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Effect of integrated nitrogen management on cane yield, juice quality and nutrient uptake of sugarcane ratoon crop

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Abstract
A field experiment was conducted in sugarcane ratoon crop at Sugarcane Research Station, Vuyyuru with an objective to study the effect of integrated management of nitrogen by substituting the recommended doses of nitrogen with organics such as neem cake, castor cake, vermicompost, *azospirillum* and green manures. Six treatments were replicated four times in randomized design. Variety tested was 99 V 30. The treatments include T_1: 50% N through urea + 50% N through press mud cake + RDP & K, T_2: 50% N through urea + 50% N through vermicompost + RDP & K, T_3: 50% N through urea + 50% N through castor cake + RDP & K, T_4: 50% N through urea + *Azospirillum* @ 5kg/ha + 25% N through green manure + RDP & K, T_5: 50% N through urea + 50% N through neem cake + 100% RDP & K and T_6: 100% N through urea + RDP & K. Substitution of nitrogen up to 50% with organics rerecorded more yield compared to 100% recommended dose of nitrogen. Among the sources tried, castor cake resulted with highest shoot population at different stages of crop growth, cane yield, sugar yield and nutrient uptake by sugarcane ratoon crop followed by pressmud cake.

Keywords: INM, urea, castor cake, pressmud cake, neem cake, azospirillum, green manure crop, sugarcane ratoon crop, yield, quality and nutrient uptake

Introduction
Self sufficiency, food safety and security are very much essential for meeting the essentials of ever increasing population. Hence, varieties having high yield potentials and hybrids have been evolved to urge the needs of the people. These varieties also need rich quantities of nutrients to produce up to their capacities for which soil nutrients were depleted without replenishment up to the mark. Sugarcane is not exception in this way and is very exhaustive crop, needs high quantities of nutrients as it is long duration crop (11-12 months) and retain in the field year long.

In previous decades, intensive agriculture and indiscriminate use of fertilizers for getting higher yields in order to meet the needs of the people lead to disrupt the soil structure and texture resulting in reduced productivity and fertility. Therefore, it is very much essential to improve fertility in order to maintain sustainable production for future generations also. Integrated nutrient management helps to achieve sustainable agriculture by maintaining quality of produce besides improving soil health.

Integrated nutrient management includes combined use of organic and inorganic fertilizers judiciously. Organic manures provides nutrients slowly, improves physical, chemical and biological properties of soils, provides good environment for microbial population resulting in good soil tilth and improved water and nutrient holding capacity. Organic manures includes FYM, poultry manure, vermicompost, green manures and biofertilisers. In addition, indigenous sources such as oil cakes, factory byproducts can also be included for meeting sustainable needs of the people. Neem cake is available in rural areas as waste after producing neem oil and pressmud is byproduct of sugar factories. It is making viable to the farmers by so many sugar factories and some factories are enriching it with microbial cultures such as Phosphobacteira, *Trichoderma viridi etc.* and providing to the farmers.

Integrated use of organic and inorganic manures rather than individual use helps to get sustainable production, reduce cost of cultivation besides improving soil health. Santhy *et al.* 1998 [9] reported that organic materials along with nitrogenous fertilizers resulted in increasing

total nitrogen and distribution of organic fractions of nitrogen by conducting long term experiment. Keeping in view all the above aspects, experiment was conducted on sugarcane to study the effect of integrated nitrogen management including neem cake, pressmud cake, green manures and biofertilisers as 50% substitution for inorganic fertilizers.

