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Effect of Biofertilizers, Organic Manures and Chemical Fertilizers on Microbial Population, Yield and Yield Attributes and Quality of Sweetcorn (*Zea mays* L., saccharata) cv. Madhuri

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ABSTRACT

A field experiment was conducted at the Main Maize Research Station, Anand Agricultural University, and Godhra to study the "Effect of Biofertilizers, Organic manures and Chemical fertilizers on Microbial population, Yield attributes and Yield and Quality of Sweetcorn (*Zea mays* L., saccharata) cv. Madhuri The experiment was laid out in randomized block design with four replication and fifteen treatments. The results of study revealed that an increase in dehusked cob's length and girth, number of cobs and average weight of cobs were recorded highest in the treatment (T_8) where seed inoculation with biofertilizers (Azotobacter-1 + PSB1-16) + Vermicompost @ 2.5 t ha^{-1} + 100% RDF was given which was at par with T_{10} and T_2. Treatment T_8 produced significantly higher green cobs and fodder yield followed by T_2 and thereby obtained higher harvest index in treatment T_8 followed by T_1, T_2, T_{10} and T_3. With respects to quality parameters, the total sugar content and TSS were significantly higher under treatment T_8 followed by T_{10} and T_2 while, ascorbic acid was registered significantly higher under T_{13} than rest of the treatments. Moisture content was found non-significant in all the treatments. Looking to the results of microbial population, the bacterial, fungal and actinomycetes population were significantly higher in those treatments receiving Biofertilizers, FYM and vermicompost except treatment T_{15} (100% RDF alone) had the lowest microbial population where only application of chemical fertilizers. The maximum microbial load was recorded in the treatment (T_8) followed by (T_{13}) and (T_{10}) over rest of the treatments.

Introduction

Sweet corn (*Zea mays* L. saccharata) is one of the most popular vegetable in countries like USA and Canada. It is becoming increasingly popular in India and other Asian countries. It is widely used as a fresh or processed and frozen kernel as vegetable which indicates its popularity. Sweet corn (*Zea mays* L. saccharata), a diploid species with 2n = 20 chromosomes, is a member of the grass family (Grammineae), (Beadle, 1939). Sweet corn is of relatively recent origin. The major difference between sweet corn and field corn is its genetic makeup rather than systematic or taxonomic characterization. Fresh horticultural produce with less chemical residues will be a boon for the public health (Chaudhary *et al.*, 2004). This is of special importance for vegetables, which are consumed either raw or mildly cooked. The poor soil health has reflected conspicuous decline the yield and quality of the fresh horticultural produce. This is a matter of major concern. The nutritive value and quality of vegetables depend upon genetic, climatic, biotic, edaphic, chemical and other factors as well as combinations of these factors. Some ecological, cultural and physical factors including fertilizer management have significant influence on the chemical and nutritional composition of plants as well as their anatomical and morphological structure (Salunkhe and Kadan, 2005). This is possible only when chemical based inputs supplemented with biologically derived inputs/bio-resources and biofertilizers to supply nutrients. Therefore, biofertilizers are used as a partial substitute for chemical fertilizers. As sweet corn fits well in semi-urban agriculture and it needs to be consumed in a short time after harvest, contributes to diet diversification and improve nutrition, therefore this investigation was needed to find out integrated nutrients effects on yield, microbial load and quality of sweet corn.

