYM and vermicompost were applied as fresh in the plots. The moisture content of all three manures was calculated and all were applied on dry weight basis. The recommended dose of NPK (100% RDF) represents 150-75-60-40 kg NPKS ha^{-1}.

Growth attributes of baby corn

Plant height and number of green leaf plant^{-1}

Observation on plant height and number of green leaf plant^{-1} were measured in five randomly selected plant (tagged with mark) at 15, 30 and 45 and at harvest and average was calculated.

Leaf area index

This was measured directly with the help of plant canopy meter/analyzer model no. LP-80 AccuPAR from each plot at three places and then average was worked out at 30 and 45 DAS.

Chlorophyll content (SPAD value)

The SPAD (soil plant analysis development)-502 or a hand held chlorophyll/SPAD meter (Minolta corporation Ramsey, NJ) was used for rapid and non-destructive estimation of extractable chlorophyll in leaves at 30 and 45 DAS. For taking SPAD reading, topmost fully expanded leaf from sample plants (three plants from center three rows) were selected and expressed in SPAD unit.

Dry matter accumulation plant-1

Four plants taken from the border rows in each plot were used to work out the dry matter production plant^{-1}at 15, 30, 45 DAS and at harvest. These plant samples were first sun dried then oven dried at 70^0C for 48 h and weighed to work out the dry matter production plant^{-1}.

Statistical analysis

The significance of treatment differences were judged by *F*-test. To evaluate the significant difference between two treatment means, critical difference (CD) at 5% level was worked out.

Table 1. Effect of fertility, nitrogen levels and organic sources on plant height (cm) and number of green leaf plant^{-1} at different growth stages of baby corn.

	Plant height (cm)							
	At 15 DAS		At 30 DAS		At 45 DAS		At 60 DAS	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels								
100% RDF	30.17	32.85	69.31	74.59	130.3	135.9	191.0	198.4
75% RDF	29.71	31.50	60.43	64.44	110.9	115.6	164.1	170.5
50% RDF	28.90	30.19	49.42	52.43	91.9	95.4	134.8	139.3
SEm ±	0.66	0.85	1.63	1.56	2.79	3.27	4.16	3.69
CD (p=0.05)	NS	NS	6.41	6.13	10.94	12.84	16.33	14.47
Nitrogen levels (kg ha^{-1} through organic sources)								
N_{25}	29.19	30.70	55.04	58.56	102.0	105.8	150.4	155.7
N_{50}	30.00	32.33	64.41	69.08	120.1	125.4	176.2	183.1
SEm ±	0.50	0.60	1.30	1.58	2.09	2.56	3.03	2.90
CD (p=0.05)	NS	NS	3.75	4.56	6.03	7.39	8.75	8.39
Organic sources								
FYM	28.88	30.49	56.11	59.68	104.5	108.0	153.6	159.0
Vermicompost	29.79	31.66	62.26	66.42	115.4	121.2	171.3	177.5
Sewage sludge	30.10	32.39	60.80	65.36	113.2	117.7	165.0	171.7
SEm ±	0.61	0.73	1.59	1.93	2.56	3.13	3.71	3.56
CD (p=0.05)	NS	NS	4.60	5.58	7.38	9.05	10.71	10.27

Table 1. Continued.

	Number of green leaf plant^{-1}							
	At 15 DAS		At 30 DAS		At 45 DAS		At 60 DAS	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels								
100% RDF	5.90	5.94	12.11	12.65	13.30	13.85	14.29	15.05
75% RDF	5.84	5.87	10.21	10.50	11.09	11.40	11.88	12.39
50% RDF	5.73	5.76	8.61	8.96	9.49	9.85	10.10	10.59
SEm ±	0.13	0.13	0.20	0.20	0.21	0.15	0.21	0.25
CD (p=0.05)	NS	NS	0.77	0.80	0.81	0.57	0.84	0.97
Nitrogen levels (kg ha^{-1} through organic sources)								
N_{25}	5.79	5.84	9.51	9.86	10.39	10.74	11.10	11.62
N_{50}	5.87	5.87	11.11	11.55	12.19	12.65	13.08	13.74
SEm ±	0.07	0.09	0.17	0.14	0.16	0.15	0.18	0.16
CD (p=0.05)	NS	NS	0.48	0.40	0.47	0.45	0.52	0.45
Organic sources								
FYM	5.76	5.78	9.77	10.12	10.67	11.04	11.41	11.93
Vermicompost	5.83	5.87	10.73	11.15	11.77	12.21	12.67	13.32
Sewage sludge	5.89	5.92	10.43	10.84	11.44	11.84	12.19	12.78
SEm ±	0.08	0.10	0.21	0.17	0.20	0.19	0.22	0.19
CD (p=0.05)	NS	NS	0.59	0.49	0.58	0.55	0.63	0.55

