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RESEARCH ARTICLE :

Studies on organic manures and liquid organic manures to quality parameters in sweet corn [*Zea mays* (L.) *Saccharata*]

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SUMMARY : The experiment has twenty four treatment combinations comprising of six main plots, organic manures mainly green leaf manure (GLM), enriched compost, FYM and vermicompost in combinations compared with RDF and FYM + RDF and four sub plots, liquid organic manures mainly bio-digester liquid manure, panchagavya and cow-urine. The treatments comprised of application of 7.5 t FYM + RDF (100 : 50 : 25 N, P_2O_5, K_2O kg ha^{-1} + 10 kg $ZnSO_4$) (RPP) and (100:50:25 N, P_2O_5, K_2O kg ha^{-1} + 10 kg $ZnSO_4$) (RDF) alone exhibited significant effects on quality parameters *viz.*, protein content, reducing and non-reducing sugar, total sugar, total soluble solids and total carbohydrates content in sweet corn kernels of sweet corn. Among the organic manurial combinations GLM + EC + VC (top dressing at GGS) recorded higher quality of sweet corn with all liquid organic manures over basal applied vermicompost. Similarly, Bio-digester and cow urine @ 10% spray noticed higher quality of sweet corn over control. Irrespective of organic manures, the dehydrogenase activity was significantly higher with GLM + FYM + VC (top dressing at GGS) and GLM + EC + VC (basal) equivalent to RDN over RPP and RDF.

KEY WORDS : Sweet corn, Organic manures, Liquid organic manures, Fertilizer, Dehydrogenase activity, Quality

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BACKGROUND AND OBJECTIVES

Sweet corn is peculiarly an American crop. It cannot be regarded as a staple food but it is consumed fresh as a confection. In sweet corn, the conversion of sugar into starch in the endosperm of the kernels does not proceed to completion as it does in starchy types of maize *viz.*, dent, flint and pop. Thus, the storage material in the endosperm is composed of sugars-glucose and sucrose and of intermediate polysaccharide products generally classified as dextrins. In Mexico and among the Indians of the upper Mississippi, sweet corn was the basis of pinole, a confection prepared by grinding the mature seeds. In Peru, kernels of sweet corn were parched to produce a favourite food, kamela. In that region, sweet corn also found a special nihe in the preparation of the native beer, chinch to which by the virtue of its greater sugar content it imparted a higher alcoholic potency. Subsequently, it found a special niche in the United States, where it is consumed as a green corn or roasted ears or as canned and frozen corn. In India, the green ears of maize are consumed directly as roasted ears in and around cities. He demand for sweet corn in the amusement parks, theaters, circus and exhibitions is increasing with increasing urban population. Due to its increasing demand, there is an increasing tendency for commercial production of sweet corn.

RESOURCES AND METHODS

The present investigation was carried out in *Kharif* 2009-10, under Main Agricultural Research Station, Dharwad which comes under Northern Transitional Zone of Karnataka with an average annual rainfall of 750 mm. The sweet corn variety Madhuri was used. The seeds were hand dibbled at 60 x 30 cm spacing at optimum moisture conditions. The crop was raised under rainfed conditions. The trial comprising of 24 treatment combinations having six main plots, mainly four organic manurial combinations equivalent to recommended chemical fertilizer, one recommended dose of chemical fertilizer (RDF) and a recommended package of practice (RPP) (7.5 t FYM +RDF) with four sub plots having 3 liquid organic sprays and control were laid out in Split-plot design with three replications. Based on the nutrient content of organic manures, the quantity of organic manures 1/3 each of green leaf manure (GLM), farm yard manure (FYM), FYM, enriched compost (EC), vermicompost in combination were applied equivalent to recommended dose of nitrogen. Based on phosphorus and potassium content of organics it was confirmed that this quantity of organic manures will meet the recommended quantity of phosphorus and potassium.

All the organic manures equivalent to RDN were applied 15 days before sowing except vermicompost which was applied at grand growth stage (GGS). The Sub plots received three liquid organic sprays at GGS and tasseling as per the treatments. The recommended chemical fertilizer (RDF) treatment received 50% RDN and full phosphorus, potassium and $ZnSO_4$ at sowing and 50% RDN was applied at GGS. Recommended package received RDF with FYM @ 7.5 t ha^{-1} which was applied 15 days before sowing. In organic treatments weeds and pests were managed by cultural practices and by using bio-pesticides.

