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INM on sweet corn kernel quality of sweet corn

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Abstract
A field experiment was conducted during *rabi* 2014-2015 on clay loam soil at irrigated upland farms of Eastern block, Tamil Nadu Agricultural University, Coimbatore to study the effect of integrated nitrogen management on kernel quality of sweet corn hybrid. The experiment was replicated thrice, with 12 treatments comprising integration of organic manures *viz.*, FYM, vermicompost, poultry manure, goat manure and biogas slurry at 2 levels (25 and 50 percent) with inorganic N at 75 and 50 per cent. The remaining two treatments were 100 per cent N as inorganic fertilizer and 100 per cent N as inorganic fertilizers with 12.5 t ha^{-1} of FYM. Application of 25 per cent N as poultry manure with 75 per cent N as inorganic improved the quality parameters of sweet corn kernel *viz.*, sugars, starch, protein, total soluble solids, phenol and calcium. It was comparable with the application of 25 per cent N as goat manure combined with 75 per cent N as inorganic fertilizer.

Keywords: Sweet corn, quality parameters, poultry manure, goat manure

Introduction
Recently, sweet corn is gaining popularity among nutritive and health conscious urban masses in India with an immense potential in domestic and international market. Sweet corn is an excellent source of sugars, dietary fibre, vitamin-C, beta-carotene, niacin, in addition to calcium and potassium. Presently, greater emphasis is given to the cultivation of sweet corn due to its increasing demand. There is an increasing tendency to produce sweet corn at commercial level, to augment the income of the farming community dwelling in the outskirts of big cities and metropolities. Since there is a limited scope to increase the area under cultivation, the only alternative is through enhancement of productivity by various management factors. The use of organic fertilizers such as animal manures and composted materials has been proposed as one of the main pillars of sustainable agriculture as they provide large amounts of macro and micro nutrients for crop growth and eco-friendly besides being renewable alternatives to mineral fertilizers (Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [18, 19, 20, 21, 22, 23, 24, 25, 26]. Inorganic fertilizers on the other hand have high concentration of nutrients and readily available to crops but its excessive use is harm full to the crop as well as to the environment. Although increased levels of production can be achieved by increased use of inorganic fertilizers alone but it may lead to deterioration in soil quality besides pollution problems. It is an established fact that the higher grain yield depends on different nutrient management practices. Integration of different organic and inorganic manures affects the yields and thereby the quality of produce. By using these combinations to produce the highest possible yields with the greatest efficiency in terms of the produce quality has been the aim of this study.

Materials and Methods
The field experiment was carried out during *rabi* 2014-15 at irrigated upland farm of Eastern block, Tamil Nadu Agriculture University, Coimbatore which is situated at11° N latitude and 77° E longitude with an altitude of 426.74 meters above mean sea level. The soil of the experimental field was clay loam, alkaline in reaction (pH: 8.6), non saline (EC: 0.28 dSm^{-1}), medium in organic carbon (0.46%) and low available nitrogen (208 kg ha^{-1}), medium available phosphorus (18 kg ha^{-1}) and high available potassium (415 kg ha^{-1}) in the plough layer.

Table 1: Soil characteristics of the field at the inception of experiment

Particulars	Values	Method	Author(s)
Textural composition (Moisture free basis)			
Clay (%)	29.15	Robinson's international pipette method	Piper (1966) [16].
Silt (%)	17.42		
Coarse sand (%)	23.10		
Fine sand (%)	30.33		
Texture	Clay loam		
Chemical composition			
Available N (kg ha^{-1})	208 (Low)	Alkaline permanganate method	Subbiah and Asija (1956) [29].
Available P_2O_5 (kg ha^{-1})	18 (Medium)	Olsen method	Olsen *et al*. (1954) [14].
Available K_2O (kg ha^{-1})	415 (High)	Neutral normal ammonium acetate method	Stanford and English (1949) [27].
Organic carbon (%)	0.36	Chromic acid wet digestion method	Walkley and Black (1934) [31].

Field experiment was laid out in randomized block design with 12 treatments and replicated thrice. The treatments include, T_1 (25% N as FYM + 75% N as inorganics), T_2 (25% N as vermicompost + 75% N as inorganics), T_3 (25% N as poultry manure + 75% N as inorganics), T_4 (25% N as goat manure + 75% N as inorganics), T_5 (25% N as biogas slurry + 75% N as inorganics), T_6 (50% N as FYM + 50% N as inorganics), T_7 (50% N as vermicompost + 50% N as inorganics), T_8 (50% N as poultry manure + 50% N as inorganics), T_9 (50% N as goat manure + 50% N as inorganics), T_{10} (50% N as biogas slurry + 50% N as inorganics), T_{11} (100% N as inorganic) and T_{12} (100% N as inorganic + FYM @ 12.5 t ha^{-1}) which is the recommended practice and fixed as bench mark.

