Research Article

Uptake and Transformations of Nitrogen in Sweet corn hybrid production through INM method

A Bharathi[1]*, M Balusamy[2], E Somasundaram[3] and R Shanmugasundaram[4]

[1]School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Srivilliputhur, Virudhunagar - 626126, TN, India
[2]Department of Agronomy, AC & RI, TNAU, Coimbatore-641003, TN, India
[3]Department of Sustainable Organic Agriculture, AC & RI, TNAU, Coimbatore-641003, TN, India
[4]Department of Soil Science and Agricultural Chemistry, AC & RI, TNAU, Coimbatore-641003, TN, India

Abstract

An 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 of sweet corn hybrid on nitrogen transformation. 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. The uptake, net gain and loss in available nitrogen during the period of study were calculated using the corresponding available nutrient status at the beginning and at the end of the specified period. N uptake by plants was distinctly higher in 100 per cent N with 12.5 t ha^{-1} of FYM (T_{12}) which was 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). Application of organic manures positively influenced post harvest available N and its balance. The balance was positive, indicating a net gain, when sweet corn received 50 per cent N as organic manures irrespective of the source. Soil available N balance ranged from -5.0 kg ha^{-1} in 25 per cent N as biogas slurry with 75 per cent N as inorganic (T_5) to 57.9 kg ha^{-1} in recommended 100 per cent N as inorganic with 12.5 t ha^{-1} FYM (T_{12}).

Keywords: Nitrogen uptake, Soil available nitrogen, Net gain or loss

***Correspondence**
Author: Bharathi
Email: mailmebharathia@gmail.com

Introduction

Sweet corn (*Zea mays* L. sub sp. *saccharata*) is consumed as human food in soft dough stage with succulent, sweet, creamy, tender, and crispy kernels, which tastes almost shell-less. The higher content of water soluble polysaccharide in the kernel adds texture and quality to sweetness [26]. Its demand in amusement parks, theatres, circus and exhibition is increasing with increasing urban population not only in India [18] but in international markets [9]. This created an increasing tendency for commercial production. Unlike maize, sweet corn is also an energy rich crop, so its productivity largely depends upon nutrient management practices.

Non availability of chemical fertilizers in time and their higher cost are the reasons for creates an imbalance in the soil. To sustain the soil health and provide adequate plant nutrition, it is about the plant nutrient sources other than the chemical fertilizers and their application in integration [21]. Use of organic manures along with inorganic fertilizers not only reduces the demand of inorganic fertilizers, but also, increases the efficiency of applied nutrients due to favourable effect on physical, chemical and biological properties of soil [15].

The effectiveness of integrated nutrient management practice can depend on season, soil type, climate, water management, variety and cropping pattern. Probably, there will be no universally best integrated nutrient management practice. Thus more efforts are needed to identify the improved nutrient management strategy for a particular target environment. Integration of different organic and inorganic manures affects the yields. This study is aimed to highlight which treatment plants absorbed more nitrogen and which plot left more amount of available nitrogen after harvest.

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^{o} N latitude and 77^{o} E longitude with an altitude of 426.74

meters above mean sea level (**Figure 1**). 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. The details of the soil characteristics are furnished in **Table 1**.

Figure 1 General view of the experimental field

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)
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)
Available P_2O_5 (kg ha^{-1})	18 (Medium)	Olsen method	Olsen *et al*. (1954)
Available K_2O (kg ha^{-1})	415 (High)	Neutral normal ammonium acetate method	Stanford and English (1949)
Organic carbon (%)	0.36	Chromic acid wet digestion method	Walkley and Black (1934)

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 [3].

Plant samples were collected at 30, 60 DAS and at harvest for analysing the nutrient uptake by sweet corn. The plant samples of sweet corn were oven dried (75°C), chopped and ground into powder in Willey mill. The powdered samples were stored in butter covers for further analysis of total Nitrogen. Nitrogen content in the plant sample was estimated by micro-kjeldhal method as per the procedure given by [5]. The values obtained in the analysis were computed to kg ha^{-1} by multiplying it with the corresponding DMP obtained for each treatment.