The dehydrogenase activity in the soil samples was determined by following the procedure as described by Casida *et al.* (1964). Ten g of soil and 0.2 g $CaCO_3$ were thoroughly mixed and dispensed in the conical flasks. Each flask was added with 1.0 ml of 1.5 per cent, 2, 3, 5-triphenyl tetrazolium chloride (TTC), 1.0 ml of 1 per cent glucose solution and 8.0 ml of distilled water to leave a thin film of water above soil layer. The flasks were stoppered with rubber bunks and incubated at 30^0C for 24 hours. At the end of incubation, the contents of the flask were rinsed down into small beaker and a slurry was made by adding 10 ml of methanol. The slurry was filtered through Whatman No. 42 filter paper. Repeated rinsing of soil with methanol was continued till the filtrate ran free of red colour. The filtrate was made upto 50 ml with methanol in volumetric flask. The intensity of red colour was measured at 485 nm against a methanol blank using spectrometer.

Grain of fresh cobs from readily selected five kernel plants in the plot area were separated and studied for quality parameters.

Reducing content of sweet corn kernel was estimated by Somogyi (1945) method and was expressed in percentage. Total sugar content of sweet corn kernel was estimated by the same procedure of reducing sugar. Non-reducing sugar was calculated by using a formula given below and expressed in percentage.

Non-reducing sugar=(Total sugar - reducing sugar) x 0.95

The nitrogen content of sweet corn kernel was estimated by modified microkjeldhal's method (Jackson, 1973). The protein content was calculated by multiplying the nitrogen content with factor 6.25 and expressed in percentage. Fresh sweet corn cobs were given to a panel of members to know the consumer acceptance and they were asked to grade the sweet corn kernels based on relative total soluble solids. The carbohydrate content of sweet grain was estimated by Anthron method as suggested by Hedge and Hofreiter (1962). It was expressed in percentage and results were tabulated.

Liquid organic manures mainly panchagavya, bio-digester was done by following the standard procedures and panchagavya was sprayed at 3 per cent and bio-digester was sprayed at 10 per cent. The fresh cow urine was collected and sprayed at 10 per cent.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Protein content :

The RPP and RDF treatment resulted high content of protein (9.94 and 9.67 %) in the grains (Table 1). Among organics GLM + EC + VC (top dressing at GGS) (9.27%) treatment produced significantly higher protein content over other organics. This might attributed the role N and Zn helps an important role in synthesis of nucleic acid and protein. Significantly higher protein content of maize with 150 kg N over the 120 kg N per ha and no nitrogen reported by Muthukrishnan and Subramanian (1980). The increased nutrient uptake in treatment receiving vermicompost applied in top dressing at grand growth stage can be well supported by the increased yield levels of sweet corn, over vermicompost applied at basal. The application of vermicompost @ 5.0 t per ha to sugarcane increased the sugar recovery by 0.92 per cent compared to application of chemical fertilizers (Hapse, 1993).

The significantly higher protein content (9.27%) was recorded with cow urine @ 10% spray over rest of the treatments. This might de contributed by presence uric acid and plant growth substances in cow urine. Application of panchagavya and bio-digester foliar sprays at cob formation stage of maize enhanced the protein and carbohydrates content opined by Singh and Singh (1968).

Significantly higher protein content was recorded in RPP + cow urine @ 10% spray (10.40%) over other combinations. This might be due to the presence of essential plant nutrients in panchagavya and uric acid and plant regulatory substances in cow urine helps to increasing quality characters of sweet corn. The absence of either FYM with inorganic fertilizer is found to be reflected in higher protein value of the maize grain reported by Reddy *et al.* (1990) and the continuous organic farming is of considerable value in increasing the protein (Addy *et al.,* 1987).

Reducing and non-reducing sugars :

Reducing and non-reducing sugar content (3.65, 3.57% and 20.76, 21.40%) was significantly higher recorded in RDF and RPP treatments. However, significantly lower reducing and non-reducing sugar content (2.57%) was recorded in GLM + FYM + VC (basal) equivalent to RDN. This might be to increased availability of N, P, K in RPP and RDF promoted the improving reducing and non-reducing sugars than organic manures.

Among liquid manures, panchagavya @ 3% spray recorded significantly higher reducing sugar content (3.50%) and non-reducing sugar content (20.21%) significantly higher was recorded in bio-digester liquid @ 10% spray treatment (Table 1). This might be due to increased availability of nutrients and nutrient uptake ultimately increases the reducing sugar. The kernel weight of sweet corn, reducing sugar, non-reducing sugar, total sugar and protein content in grain was significantly increased with increase in nitrogen levels (Raja, 2001).

The treatment combinations of RDF + panchagavya @ 3% spray (3.82%) and RDF + cow urine @ 10% spray were found significantly higher reducing sugar content (3.82%) over rest of the treatment combinations. While, significantly higher non-reducing sugar content (22.90%) recorded in RDF + control treatment. This might due to efficient use of soil moisture due to better root growth caused by better availability of nutrients helped improving the sugar content in grains.