Materials and Methods

A field experiment was conducted at the Main Maize Research Station, Anand Agricultural University, Godhra during the *rabi* season of year 2005-06 and 2006-07 to study the "Influence of bioorganics and levels of chemical fertilizers on the growth, yield and post-harvest quality of sweet corn (*Zea mays* L., saccharata) cv. Madhuri." The soil of experimental plot was sandy loam in texture. The soil was low in organic carbon and nitrogen, medium in available phosphorous and high in potassium, during both the years. The experiment was laid out in randomized block design with four replication and fifteen treatments. The fifteen treatments comprised of two organic manure i.e. FYM, VC, two level i.e. (ABA-1 + PSB-16) and no biofertilizers and three levels of chemical fertilizers (50% RDF, 75% RDF and 100% RDF) with additional treatments T_{13} (application of 10 t ha^{-1} FYM + 2.5 t ha^{-1} VC and seed inoculated with biofertilizers), T_{14} (application of 100% RDF and seed inoculated with biofertilizers) and treatment T_{15} as control (application of 100% RDF (120:40:0 kg NPK ha^{-1}) through chemical fertilizers).

The seeds of sweet corn variety Madhuri were dibbled manually in previously opened furrows at a distance of 45 cm between rows and 20 cm within the row @ 20 kg ha^{-1} according to inoculated and uninoculated treatments. Two seeds per hill were sown at 3-4 cm depth. The furrows were slightly covered with soil. The full dose of phosphate and one third quantity of nitrogen in the form of DAP and urea were applied as a basal dose and remaining two third quantity of nitrogen was applied as top dressing in equal two splits at knee high stage and silking stage. The Azotobacter-1 and PSB-16 were used 25 g inoculated kg seed^{-1} containing 10^8 CFU g^{-1} carrier for treating seed with water slurry a day prior to sowing.

Yield attributes

The biometric observations for all the yield attributing characters, except (number of cobs plant^{-1} and mean weight of cob) were recorded from five randomly selected tagged plants within each net plot.

Harvest index is the ratio of economic yield to the biological yield plot^{-1}. It was calculated by using the formula (Donald and Hamblin (1976)) as given below.

$$\text{HI (\%)} = \frac{\text{Economic yield, kg ha}^{-1}}{\text{Above ground biological yield, kg ha}^{-1}\text{ (Green cobs yield + Green Stover yield)}}$$

Quality parameters

Sugar content, moisture, total soluble solids and ascorbic acid ($mg100g^{-1}$) the individual treatment were determined as per procedure described below.

Total soluble sugar content of grains of green cobs of sweet corn was determined by anthrone reagent method described by Franscistt *et al.*, (1971).

Total soluble solids (TSS) was recorded by using ERMA hand refractometer with a range of 0 to 32º Brix and a resolution of 0.2º Brix by placing 1 to 2 drop of clear juice on the prism (Rangamma, 1987).

Spectrophotometric method for determination of ascorbic acid with 2, 4-DNPH was used to determine ascorbic acid content of green cobs of sweet corn.

The moisture content of kernels at harvest was determined using the hot air oven during method.

$$\text{Moisture \%} = \frac{100\,(W1 - W2)}{W}$$

Where,

W_1 = Weight in grams of the dish with the material before drying

W2 = Weight in grams of the dish with the material after drying

Microbial population

The composite soil sample collected from plot before sowing was taken for determination of initial status of soil microbial count. For individual treatment the soil sample was collected from the root-zone periphery of five plants from central rows of each net plot of the treatment of respective replication at 60 DAS crop stage were taken for soil microbial count determination during the year 2006-07.

To estimate the number of soil micro flora, count were calculated on the basis of serial dilution technique, using pour plate method and replicated 10 g soil and appropriate dilution as described by Johnson and Curl, (1972).

Statistical analysis

Both the year data were analyzed and presented here only pooled value for better explanation. Data on different aspects of sweet corn crop were subjected to statistical analysis as per the procedure of Randomized Block Design described by Cochran and Cox (1957) at the Computer Center, Department of Agricultural Statistics, BACA, AAU, Anand. Comparisons of the treatment means were done by using Duncan's Multiple Ranking Test (Duncan, 1955).