The recommended dose of fertilizer was applied as N: P_2O_5: K_2O @ 120:60:45 kg ha^{-1}. Based on N equal basis required quantities of organic manures were incorporated in the soil one week before sowing. P and K requirements of the crop were applied separately as fertilizer. All the package of practices was carried out as per recommendation of CPG (2012) [4].

All the relevant observations on quality parameters *viz*., sugars, starch, protein, total soluble solids, phenol, ascorbic acid and calcium were recorded after adopting standard procedure as follows:

Quality parameter	Standard procedure	Author
Estimation of sugars	Anthrone method	Somogyi, 1952 [17].
Starch	Anthrone method	A.O.A.C., 1975 [1].
Protein	Lowry method	Lowry *et al*., 1951 [10].
Total soluble solids	Hand refractometer	Dadzie and Orchard, 1997 [5].
Phenol	Folin – ciocalteau reagent	Malick and Singh, 1980 [11].
Calcium	Versanate method	

The data recorded on various parameters recorded during the course of investigation was statistically analysed as per the procedures suggested by Gomez and Gomez (1984) [6] for randomized block design. Wherever the treatmental difference were found significant ('F' test), critical difference was worked out at 0.05 probability level. Treatmental differences that were non-significant were denoted by 'NS'.

Results and Discussion

Apart from the yield, the kernel quality assumes significant from productivity considerations. The kernel quality is an integrated effect of the nutritional, physiological and biochemical factors. As a general rule, the amount of starch, protein and sugars accumulating in the kernel is a genetic parameter. However, marginal changes in the quality do occur due to environmental changes. The effect of this differential treatments on the kernel is therefore of particular interest and hence, investigations on the amount of the protein, starch, sugars, phenols, ascorbic acid and calcium content accumulated under each of the treatments are taken up.

Sugar content

The values of total sugars ranged from 20.1 to 25.6 per cent. The application of 100 per cent N as inorganic with 12.5 t ha^{-1} of FYM (T_{12}) was found to be the best by accounting the highest amount total sugars, reducing and non-reducing sugars, which was found comparable with 25 per cent N as poultry manure +75 per cent N as inorganic (T_3) and followed by 25 per cent N as goat manure +75 per cent N as inorganic (T_4) and 100 per cent N as inorganic (T_{11}). Considering the sugar content in the sweet corn kernel, the favourable nature of the poultry manure for increasing the sweetness of the kernel could be observed as Stephen Mason *et al*., (2010) [28]. The presence of higher amount of reducing sugars resulted in enhanced palatability, due to the application of 25 per cent N as poultry/goat manure + 75 per cent N as inorganic fertilizer. Poultry and goat manure promoted the per cent of reducing sugars which in turn reflected on the better quality. Fifty per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) treated plots registered low content (2.2, 17.0 and 20.1 per cent) of reducing sugars, non-reducing sugars and total sugars respectively.

Starch content

Starch is the most important food carbohydrate which is especially abundant in cereals. The higher starch content (66.4 mg g^{-1}) in sweet corn kernels was recorded with the application of 100 per cent N as inorganic with 12.5 t ha^{-1} of FYM (T_{12}) which was comparable with 25 percent N as poultry manure + 75 per cent N as inorganic (T_3), 25 per cent N as goat manure + 75 per cent N as inorganic (T_4) and recommended 100 per cent N as inorganic (T_{11}) is presented in Table 2.

The production factors which improved the cob yield also improved the starch content of the kernel (Stephen Mason *et al*., 2010) [28].

Table 2: INM on quality parameters of sweet corn kernel

Treatment	Starch (mg g^{-1})	Protein (%)	TSS (^{O}B)	Phenols (%)	Calcium (mg/100 g of sample)
T_1–25%N FYM + 75% inorganic	64.0	8.7	15.34	0.17	39.23
T_2 –25%N VC+ 75%N inorganic	64.8	8.7	15.41	0.18	39.76
T_3–25%N PM + 75%N inorganic	66.0	9.1	15.69	0.18	41.33
T_4 –25%N GM + 75% N inorganic	65.5	9.0	15.58	0.18	40.21
T_5 –25%N BS + 75%N inorganic	64.0	8.6	15.14	0.17	38.66
T_6 –50%N FYM + 50%N inorganic	62.0	8.4	14.96	0.15	37.33
T_7 – 50%N VC + 50%N inorganic	63.3	8.5	15.06	0.15	37.88
T_8 – 50%N PM + 50%N inorganic	63.8	8.6	15.11	0.16	38.65
T_9 – 50%N GM + 50%N inorganic	63.5	8.5	15.09	0.16	38.31
T_{10} – 50%N BS + 50%N inorganic	61.8	8.3	14.94	0.14	37.28
T_{11} – 100% N inorganic	65.1	8.9	15.45	0.18	40.41
T_{12}–100%N inorganic +12.5 t ha^{-1} FYM	66.4	9.2	15.76	0.19	42.66
Mean	64.2	8.7	15.29	0.17	39.31
SEd	0.7	0.1	0.14	0.01	0.80
CD (P=0.05)	1.5	0.3	0.29	0.02	1.66

