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Green Technology For Production Of Baby Corn (Zea mays L) Under North-West Himalayan Conditions

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Abstract: An experiment was conducted at the research farm of Central Institute of Temperate Horticulture, Regional Station, Mukteshwar, Uttarakhand (India), during successive seasons of 2009 and 2010 to investigate the effect of different biofertilizers and organic manure on growth and yield of baby corn with the aim to develop green technology for baby corn production. The variety VL-78 was used as experimental material and treatments consisted of various combinations of bacterial biofertilizers *viz*. *Azospirillum*, *Bacillus megaterium* var *phosphaticum* and *Frateuria aurentia* and organic manures. Biofertilizers significantly increased yield and yield attributing characters. The best treatment identified was Vermicompost (1.92 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed) where yield of baby corn was recorded 18.57 q/ha. This treatment also showed increase in leaf chlorophyll content.
Key words: Green technology, *Azospirillum* sp., *Microphos* sp., babycorn.

Introduction[1-6]

Baby corn cultivation, being a recent development, has proved an enormously successful venture in countries like Thailand and Taiwan. Attention is now being paid to explore its potential in India, for earning foreign exchange besides higher economic returns to the farmers. In India, baby corn is emerging as a potential remunerative crop among the progressive farmers. It is interesting to know that these tiny corn cobs are not genetically mutated dwarf ears of corn but are just immature ears of regular corn. Baby corn is typically eaten whole, in contrast to mature maize, whose cob is too hard for human consumption. Almost all commercial baby corn is imported from countries with low labour costs as harvesting and de-husking are done manually. India being rich in availability of cheap labour, has a great potential for its production and export. The use of chemical fertilizer may help in achieving maximum yield of baby corn but keeping present scenario of sustainability and soil and public health in mind, the need was felt to standardize green technology for production of safe baby corn through supplementation of nutrient requirement through biofertilizers and organic manures. The chemical fertilizers pose health hazards and reduce microbial population in soil; besides being quite expensive and thereby making the cost of production high. Under such circumstances, biofertilizers and organic manure may play a major role[1]. Such eco-friendly approach has great potential for the hilly states like Uttarakhand where the use of biofertilizers and manure are promoted among the farmers. The biofertilizers (Biospirillum®, Biophos®

and Biopotash®) and organic manure (Farm yard manure (FYM), leaf mould and vermicompost) are able to increase the supply and availability of nutrient and thereby reduce the fertilizer requirements which ultimately results in reduction of cost of production besides good quality. Application of biofertilizer showed increase in yield and quality by various researchers, but the effect of these biofertilizers on crop plants is enormously influenced by the agroclimatic conditions. The information on these aspects is meagre for high altitude of Uttarakhand. Hence, the present investigation was undertaken to explore the effect of different biofertilizers and organic manure on growth and yield of baby corn with the aim to standardize green, environmentally safe technology for baby corn production.

Materials And Methods[1-6]

The experiment was conducted at the research farm of Central Institute of Temperate Horticulture, Regional Station, Mukteshwar, Uttarakhand (India), situated at 29^0N latitude, 79^0 E longitude and at an elevation of 2200 m above mean sea level during successive seasons of 2009 and 2010. Baby corn variety VL78 was used as experimental material. The land was well prepared and Biospirillum®, Biophos®, Biopotash® (procured from Biotech International Ltd. New Delhi, India) and organic manure were applied as per treatment details given in table 1. Biospirillum, Biophos and Biopotash are eco-friendly liquid biological fertilizer formulation containing bacteria (10^9 cfu per ml) *Azospirillum*, *Bacillus megaterium* var *phosphaticum* and *Frateuria aurentia*, respectively. Standard cultural practices except use of chemical fertilizer and pesticide were followed[2]. Seeds were sown in plot size of 1.2X5 m^2 at a distance of 40 cm between rows and 15 cm within rows. The layout of the experiment was Randomized Block Design with three replications. All the data on growth, cob and yield characters were recorded and pooled data of both the years were analyzed in SPSS 13.0 software.