Results and Discussion

Effect of treatments on yield attributes and yield

Observation on yield attributing characters of sweetcorn presented in Table 1, revealed that the maximum number of cob $plant^{-1}$ (1.45 cob/plant) and average weight of cob (178.53 g/plant) were obtained with application of vermicompost @ 2.5 tha^{-1} + 100 % RDF + seed inoculation with biofertilizers in treatment T_8 followed by T_{10} and T_2 than rest of treatments. With respect to dehusked green cob length and girth, treatment T_8 recorded highest i.e 16.71cm and 14.69 cm respectively followed by T_{10} and T_2. This increased in yield attributes was due to the growth pattern at different intervals of crop growth phase. It might be the reflection of source of nutrient available in the root zone which stimulate the physiological processes in plant, ultimately results into increased in girth and length of cob and the integrated effect of inorganic fertilizer, organic manures and biofertilizers. These results are in accordance with Kar *et al.,* (2006) on N in sweet corn, Sahoo and Mahapatra (2004) on N in sweet corn and Zende (2007) on INM in sweet corn.

Among the treatments, T_8 resulted significant increase in green cob and fodder yield. The green cobs yield and green fodder yield were registered significantly the higher in treatment T_8 i.e. 15705 kg/ha and 21917 kg/ha respectively followed by T_2 than rest of the treatments. The harvest index was observed significantly higher in treatment T_8 (42.55%) followed by T_1, T_2, T_{10}, T_7, T_3, and T_9.This might be due to the pronounced effect of integrated nutrient management on green cobs yield reflects the increased in growth and yield attributes of sweet corn, resulted in green higher cobs yield and fodder yield which ultimately noted the higher harvest index. Further vermicompost application increased green cobs yield over FYM application. These might be due to vermicompost which improved the soil fertility where all the appropriate nutrients are in readily available forms to the plants and have narrow C: N ratio (below 20:1) than FYM. These results are in accordance with the findings by Sambhavi and Sharma (2008) in potato. Organic manures along with inorganic fertilizer and seed inoculated with azotobacter and phosphate-solubilizing bacteria had beneficial effect on green cob yield and green fodder yield. These might be due to fixation of atmospheric N and secretion of growth promoting substances of azotobacter and increased bacterial efficiency by phosphobacteria combined together might have increased the growth and yield parameters as reported by Somani *et al.,* (2005). Similar effect was also observed by Thavanprakash *et al.,* (2005) in baby corn, Patil *et al.,* (2001) and Mishra *et al.,* (1998) in Maize, Geleta (2004) on sweet corn and Zende (2007) on INM in sweet corn.

Effect of treatments on quality parameters

Data pertaining to quality parameters presented in Table 2 revealed that the total sugar content and TSS were significantly observed higher under treatment T_8 (21.05% and 17.38^{0}brix respectively) followed by T_{10} and T_2 than rest of the treatments. The rise in total soluble sugar content of sweet corn might be due to starch protein hydrolysis to soluble sugar and carbon skeleton has been used for amino acid synthesis and subsequently protein biosynthesis via TCA intermediate and increase in photosynthesis rate and chlorophyll content which enhanced total soluble sugar of sweet corn (Duffs and Duffs, 1984). Arbad *et al.,* (2008) found impact of inorganic fertilizers along with vermicompost and seed inoculation with biofertilizers on total sugar in sweet sorghum due to balance C: N ratio, which improved soil physical, chemical and microbial properties and thereby increased availability of N, P & K and micronutrients. These results were in accordance with Zende N. (2007) in sweetcorn, Gutte *et al.,* (2008) in sorghum, Arunkumar *et al.,* (2007[b]) in sweet corn, Khadtare *et al.,* (2006[b]) in sweet corn and Hailu *et al.,* (2008) in carrot. The highest ascorbic acid content (7.660 mg/100g) was recorded in T_{13} than rest of the treatments.

This might be due to available Zn in organic manures, which ultimately stimulate the higher ascorbic acid. Zn act as a potential inhibitor of Cu uptake which forms parts of the enzyme ascorbic acid oxidase. These results were in agreement with Sambhavi and Sharma (2008) in potato, Bahadur *et al.,* (2006) in garden pea. The moisture content in the kernel of cobs of sweet corn exerted no differences among different treatments.