Post experimental composite sample were collected separately from each plot, shade dried, powdered and sieved to pass through 2 mm sieve, and then cleaned sample was preserved in polythene bags for further analysis. Available soil nitrogen has been estimated as per the procedure suggested by [23] and expressed in kg ha^{-1}.

The net gain in available nitrogen during the period of study was calculated using the corresponding available nutrient status at the beginning and at the end of the specified period. The residual and cumulative effects were not accounted in the calculation [24].

The data recorded on various parameters recorded during the course of investigation was statistically analyzed as per the procedures suggested by [4] 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

Nitrogen uptake

Nitrogen uptake was influenced by various nutrient management practices at all the three growth stages of crop growth of the study period. At 30, 60 DAS and harvest stage, the N uptake by plants was distinctly higher in 100 per cent N with 12.5 t ha^{-1} of FYM (T_{12}) which was 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) (**Figures 2-4**). The lowest uptake of N was recorded in 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) at all the three stages of sweet corn growth (**Table 2**).

Figure 2 T_{12} - Recommended N + 12.5 t ha^{-1} FYM applied plot at harvest

Figure 3 T_3 – 25 % N as poultry manure + 75 % N as inorganic applied plot at harvest of sweet corn

Figure 4 T_4 – 25 % N as goat manure + 75 % N as inorganic applied plot at harvest of sweet corn

Higher uptake of N with 25 per cent N as poultry manure + 75 per cent N as inorganic fertilizer (T_3) was due to increased availability of nutrients. Increase in available N due to application of poultry manure and fertilizer was also reported by [16].

Accelerated growth in terms of DMP and N content augmented more N uptake of crops. These two parameters are higher in poultry / goat manure treatment in combination with 75 per cent N through inorganic fertilizer. This is due to the fact that organic manure would change rapidly N to ammonium form for utilization by plants [14] and [1]. The higher N uptake with poultry/ goat manure and inorganic sources was also reported by [10] and [20].

Table 2 Effect of integrated nutrient management practices of sweet corn hybrid on nitrogen uptake (kg ha^{-1}) and soil available nitrogen (kg ha^{-1})

Treatments	**Plant Nitrogen uptake (kg ha^{-1})**			**Soil available nitrogen (kg ha^{-1})**		
	30 DAS	**60 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**Harvest**
T_1 – 25% N as FYM + 75% N as inorganic	10.8	107.1	123.5	313.9	220.9	200.2
T_2 – 25% N as vermicompost + 75% N as inorganic	10.8	109.7	126.2	312.6	218.3	197.4
T_3 – 25% N as poultry manure + 75% N as inorganic	17.3	128.8	149.5	307.3	199.2	173.5
T_4 – 25% N as goat manure + 75% N as inorganic	15.3	126.9	146.2	309.3	201.1	176.9
T_5 – 25% N as biogas slurry + 75% N as inorganic	10.6	105.6	120.7	314.0	222.4	203.0
T_6 – 50% N as FYM + 50% N as inorganic	8.5	89.8	107.6	316.1	238.2	216.4
T_7 – 50% N as vermicompost + 50% N as inorganic	8.7	86.1	105.1	315.9	241.9	218.9
T_8 – 50% N as poultry manure + 50% N as inorganic	10.4	100.3	114.1	314.2	227.7	209.7
T_9 – 50% N as goat manure + 50% N as inorganic	9.3	96.2	110.2	315.3	231.8	213.7
T_{10} – 50% N as biogas slurry + 50% N as inorganic	7.8	80.7	101.9	316.8	247.3	222.2
T_{11} – 100% N as inorganic	12.4	116.1	134.0	312.2	211.9	189.4
T_{12} – 100% N as inorganic + 12.5 t ha^{-1} FYM	19.3	144.1	158.8	374.3	283.9	265.9
SEd	1.8	8.2	9.2	13.1	11.2	11.9
CD (P=0.05)	3.7	17.0	19.0	27.1	23.3	24.6

Available soil Nitrogen

The data on the available soil nitrogen (kg ha^{-1}) at different crop growth stages are presented in Table 2. The highest status of soil available nitrogen was recorded in 100 per cent N as inorganic with 12.5 t ha^{-1} of FYM (T_{12}). It was followed by with 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) and 50 per cent N as FYM + 50 per cent N as inorganic (T_6).