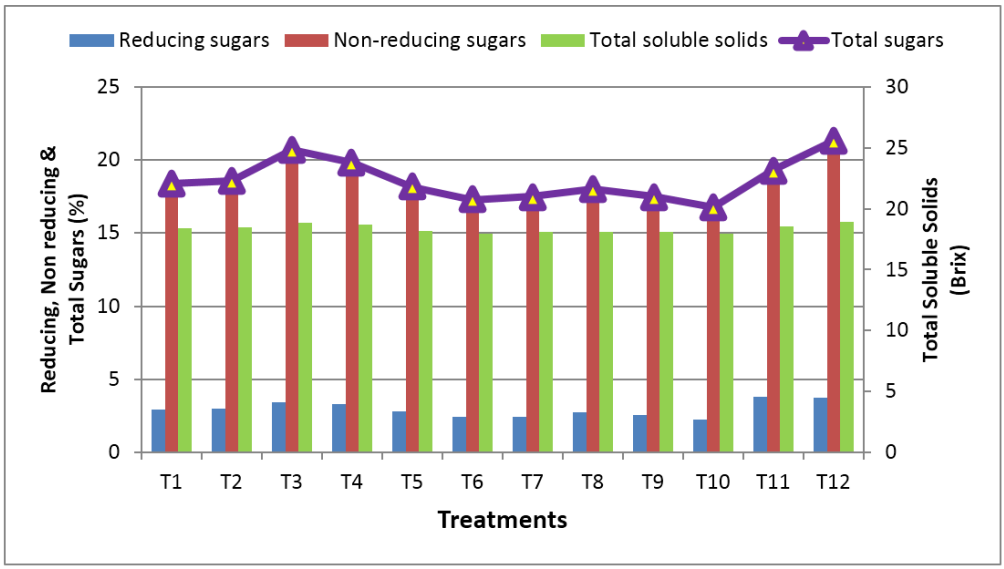

Fig 1: INM on reducing sugar (%), non-reducing sugar (%), total sugar (%) and Total Soluble Solids (^{o}B) of sweet corn kernel

Protein content

Application of 25 per cent N as poultry/goat manure + 75 per cent N as inorganic fertilizer proved its superiority in enhancing the kernel quality (Table 2). Higher protein content was observed in treatments receiving 25 per cent N as poultry/goat manure + 75 per cent N as inorganic fertilizer. Higher nitrogen uptake would have resulted in higher amino acid, protein, starch and phenol content in sweet corn kernel. (Patil and Padmani, 2007 and Abdullah, 2008) [15, 2]. The lowest protein content (8.3 per cent) was recorded 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) treated plots.

Total soluble solids (^{o}B)

The values of TSS ranged from 15.76 to 14.94 ^{o} B. The application of 100 per cent N as inorganic along with 12.5 t ha^{-1} of FYM (T_{12}) was found comparable with 25 per cent N as poultry manure + 75 per cent N as inorganic (T_3) and 25 per cent N as goat manure + 75 per cent N as inorganic (T_4). Similar trend was also observed by Agyenim *et al.*, (2006) [3] and Kumar (2009) [9]. Application of 50 per cent N as biogas slurry + 50 per cent N as inorganic recorded lowest TSS value as presented in Table 2.

Phenol content

From the biochemical angle, the phenol production is found to be specific attribute closely related to the pest and disease resistance. It is gratifying that 100 per cent N as inorganic with 12.5 t ha^{-1} of FYM (T_{12}) could ensure higher accumulation of phenol content (0.19 per cent) in the kernel and it was found on par with 100 per cent N as inorganic (T_{11}), 25 per cent N as poultry manure + 75 per cent N as inorganic (T_3) and 25 per cent N as goat manure + 75 per cent N as inorganic (T_4) as both the manure had high K content (Table 2). This follows in line with Kumar (2008) [8], Nath *et al.* (2009) [12] and Suthar *et al.* (2012) [30].

Calcium content

Higher content in sweet corn kernels was recorded with treatments applied with 25 per cent N as poultry/goat manure + 75 per cent N as inorganic fertilizer as both the manure had high K content (Jat *et al.*, 2012) [7].

Conclusion

In general, good kernel quality fetches higher premium price to the farmers and kernel quality characters are very important parameters for determining consumer acceptance for any variety or hybrid. On the basis of results emanated from the present experiment conducted during *rabi* 2014-15, it was concluded that under prevailing agro-climatic conditions, sweet corn variety 'Sugar 75' when applied with 25 per cent N as poultry / goat manure + 75 per cent N as inorganic fertilizer produced better quality kernel than other combinations.

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