Total sugar and total soluble solids :

Total sugar content (24.97 %) and total soluble solids (13.08 %) (T.S.S %) in sweet corn kernels was significantly higher observed in RPP. This might be due to more availability of nutrients. Similarly, highest sugar content in sweet corn grain at green stage was found under 50 kg P_2O_5 + 50 kg K_2O ha^{-1} opined by Gawade (1998).

Among liquid manures bio-digester liquid @ 10% spray and cow urine @ 10% spray treatment yielded significantly higher total sugar and total soluble solids (23.16 and 23.10, 12.14 and 12.22 %), respectively. This might be contributed by presence uric acid and plant growth substances in cow urine. Application of panchagavya and bio-digester foliar sprays at cob formation stage of maize enhanced the protein and carbohydrates content (Singh and Singh, 1968).

The interactions data revealed that, significantly higher total sugar content (26.33%) and total soluble solids (13.60%) was recorded with application of RDF + control and RPP + bio-digester liquid @ 10% spray. While, significantly lower total sugar content (18.28%) was recorded in GLM + FYM + VC (basal) equivalent to RDN + panchagavya @ 3% spray and total soluble solids was noticed in all organic manure combinations. Due to

Table 1 : Protein (%), reducing sugar (%), non-reducing sugar (%), total sugar (%), TSS (%) and total carbohydrates (%) content in sweet corn and dehydrogenase activity (µg TPF g^{-1} soil /day) as influenced by different Organic and Conventional nutrient management practices

Treatments	Protein (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	TSS (%)	Total carbohydrates (%)	Dehydrogenase activity (µg TPF g^{-1} soil /day)
Main plot (Organic manures)							
M_1- GLM+FYM+VC (Basal) eq. RDN	8.66 c	2.57 e	19.46 d	19.04 f	11.75 c	67.85 d	31.30 b
M_2- GLM+EC+VC (Basal) eq. RDN	8.17 d	2.76 d	19.18 d	21.95 e	11.77 c	68.34 d	33.07 a
M_3- GLM+FYM+VC (Top dressing at GGS)	8.24 d	3.42 c	19.36 d	22.79 d	11.70 c	73.87 c	33.29 a
M_4- GLM+EC+VC (Top dressing at GGS)	9.27 b	3.51 b	20.41 c	23.92 c	11.35 d	76.15 b	31.77 b
M_5- (100:50:25 N, P_2O_5, K_2O kg ha^{-1}) + 10 kg $ZnSO_4$ (RDF)	9.67 a	3.65 a	20.76 b	24.41 b	12.52 b	78.36 a	24.96 c
M_6-7.5 t FYM+RDF(100:50:25 N, P_2O_5, K_2O kg ha^{-1}) + 10 kg $ZnSO_4$ (RPP)	9.94 a	3.57 b	21.40 a	24.97 a	13.08 a	77.21 b	23.03 d
S.E. ±	0.14	0.02	0.11	0.10	0.05	0.50	0.46
Sub-plot (Liquid organic manures)							
S_1- Bio-digester liquid spray @ 10% at GGS and tasseling stage	8.94 b	3.36 b	20.21 a	23.16 a	12.14 a	74.31 b	30.62 a
S_2- Panchagavya spray @ 3% at GGS and tasseling stage	9.21 a	3.50 a	19.21 c	22.56 b	11.96 b	76.36 a	30.34 a
S_3- Cow urine spray @ 10% at GGS and tasseling stage	9.27 a	3.34 b	19.76 b	23.10 a	12.22 a	73.26 c	30.23 a
S_4- Control	8.55 c	2.95 c	19.20 c	22.56 b	11.79 b	70.60 d	27.09 b
S.E. ±	0.08	0.01	0.10	0.10	0.07	0.40	0.35
Interaction (M x S)							
M_1S_1	8.80 e-g	2.65 l	16.22 n	18.87 m	11.47 d	67.88 ij	32.52 a-d
M_1S_2	8.78 e-g	2.50 m	15.78 n	18.28 m	11.47 d	71.64 gh	31.82 b-e
M_1S_3	8.65 f-h	2.83 k	17.47 m	20.30 l	12.47 c	68.72 hi	31.65 b-f
M_1S_4	8.42 g-i	2.31 n	16.38 n	18.69 m	11.60 d	63.15 k	29.19 e-f
M_2S_1	7.76 jk	3.21 i	18.78 j-l	21.99 i-k	11.53 d	67.37 ij	34.11 ab
M_2S_2	8.89 e-g	2.91 k	18.59 kl	21.50 k	11.60 d	72.92 fg	34.28 ab
M_2S_3	8.66 f-h	2.52 m	19.92 f-h	22.44 g-j	12.53 bc	67.82 ij	34.14 ab
M_2S_4	7.38 k	2.42 m	19.44 g-k	21.86 jk	11.40 d	65.27 jk	29.76 d-f
M_3S_1	8.11 h-j	3.35 gh	19.65 g-i	23.00 f-h	12.33 c	75.87 c-f	34.79 a
M_3S_2	7.98 i-k	3.68 bc	18.51 l	22.19 h-k	11.60 d	76.49 b-e	33.59 a-c
M_3S_3	8.57 g-i	3.63 cd	19.16 h-l	22.79 f-i	11.33 d	73.48 e-g	33.99 ab
M_3S_4	8.30 g-j	3.04 j	20.12 fg	23.17 e-g	11.53 d	69.64 hi	30.78 c-f
M_4S_1	9.24 d-f	3.82 a	19.58 g-j	23.40 d-f	11.40 d	75.59 d-f	32.93 a-c
M_4S_2	9.42 c-e	3.50 ef	20.66 ef	24.16 cd	11.00 d	79.45 ab	33.18 a-c
M_4S_3	9.66 b-d	3.49 ef	19.69 g-i	23.19 e-g	11.60 d	74.95 d-f	32.04 a-d
M_4S_4	8.77 fg	3.25 hi	21.69 bc	24.94 bc	11.40 d	74.61d-g	28.93 f
M_5S_1	9.97 a-c	3.55 de	18.84 i-l	22.40 g-j	12.53 bc	80.24 a	25.53 g
M_5S_2	10.18 ab	3.82 a	20.16 fg	23.98 de	12.60 bc	79.68 ab	25.95 g
M_5S_3	9.67 b-d	3.82 a	21.12 c-e	24.94 bc	12.33 c	77.55 a-d	25.93 g
M_5S_4	8.86 e-g	3.42 fg	22.90 a	26.33 a	12.60 bc	75.98 c-f	22.41 h
M_6S_1	9.75 b-d	3.56 de	22.16 ab	25.72 ab	13.60 a	78.92 a-c	23.82 g-h
M_6S_2	10.05a-c	3.68 bc	21.54 b-d	25.23 b	13.47 a	77.97 a-d	23.21 g-h
M_6S_3	10.40 a	3.77 ab	21.19 c-e	24.96 bc	13.07 ab	77.03 a-d	23.62 g-h
M_6S_4	9.58 b-d	3.26 hi	20.71 d-f	23.98 de	12.20 c	74.92 d-f	21.45 h
S.E. ±	0.19	0.03	0.26	0.26	0.18	1.00	0.85