Among the various nutrient management practices, application of 50 percent N as organic and 50 per cent as inorganic added more organic carbon to the soil than rest of integrated and inorganic treatment. Further, the mineralization of organic manures and release pattern of nutrients in to the soil solution differs large and accordingly, the final balances of soil organic carbon and available NPK reflected source-wise. This is in line with findings of [19] and [25]

Significantly lesser status of soil available nitrogen (173.5 kg ha^{-1}) was recorded with application of 25 per cent N as poultry manure + 75 per cent N as inorganic (T_3) at harvest soil analysis. Maize being a cereal crop removed more N from soil and mineralization of organic sources as supplies nutrients to soil and also solublize the native labial pool. Besides, higher biomass production may be the most pertinent reason for higher uptake of nutrients and reduction in available soil N during harvest. These findings are in close agreement with results reported by [12] and [6]

Soil available nitrogen balance

The application of organic manures with inorganic sources altered the balance of soil available nitrogen (Figure 5). Application of organic manures positively influenced post harvest available N and its balance. The balance was positive, indicating a net gain, when sweet corn received 50 per cent N as organic manures irrespective of the source. Soil available N balance ranged from -5.0 kg ha^{-1} in 25 per cent N as biogas slurry with 75 per cent N as inorganic (T_5) to 57.9 kg ha^{-1} in recommended 100 per cent N as inorganic with 12.5 t ha^{-1} FYM (T_{12}) (**Table 3**).

Table 3 Effect of integrated nutrient management practices on soil available nitrogen balance (kg ha^{-1})

Treat ments	Initial soil N (A)	N applied as fertilizers	N applied as organic source	Total N (B)	Plant uptake (C)	Computed balance (B-C)	Post harvest soil N (D)	Net gain or loss (A-D)
T_1	208	90	30	328	123.5	204.5	200.2	-7.8
T_2	208	90	30	328	126.2	201.8	197.4	-10.6
T_3	208	90	30	328	149.5	178.5	173.5	-34.5
T_4	208	90	30	328	146.2	181.8	176.9	-31.1
T_5	208	90	30	328	120.7	207.3	203.0	-5.0
T_6	208	60	60	328	107.6	220.4	216.4	8.4
T_7	208	60	60	328	105.1	222.9	218.9	10.9
T_8	208	60	60	328	114.1	213.9	209.7	1.7
T_9	208	60	60	328	110.2	217.8	213.7	5.7
T_{10}	208	60	60	328	101.9	226.1	222.2	14.2
T_{11}	208	120	-	328	134	194	189.4	-18.6
T_{12}	208	120	100	428	158.8	269.2	265.9	57.9