Results and Discussion

Plant height (cm)

A critical examination of the data showed that plant height increased significantly with increasing levels of fertility from 50% RDF to 100% RDF at 30 and 45 DAS as well as at harvest. The enthusiastic growth of above ground parts at higher fertility level (100% RDF) might have occurred due to rapid division and elongation of cells with balanced and adequate NPKS supply, which seemed to be the reason behind the favorable influence on all the growth attributes of baby corn [1]. Likewise, the application of nitrogen through organic sources had a significant influence on plant height at 30 and 45 DAS as well as at harvest and increase in nitrogen level from 25 to 50 kg N ha^{-1} significantly increased the plant height during both the years of experiment, respectively. The significantly highest plant height was observed with the application of vermicompost over FYM.Nevertheless, the difference between vermicompost and sewage sludge was non significant at 30, 45 DAS and at harvest stage of the crop. All the treatments failed to bring significant difference on plant height at 15 DAS (Table 1). The increase in plant height may be attributed to presence of growth hormones, enzymes and other sections of earthworms which could stimulate the growth and development of crop [5].

Number of green leaf $plant^{-1}$

Increasing fertility levels from 50% RDF to 100% RDF exerted marked improvement in number of green leaves $plant^{-1}$ at different growth stages of crop during both the years of investigation. However, the differences could not touch the level of significance at initial stage. This is attributed that taller plants at higher fertilizer doses helped the baby corn plants in producing higher number of green leaf. This is well established fact that vegetative growth mainly consists of formation of somatic cells, which results in growth and development of new leaves as well as roots and these meristematic tissues have a very active protein metabolism. The findings of the present investigation are in close conformity with the findings of Singh et al. [6]. Application of 50 kg N ha^{-1} through organic sources also showed marked improvement on number of green leaf $plant^{-1}$ over 25 kg N ha^{-1} at all growth stages of crop growth except at 15 DAS in both the years. The significantly highest number of green leaves $plant^{-1}$ was observed with the application of vermicompost over FYM. However, application of vermicompost was at par with the application of sewage sludge at all stages of the crop growth during both the years (Table 1). The might be due to that the organic matter functioned as a source of energy for soil micro flora which brings about solubilization of inorganic forms of nutrients present in the soil to readily available forms which can be utilized by plants [7].

Leaf area index (LAI) and chlorophyll content (SPAD value)

Application of 100% RDF, 50 kg N ha^{-1} through organic sources and application of vermicompost resulted in significantly highest leaf area index and chlorophyll content of baby corn at 30 DAS and 45 DAS stage of crop during both the years of study. However, application of vermicompost and sewage sludge found to be statistically comparable with each other (Table 2). The application of higher fertilizer dose to baby corn might have enhanced differentiation and expansion of tissues resulting in taller plants and production of more leaf $plant^{-1}$ with expanded surface. The findings are in conformity with earlier results [8, 9]. Vermicompost contains many humic acids which improves morphological traits of crop and thus increases leaf area index and leaf expansion rate because of increased plant nitrogen content. Similar findings were also reported earlier [10, 11].

Dry matter accumulation $plant^{-1}$

Fertility levels markedly influenced dry matter content at all the growth stages except 15 DAS during both the years and application of 100% RDF recorded significantly higher dry matter content over 50% and 75% RDF at all stages. At harvest, as compared to 50% and 75% RDF, the higher fertility level (100% RDF) recorded 41.59% and 14.36% higher dry matter $plant^{-1}$ during 2014 and 43.05% and 15.38% higher dry matter $plant^{-1}$ during 2015, respectively (Table 3). Adequate and balanced fertilization that promotes the plant growth parameters viz. plant height, number of

Table 2. Effect of fertility, nitrogen levels and organic sources on leaf area index (LAI), chlorophyll content (SPAD value) and dry matter accumulation plant^{-1} at different growth stages of baby corn.