Table.1 Effect of biofertilizers, organic manures and chemical fertilizers on yield attributes and yield of sweetcorn (*Zea mays* L., saccharata) cv. Madhuri

Treatments		Green cob length (cm)		Green cob girth (cm)		Number of cobs plant^{-1}		Average weight of cob (g)		Green cobs (kgha^{-1})		Green fodder (kgha^{-1})		Harvest index (%)	
T_1	F_{10} + 100% RDF + B_0	15.18	bcde	13.41	bcd	1.30	cde	156.69	cde	12996	cde	17824	c	42.21	ab
T_2	F_{10} + 100% RDF + B_1	15.62	abc	13.62	abc	1.36	abc	165.79	bc	14098	bc	19565	bc	41.91	abc
T_3	F_{10} + 75% RDF + B_0	14.74	def	13.13	bcdef	1.24	ef	146.30	efg	12425	de	17640	c	41.13	abcde
T_4	F_{10} + 75% RDF + B_1	15.30	bcde	13.35	bcde	1.33	bcd	157.63	cde	13370	cd	19462	bc	40.70	bcdef
T_5	F_{10} + 50% RDF + B_0	14.05	f	12.05	g	1.07	g	130.44	h	8844	f	13554	d	39.39	f
T_6	F_{10} + 50% RDF + B_1	14.50	ef	12.29	fg	1.12	g	136.30	gh	9345	f	14460	d	39.22	f
T_7	$V_{2.5}$ + 100% RDF + B_0	15.51	abcd	13.70	bc	1.30	cde	159.40	bcd	13449	cd	18843	bc	41.70	abcd
T_8	$V_{2.5}$ + 100% RDF + B_1	16.71	a	14.69	a	1.45	a	178.53	a	15705	a	21917	a	42.55	a
T_9	$V_{2.5}$ + 75% RDF + B_0	15.15	bcde	13.03	cdef	1.28	cde	150.68	def	13168	cde	18587	c	41.36	abcd
T_{10}	$V_{2.5}$ + 75% RDF + B_1	16.13	ab	14.11	ab	1.39	ab	171.63	ab	15084	ab	21006	ab	41.83	abc
T_{11}	$V_{2.5}$ + 50% RDF + B_0	14.31	g	12.52	efg	1.10	g	133.53	h	9229	f	13726	d	40.20	def
T_{12}	$V_{2.5}$ + 50% RDF + B_1	14.46	ef	12.66	defg	1.15	fg	138.55	gh	9618	f	14705	d	39.62	ef
T_{13}	F_{10} + $V_{2.5}$ + B_1	14.63	def	12.81	defg	1.09	g	139.68	fgh	9933	f	14991	d	39.73	ef
T_{14}	F_0 + 100% RDF + B_1	15.01	cde	13.41	bcd	1.25	b	146.94	efg	12127	de	17935	c	40.36	cdef
T_{15}	F_0 + 100% RDF + B_0	14.83	def	13.62	abc	1.23	ef	143.89	h	11805	e	17311	c	40.52	cdef
S. Em ±:		0.29		0.26		0.03		3.63		497.46		687.85		0.48	
C.D. (5 %) :		0.818		0.726		0.075		10.189		1398.2		1933.4		1.336	
C.V. % :		5.85		5.93		6.15		7.31		12.55		11.93		3.31	

Note : Treatment means with the letter/letters in common are not significant by Duncan's New Multiple Range Test at 5% level of significance

Table.2 Effect of Biofertilizers, Organic manures and Chemical fertilizers on Quality of Sweetcorn (*Zea mays* L., saccharata) cv. Madhuri