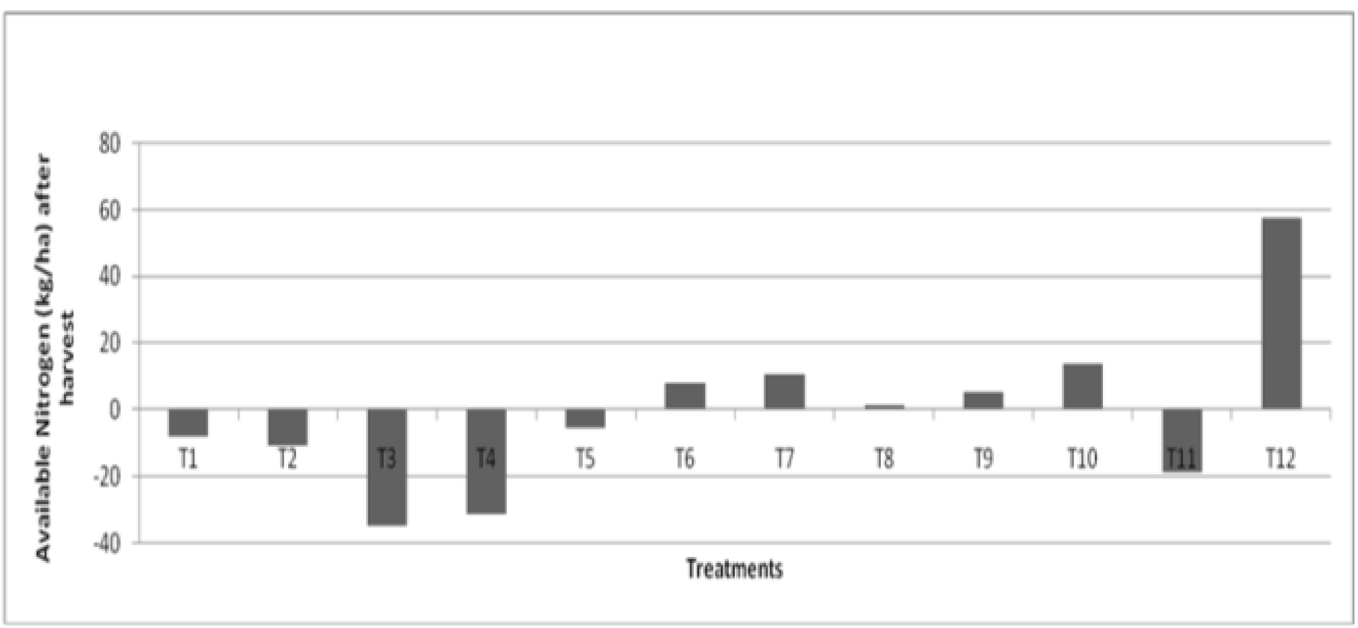

Figure 5 Effect of integrated nutrient management practices on soil available nitrogen balance (kg ha^{-1})

At the end of the cropping period, there is no net gain of nutrients under 100 per cent N as inorganic and treatments receiving 25 per cent N as organic and 75 per cent N as inorganic, which again proves that maize is an exhaustive crop whose absorption depleted the native soil nutrient pool.

Application of recommended N as fertilizer showed net negative balance. This is due to susceptibility of inorganic fertilizers to various losses like volatilization, leaching, etc. during and after mineralization in addition to uptake by the crop. The results are in close agreement with that of [8].

All the integrated nutrient management treatments receiving 25 per cent N as organic and 75 per cent N as inorganic showed net negative balance indicating loss. As manure is surface applied, it is subjected to loss of nutrients into the atmosphere and more immobilization. These findings are in accordance with [7]. In addition to that maize being a great feeder by uptake it reduced most of the soil available nitrogen.

Treatments receiving half substitution of N as organic showed positive balance of N, indicating net gain. Among the INM treatments, 50 per cent N as biogas slurry + 50 per cent N as inorganic fertilizers recorded higher positive N balance of 14.4 kg ha^{-1}. This is due to slow decomposition of biogas slurry. Even after the completion of crop growing period, mineralization of N could be continued to the soil pool. This helped in maintain the soil available N, inspite of depletion by the crop as registered by [2].

Conclusion

Improvement in Nitrogen uptake was observed with the application of 25 per cent N as poultry manure / goat manure with 75 per cent N as inorganic fertilizer. Enrichment in soil available nutrient status was recorded higher under application of 50 per cent N as biogas slurry combined with 50 per cent N as inorganic fertilizer. Among the different INM treatments, higher net gain in soil available N was recorded with half substitution of organic manures with inorganic fertilizer which resulted in buildup of soil organic carbon content at the end of cropping period.

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