Materials and Methods

A field experiment was conducted in sugarcane ratoon crop at Sugarcane Research Station, Vuyyuru with an objective to study the effect of different sources of nitrogen along with recommended dose of phosphorus and potassium on cane yield, juice quality and nutrient uptake of sugarcane. 50% of nitrogen was substituted with five organic sources such as neem cake, castor cake, vermicompost, pressmud cake, green manures and *azospirillum* and were tested against 100% recommended dose of fertilizers. Recommended dose of 100 kg P_2O_5 and 100 kg K_2O per hectare were applied to the crop irrespective of treatments. Variety used was 99 V 30. The treatments include:

T_1: 50% N through urea + 50% N through press mud cake + RDP & K
T_2: 50% N through urea + 50% N through vermicompost + RDP & K
T_3: 50% N through urea + 50% N through castor cake + RDP & K
T_4: 50% N through urea + *Azospirillum* @ 5kg/ha + 25% N through green manure + RDP & K
T_5: 50% N through urea + 50% N through neem cake + 100% RDP & K
T_6: 100% N through urea + RDP & K

Six treatments were replicated four times in RBD design. Variety used for testing was 99 V 30. Initial soil sample was collected and analysed for pH, EC, organic carbon and available nutrient status of nitrogen, phosphorus and potassium. Soils were Neutral, non-saline, low in nitrogen, high in phosphorus and potassium. Data was collected on germination percentage, shoot population at different stages of crop growth, cane yield and juice quality. Whole cane plant samples were collected at grand growth period, cut into pieces, oven dried, powdered and analysed for nutrient contents of N,P & K using standard methods (Bremner and Mulvaney, 1982 [1], Jackson, 1973 [2] and Muhr *et al.*, 1963 [3], respectively). Uptake of nutrients was calculated using the following formula.

$$\text{Uptake of nutrient (kg/ha)} = \frac{\text{\% Concentration of nutrient x Cane yield (t/ha)}}{100} \times 1000$$

All the data was statistically analysed using method described by Panse and Sukhatme (1978) [7].

Results

The data on germination percentage, yield parameters, cane yield and quality of juice were collected and analysed statistically and presented in the following table 1. From the data presented in the table - 1, it can be revealed that shoot population at different stages of crop growth (120, 180, 240 and 300 days after planting) was more in T_3 treatment where 50% N through urea and 50% N was substituted with castor cake along with recommended doses of P & K. Kanjana and Pitchai (2009) [4] reported significant improvement in number, length and girth of millable canes, number of nodes and length of internodes with the combination of organic and inorganic plant nutrient sources along with biofertilizers. T_1 and T_4 treatments were on par with T_3 where 50% N was substituted with pressmud cake and combined use of *azospirillum* (25% N) and green manure crop (25% N), respectively. Highest number of millable canes, longest and thickest canes with addition of pressmud (@ 10 t ha were reported by Singh *et al.*, (2007) [12] and significant improvement in germination, tillering, number of millable canes, and girth and height of cane in *Azospirillum* + *Azotobacter* treatment with fertilizer N along with saving of 25-50 kg ha^{-1} fertilizer-N was reported by Navale *et al.*, (1995) [6]. Kathiresan and Manoharan (1999) [5] noticed that *Crotolaria juncea* recorded highest number of millable canes followed by *Sesbania aculeate* among the green manures incorporated.

Table 1: Effect of integrated nitrogen management on cane yield and juice quality sugarcane ratoon crop

Treat-ments	Shoot population ('000 /ha)						Cane Yield (t/ha)	Juice sucrose (%)	CCS %	CCS Yield (t/ha)	% Purity
	90 DAP	120 DAP	160 DAP	180 DAP	240 DAP	300 DAP					
T_1	75.91	87.43	75.32	73.30	59.96	52.67	84.89	19.85	14.45	12.26	93.34
T_2	65.88	69.53	70.37	69.40	54.88	45.77	72.00	19.40	14.17	10.19	94.15
T_3	80.73	90.56	80.27	78.38	66.60	51.30	86.33	19.62	14.31	12.35	93.77
T_4	72.00	74.28	73.63	74.41	58.98	48.76	82.39	19.35	13.42	11.06	88.92
T_5	65.10	73.63	67.12	68.62	57.75	48.37	78.03	19.52	14.12	11.00	91.91
T_6	61.06	67.51	62.30	63.41	53.90	42.18	67.71	19.21	13.82	9.36	90.88
CD @ 5%	NS	8.33	NS	8.92	6.64	5.59	9.69	NS	NS	1.65	NS
CV (%)	12.40	7.20	14.20	8.30	7.30	7.70	8.20	3.50	5.10	9.90	3.90