	Leaf area index (LAI)				Chlorophyll content (SPAD value)			
	At 30 DAS		At 45 DAS		At 30 DAS		At 45 DAS	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels								
100% RDF	2.34	2.61	4.01	4.17	40.74	41.81	45.83	46.78
75% RDF	2.13	2.28	3.54	3.66	34.69	35.41	39.07	39.50
50% RDF	1.65	1.84	2.83	2.94	28.66	29.31	32.30	32.70
SEm±	0.04	0.06	0.06	0.09	0.87	0.65	0.57	0.47
CD(p=0.05)	0.15	0.23	0.24	0.36	3.42	2.56	2.25	1.86
Nitrogen levels (kg ha^{-1} through organic sources)								
N_{25}	1.88	2.06	3.20	3.30	31.98	32.68	35.95	36.42
N_{50}	2.20	2.42	3.72	3.88	37.41	38.35	42.19	42.90
SEm±	0.03	0.03	0.05	0.04	0.39	0.52	0.47	0.51
CD (p=0.05)	0.09	0.07	0.15	0.12	1.13	1.51	1.35	1.47
Organic sources								
FYM	1.92	2.11	3.27	3.37	32.85	33.55	36.91	37.32
Vermicompost	2.13	2.34	3.62	3.75	36.00	36.96	40.82	41.54
Sewage sludge	2.07	2.28	3.49	3.65	35.24	36.03	39.48	40.13
SEm±	0.04	0.03	0.06	0.05	0.48	0.64	0.57	0.62
CD (p=0.05)	0.10	0.09	0.18	0.14	1.38	1.85	1.66	1.80

Table 2. Continued.

	Dry matter accumulation plant^{-1}							
	At 15 DAS		At 30 DAS		At 45 DAS		At 60 DAS	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels								
100% RDF	3.14	3.18	11.05	13.51	50.75	52.50	136.59	142.14
75% RDF	3.10	3.34	9.53	11.94	40.36	42.60	119.44	123.19
50% RDF	3.03	3.09	7.80	9.50	35.92	36.90	96.47	99.36
SEm±	0.06	0.06	0.21	0.22	0.88	0.77	2.47	2.33
CD (p=0.05)	NS	NS	0.83	0.85	3.46	3.03	9.71	9.14
Nitrogen levels (kg ha^{-1} through organic sources)								
N_{25}	3.07	3.12	8.72	10.70	38.96	40.41	107.91	111.51
N_{50}	3.11	3.16	10.20	12.60	45.73	47.59	127.09	131.61
SEm±	0.04	0.05	0.12	0.17	0.54	0.62	1.46	1.89
CD (p=0.05)	NS	NS	0.35	0.50	1.57	1.79	4.22	5.46
Organic sources								
FYM	3.04	3.09	8.95	10.98	39.90	41.25	110.01	113.64
Vermicompost	3.09	3.15	9.73	12.16	44.48	46.20	122.79	126.99
Sewage shudge	3.13	3.18	9.56	11.81	42.65	44.55	119.70	124.06
SEm±	0.05	0.06	0.15	0.21	0.67	0.76	1.79	2.31
CD (p=0.05)	NS	NS	0.43	0.62	1.93	2.19	5.17	6.69

green leaf, leaf area index and photosynthetic activity ultimately produced higher dry matter plant^{-1}. A similar effect has also been realized that dry matter accumulation of baby corn increased significantly with the application of NPK up to 187.5 + 32.75 + 62.5 kg ha^{-1} [8].

Significant increase in dry matter plant^{-1} was recorded with increment of nitrogen level from 25 to 50 kg N ha^{-1} at 30, 45 DAS and at harvest stage of the crop. Likewise, at harvest as compared to 25 kg N ha^{-1}, nitrogen application at 50 kg N ha^{-1} increased dry matter plant^{-1} by 17.77% and 18.03% during 2014 and 2015, respectively. Among all sources, application of vermicompost obtained significantly highest dry matter plant^{-1} over FYM and remained at par with sewage sludge at 30, 45 DAS and as well as at harvest stage. At harvest, as compared to FYM and sewage sludge, vermicompost application increased the dry matter plant^{-1} by 11.61% and 2.58% in 2014 and 11.74% and 2.36% in 2015, respectively (Table 3). Higher growth rate with the application of vermicompost may attributed to the increase in organic matter content of soil including humic substances that resulted in more availability of plant nutrients, enzymes, vitamins and congenial soil characters which helped the plant to uptake more soil nutrients and may be promoted the plant growth parameters viz. plant height, number of green leaf, leaf area index and photosynthetic activity ultimately produced higher dry matter plant^{-1}. This observation confirms the findings Nagavani and Subbian [12].

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