Treatments		Moisture (%)	Total Soluble solids (°brix)		Total soluble sugar (%)		Ascorbic acid (mg/100g)	
T_1	F_{10} + 100% RDF + B_0	74.37	16.68	cde	19.74	cd	7.350	bcd
T_2	F_{10} + 100% RDF + B_1	75.30	17.10	bc	20.15	bc	7.510	abc
T_3	F_{10} + 75% RDF + B_0	74.16	15.90	fgh	19.06	efg	7.280	d
T_4	F_{10} + 75% RDF + B_1	74.16	16.55	de	19.39	def	7.325	cd
T_5	F_{10} + 50% RDF + B_0	74.16	14.98	i	17.63	i	6.950	e
T_6	F_{10} + 50% RDF + B_1	74.53	15.50	h	17.96	hi	7.235	d
T_7	$V_{2.5}$ + 100% RDF + B_0	75.08	16.75	cd	19.95	bcd	7.360	bcd
T_8	$V_{2.5}$ + 100% RDF + B_1	75.35	17.38	ab	21.05	a	7.540	ab
T_9	$V_{2.5}$ + 75% RDF + B_0	74.96	15.98	fg	19.53	cdef	7.340	bcd
T_{10}	$V_{2.5}$ + 75% RDF + B_1	75.42	17.35	ab	20.68	ab	7.575	a
T_{11}	$V_{2.5}$ + 50% RDF + B_0	74.75	15.53	gh	17.93	hi	7.170	d
T_{12}	$V_{2.5}$ + 50% RDF + B_1	74.69	15.85	fgh	18.43	gh	7.240	d
T_{13}	F_{10} + $V_{2.5}$ + B_1	75.47	17.65	a	19.35	def	7.660	a
T_{14}	F_0 + 100% RDF + B_1	75.37	16.23	ef	19.28	def	7.260	d
T_{15}	F_0 + 100% RDF + B_0	74.68	16.23	ef	18.89	fg	6.650	f
	S. Em ±:	0.45	0.15		0.22		0.060	
	C.D. (5 %) :	NS	0.42		0.64		0.168	
	C.V. % :	1.090	2.010		2.350		0.660	

NS = Non significant

Treatment means with the letter/letters in common are not significant by Duncan's New Multiple Range Test at 5% level of significance

Table.3 Effect of Biofertilizers, Organic manures and Chemical fertilizers on Microbial population of Sweetcorn at 60 DAS (*Zea mays* L., saccharata) cv. Madhuri

Treatments		Bacteria Cfug^{-1}x 10^{-6} of soil		Fungi Cfug^{-1}x 10^{-4} of soil		Actinomycetes Cfug^{-1}x 10^{-4} of soil	
Initial	F_{10} + 100% RDF + B_0	6.75	h	11.00	f	12.00	h
T_1	F_{10} + 100% RDF + B_1	15.40	cd	21.00	ab	22.00	bcde
T_2	F_{10} + 75% RDF + B_0	15.20	cd	15.50	bcdef	24.50	abc
T_3	F_{10} + 75% RDF + B_1	14.60	de	20.50	abc	14.00	fgh
T_4	F_{10} + 50% RDF + B_0	15.95	bcd	19.50	abc	19.00	bcdefg
T_5	F_{10} + 50% RDF + B_1	11.30	fg	17.50	bcde	12.50	gh
T_6	$V_{2.5}$ + 100% RDF + B_0	12.30	efg	17.50	bcde	14.50	efgh
T_7	$V_{2.5}$ + 100% RDF + B_1	15.60	cd	21.00	ab	23.00	bcd
T_8	$V_{2.5}$ + 75% RDF + B_0	18.60	ab	25.00	a	31.00	a
T_9	$V_{2.5}$ + 75% RDF + B_1	14.60	de	16.50	bcdef	21.00	bcdef
T_{10}	$V_{2.5}$ + 50% RDF + B_0	18.00	abc	22.50	ab	26.50	ab
T_{11}	$V_{2.5}$ + 50% RDF + B_1	12.05	efg	18.00	abc	16.00	defgh
T_{12}	F_{10} + $V_{2.5}$ + B_1	13.25	def	18.00	abc	18.00	cdefgh
T_{13}	F_0 + 100% RDF + B_1	19.60	a	22.00	ab	32.00	a
T_{14}	F_0 + 100% RDF + B_0	13.85	def	19.50	abc	12.50	gh
T_{15}	F_{10} + 100% RDF + B_0	10.20	g	14.00	cdef	15.50	defgh
S. Em ±		8.52		2.05		2.27	
CD		25.68		6.17		6.84	
CV%		8.49		15.50		16.41	