Table 1. Treatment details of the experiment

Treatment No.		Treatment details
T1	:	FYM (9.6 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed)
T2	:	Vermi (1.92 kg /bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed)
T3	:	Leaf Mould (5 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed)
T4	:	Vermi (1.92 kg /bed) + FYM (9.6 kg/bed)+ Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)
T5	:	Vermi (1.92 kg/bed) + leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)
T6	:	FYM (9.6 kg/bed) +Leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)

Result

Data related to plant characteristics are presented in table 2. Significant difference was recorded among the treatments with respect to plant height both at 30 and 60 days after sowing (DAS). Maximum height (37.67 cm) was recorded in the treatment having Vermi (1.92 kg /bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed): T_2, but this was found at par with treatment T1 and T3 where vermicompost was replaced with FYM and leaf mould, respectively but the biofertilizers were same. Similar trend was also recorded 60 DAS. Plant girth was also recorded after 30 and 60 DAS but no significant difference was observed. At 30 DAS, number of leaves (6.27), fresh weight of plant (12.08 gram), weight of root biomass (1.67 gram) and root length (19.88 cm) was recorded to be maximum in T_2 . No significant difference was observed with respect to leaf length and leaf width at 30 DAS. Little different trend was observed at 60DAS w.r.t above characteristics where significant difference was recorded in all the characters including leaf length and width. Effect of different organic treatments on yield and corn characters of baby corn are presented in table 3. It is clear from the table that differences between treatments were significant with regard to all the cob and corn characters except corn diameter. Maximum number of cob was recorded in T2

while minimum numbers of cob was found in treatment T5. Treatments T3, T4, T5 and T6 were found at par with respect to cob number while there was a significant difference between T1 and T2. However, highest cob weight (29.40 g) was recorded in T2 and minimum (15.33 g) in T6. Average baby corn weight was also maximum in same treatment. Yield of baby corn and cob was the maximum in T2 but it was found at par with T1. Shelling percent was the maximum in treatment T1 and minimum in T4. Maximum corn length (7.32 mm) was produced in T-1, which was found at par with treatment T2 and T3. No significant difference was recorded between the treatments with respect to diameter of corn, however, it was found maximum in T3 and T1 and minimum in T4. Chlorophyll content was also recorded from the leaves. Chlorophyll a, b and total chlorophyll showed significant difference among the treatment. Maximum chlorophyll a (3.055 mg/g), cholorophyll b (0.556 mg/g) and total chlorophyll (3.627 mg/g) was recorded in T2. It is clear from the above result, among all the organic manures, vermicompost was found the best followed by FYM. It significantly increased the yield and other plant growth characteristics when applied with biofertilizers @10ml/kg of seed.

Table 2. Effect of different organic treatments on growth of baby corn plant 30 and 60 days after sowing

	30 DOS							
Treatment	Plant Height (cm)	Plant Girth (cm)	Number of leaves	Fresh weight of plant (gram)	Weight of root biomass (gram)	Leaf length (cm)	Leaf width (cm)	Root length (cm)
T1	37.15	8.53	6.07	8.66	1.62	25.25	2.83	19.13
T2	37.67	8.67	6.27	12.08	1.67	28.93	3.05	19.88
T3	34.35	8.26	5.87	10.37	1.33	26.25	2.78	18.13
T4	35.16	8.87	6.20	5.79	0.95	23.00	2.63	15.38
T5	32.22	8.21	6.01	8.16	1.57	26.38	3.10	18.50
T6	32.47	8.63	6.20	8.00	1.53	28.75	3.50	18.75
Mean	**34.84**	**8.53**	**6.10**	**8.84**	**1.44**	**26.43**	**2.98**	**18.29**
CD0.05	3.95	NS	0.56	4.20	0.42	NS	NS	3.05
SEm	1.25	0.59	0.24	1.15	0.23	0.91	0.35	1.11

	60 DOS							
Treatment	Plant Height (cm)	Plant Girth (cm)	Number of leaves	Fresh weight of plant (gram)	Weight of root biomass (gram)	Leaf length (cm)	Leaf width (cm)	Root length (cm)
T1	110.61	21.11	11.00	166.00	27.00	66.50	8.00	26.825
T2	117.98	21.47	10.93	232.50	37.00	73.00	7.75	24.875
T3	94.98	18.70	10.73	101.00	17.50	55.12	6.00	26.375
T4	89.75	18.39	10.87	165.00	26.00.	64.75	7.75	28.625
T5	88.09	17.14	10.60	177.50	25.00	69.80	7.85	30.175
T6	88.37	25.81	10.27	168.50	24.50	67.00	8.375	27.3
Mean	**98.30**	**20.44**	**10.73**	**168.42**	**26.17**	**66.03**	**7.62**	**27.36**
CD0.05	20.29	NS	0.55	78.11	11.30	12.91	1.76	6.78
SEm	7.39	4.11	0.17	25.51	6.13	3.55	0.48	1.86

T_1= FYM (9.6 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed) ;T_2= Vermi (1.92 kg /bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed); T_3= Leaf Mould (5 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed);T_4= Vermi (1.92 kg /bed) + FYM (9.6 kg/bed)+ Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_5= Vermi (1.92 kg/bed) + leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_6= FYM (9.6 kg/bed) +Leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)