more availability of moisture and K and Zn helped to improving total sugar and total soluble solids. TSS (%) and protein content (24.13%) in seeds increased with increasing levels of phosphorus upto 60 kg per ha to pea crop reported by Shukla *et al.* (1997).

Total carbohydrates :

Total carbohydrates content (78.36 and 76.36%) significantly higher was recorded in RDF over rest of treatments. This might due to better root growth caused by better availability of P and K helps to increasing quality characters of sweet corn.

Significantly higher total carbohydrates content in panchagavya @ 3% spray over rest of the treatments. Due to presence of essential plant nutrients and plant regulatory substances in panchagavya.

Interaction effects indicated that, RDF along with bio-digester liquid @ 10% spray recorded significantly higher total carbohydrates content (80.24%) (Table 1). This might be due to better development of root system helped for utilization of nutrients and ultimately improved carbohydrates content. The both carbohydrate and fiber contents of sweet sorghum was higher with combined application of organic and inorganic nutrients reported by Almodares *et al.* (2009).

Dehydrogenase activity :

Among solid organic manurial sources, significantly higher dehydrogenase activity (33.29 πg TPF/ g soil/day) was recorded in GLM + FYM + VC (top dressing at GGS) and GLM + EC + VC (basal) equivalent to RDN (33.07 πg TPF/ g soil/day) over rest of the treatments (Table 1). This might be to more microbial activity hence ultimately increased enzymatic activity.

The sub-plot treatments data showed that there was no significant differences among liquid organic manurial treatments and were significantly superior over control.

Interaction effects showed that, significantly higher dehydrogenase activity (34.79 πg TPF/ g soil/day) was recorded in GLM + FYM + VC (top dressing at GGS) + bio-digester liquid @ 10% spray over rest combinations. Due to combined application of organic and liquid organic manures helped better microbial activity. The results corroborate the findings of Batra (1998) who reported that inclusion of legumes in rice based cropping increased the activity of rhizospheric soil and further reported that activity decreased with soil depth.

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