Effect of treatments on micobial population

Result presented in (Table 3) showed significant differences in microbial population in soil as influenced by different treatments in their microbial build of soil. Results revealed that the highest bacterial load 19.6 x 10^{-6} cfu g^{-1} was observed in treatment T_{13} (F_{10} + $V_{2.5}$ + B_1) which was at par with T_8 (18.60 x 10^{-6} $cfug^{-1}$) and T_{10} (18.00 x 10^{-6} $cfug^{-1}$).

The lowest bacterial load was recorded in T_{15} (10.20 x 10^{-6} $cfug^{-1}$).The highest fungal population was recorded in T_8 (25.0 x 10^{-4} $cfug^{-1}$) followed by treatments T_{10}, T_{13}, T_2, T_7, T_3, T_4, T_{14}, T_{11} and $T_{12.}$ The lowest fungal was recorded in T_{15} (14.00 x 10^{-4} $cfug^{-1}$). Actinomycetes load was recorded highest in T_{13} (32.0 x 10^{-4} $cfug^{-1}$) and was at par with T_8, T_{10} and T_2 whereas the lowest actinomycetes load was recorded in T_{15} (15.5 x 10^{-4}).

Looking to the results, the bacterial, fungal and actinomycetes population were significantly higher in those treatments receiving FYM and VC except treatment T_{15} (100%RDF alone) had the lowest microbial population where only application of chemical fertilizers. The maximum microbial counts were found in the treatment T_8 ($V_{2.5}$+100% RDF + B1) followed by T_{13} and T_8 over rest of the treatments.

In-organic fertilizers, organic manure and bio fertilizers combined application had greatly influenced on the soil microbial population. Increased in both general and beneficial microflora in soil can attributed to more availability of nutrients. It is also evidence from result that the beneficial population of microbes were more wherever they introduced than initial. Thus the treatment T_8 and T_{10} noted positive response with respect to different growth character, yield attributes, yield and quality of sweet corn. This may be attributed to the vermicompost containing higher amount of growth promoting substances, vitamins and enzymes, which in turn increased the microbial population and in addition to this azotobacter + phosphosolubilizing bacteria increased the root biomass production, which resulted in higher production of root exudates increasing the beneficial bacteria, fungi and actinomycetes population in rhizosphere region. Increase in bacteria population to a greater extent than actinomycetes and fungi has been reported by Maheswarappa *et al.*, (1999) in coconut. Increased in the colonization of total microbes, N-fixers in the VC applied soil compared to control plot has been reported by Kale *et al.,* (1992). Similar findings reported by Kannan *et al.*, (2005) in tomato.

In conclusion, the results discussed in the present study revealed that treatment T_8 found to be superior with respect to increase microbial load in soil, yield attributing characters and yield as well as for improving quality of sweetcorn followed by treatment T_{10}.

Therefore it is concluded that sustainable higher yield and better quality can be obtained with an application of vermicompost @ 2.5 t ha^{-1} along with 100% RDF and seed inoculation with biofertilizers (Azotobacter-1 + PSB1-16) (T_8) or an application of vermicompost @ 2.5 t ha^{-1} along with 75% RDF and seed inoculation with biofertilizers (Azotobacter-1 + PSB1-16) (T_{10}) in *rabi* sweet corn crop cv Madhuri.

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