Table 3. Effect of different organic treatments on yield and corn characters of baby corn

Treatment	total no of cobs per plot	Av cob weight (g)	Av baby corn weight (g)	Cob Yield (q/ha)	Baby corn Yield (q/ha)	shelling %	Length of baby corn (cm)	Diameter of baby corn (mm)
T1	120.33	28.07	6.73	80.60	16.27	19.94	7.32	1.24
T2	137.67	29.40	6.95	93.79	18.57	19.83	6.97	1.22
T3	100.00	19.73	6.72	48.67	13.58	30.41	6.86	1.24
T4	115.00	19.80	5.47	52.58	12.62	25.43	6.61	1.17
T5	90.33	17.93	5.87	38.32	10.53	29.83	6.85	1.21
T6	91.33	15.33	5.26	33.55	9.52	28.15	6.23	1.19
Mean	**109.11**	**21.71**	**6.17**	**57.91**	**13.52**	**25.60**	**6.81**	**1.21**
CD0.05	**35.44**	**8.67**	**1.74**	**34.32**	**5.42**	**7.11**	**0.64**	**NS**
SEm	**11.59**	**2.75**	**0.55**	**10.29**	**2.37**	**2.26**	**0.24**	**0.06**

T_1= FYM (9.6 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed) ;T_2= Vermi (1.92 kg /bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed); T_3= Leaf Mould (5 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed);T_4= Vermi (1.92 kg /bed) + FYM (9.6 kg/bed)+ Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_5= Vermi (1.92 kg/bed) + leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_6= FYM (9.6 kg/bed) +Leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)

Table 4. Chlorophyll content in leaves (mg/g of fresh weight) under different organic treatments

Treatment	Chlorophyll a	Chlorophyll b	Total Chlorophyll
T1	2.685	0.498	3.197
T2	3.055	0.556	3.627
T3	2.456	0.420	2.888
T4	2.163	0.384	2.558
T5	2.133	0.363	2.507
T6	2.042	0.375	2.426
Mean	**2.423**	**0.433**	**2.867**
CD0.05	0.50	0.09	0.59
SEm	0.16	0.03	0.19

T_1= FYM (9.6 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed) ;T_2= Vermi (1.92 kg /bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed); T_3= Leaf Mould (5 kg/bed) + Biospirillum (10ml/kg of seed) + Biophos (10ml/kg of seed) + biopotash (10ml/kg of seed);T_4= Vermi (1.92 kg /bed) + FYM (9.6 kg/bed)+ Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_5= Vermi (1.92 kg/bed) + leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed); T_6= FYM (9.6 kg/bed) +Leaf mould (5 kg/bed) + Biospirillum (5ml/kg of seed) + Biophos (5ml/kg of seed) + biopotash (5ml/kg of seed)

Plate 1. Baby corn produced through green technology

Discussion

Biospirillum, biophos and biopotash are eco-friendly liquid biological fertiliser formulation containing bacteria, *Azospirillum*, phosphate solubilising bacteria (*Bacillus megaterium* var *phosphaticum*) and *Frateuria aurentia*, respectively. *Azospirillum* enters in the cortical cells of the root and fix up atmospheric nitrogen, *Bacillus megaterium* var *phosphaticum* readily solubilizes chemically fixed phosphates and make them available to the plant system and promotes excellent plant growth. Similarly, *Frateuria aurentia* remains around the seed/ seedlings and use organic carbon including sugars, organic acids, amino acids released from germinated seeds/seedlings set in soil or root exudates. During their growth, they mobilize potash and make it available to crops. Hence, increase in baby corn yield may be attributed to higher fixation of nitrogen in soil by biofertilizer and better uptake of nitrogen, phosphorus and potash because biofertilizers are capable of mobilizing nutrient elements from non-usable form to usable form through biological processes[3]. *Azospirillum* is also reported to increase yield in garlic[4] where it increases availability of nutrient and thereby reduce the fertilizer requirements which ultimately results in reduction of cost of production. The promoting effect of these biofertilizers may be attributed to production of biologically active substances like vitamins, nicotinic acid, indole acetic acid, gibberellin etc and helps in better germination, root & shoot growth[5]. Synergistic effect of vermicompost along with biofertliger may be attributed to promoting effect of micronutrient and growth regulators present in vermicompost. The results are in close conformity with that of earlier worker[6]. The use of biofertilizers not only help improving soil health but also increase the availability of N, P and K which are in unavailable form in soil, thereby increasing growth and yield of crop. This green technology will certainly be useful in improving soil and environment health as well as will protect us from hazardous affect of chemical fertilizers and pesticides.

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