T_1: 50% N through urea + 50% N through press mudcake + 100% P_2O_5 and 100% K_2O
T_2: 50% N through urea + 50% N through vermicompost + 100% P_2O_5 + 100% K_2O
T_3: 50% N through urea + 50% N through castor cake + 100% P_2O_5 and 100% K_2O
T_4: 50% N through urea + *Azospirillum* @ 5kg/ha + 25% N through green manure+100% K_2O
T_5: 50% N through urea + 50% N through neem cake + 100% P_2O_5 and 100% K_2O
T_6: 100% N through urea + 100% P_2O_5 and 100% K_2O

Cane yield was more with the integrated use of organic and inorganic fertilizers compared to the inorganic fertilizers alone. T_3 recorded highest cane yield of 86.33 t/ha where 50% nitrogen was substituted with the castor cake. T1 (50% N through urea + 50% N through pressmud cake + 100% P_2O_5 and 100% K_2O) and T4 (50% N through urea + *Azospirillum* @ 5 kg/ha + 25% N through green manure+100% K_2O) were on par with T3. Rani *et al.*, (2011) [8] reported that cane and sugar yields were increased with 50 per cent reduction of inorganic fertilizer with oil cakes in plant crop and addition of

50 per cent more N with same amount of fertilizer for ratoon crop. Increased cane yield might be due to the increase in shoot population at initial stages, number of millable canes at later stages of crop growth and increased nutrient uptake with the integrated use of organic and inorganic sources of nitrogen.

Commercial cane sugar yield was also resulted in similar trend. 12.35 t/ha of commercial cane sugar yield was recorded with castor cake (Table 1). On par CCS yield was recorded by the substitution of nitrogen with pressmud cake (12.26 t/ha) and *Azospirillum* @ 5kg/ha (25% N) + 25% N through green manure (11.06 t/ha). Shankaraiah and Kalyanmurthy (2005) [10] noticed 21% increase in cane and sugar yield with the integrated use of enriched pressmud @ 15 t ha^{-1} and recommended fertilization over RDF. Significant increase in yield with the integrated use of inorganic + organic fertilizer along with dual biofertilizers (Azotobacter + PSB) was also reported by Singh *et al.*, (2014) [13].

But the effect of integrated use of organic and inorganic nitrogenous fertilizers is not reflected on quality as non-significant results were obtained with juice sucrose (%), CCS (%) and % Purity (Table 1). The results are in agreement with Thakur *et al.*, (2012) [15] who reported that cane juice quality *viz*., brix, sucrose and purity content remains unaffected under organic and conventional farming system and Sinha *et al.*, (2014) [14] who revealed that the quality of juice, *viz.*, sucrose and purity remains unaffected due to INM. Increased cane yield without alteration in juice quality with the application of FYM, ground nut cake and inorganic nitrogen in the ratio of 1:1:1 was observed by Vedprakash *et al.*, (2009) [16].

Table 2: Effect of integrated nitrogen management on nutrient uptake by sugarcane ratoon crop

Treatments	Whole Plant nutrient uptake (kg/ha)		
	Nitrogen	Phosphorus	Potassium
T_1	279.10	120.70	393.44
T_2	241.29	107.17	340.56
T_3	310.17	122.18	396.29
T_4	230.84	110.71	340.72
T_5	224.88	112.07	378.56
T_6	209.54	93.03	318.63
CD @ 5%	25.03	10.84	NS
CV (%)	6.70	6.50	19.60

Whole cane samples were analysed for nutrient uptake of nitrogen, phosphorus and potassium. Nitrogen uptake was more (310.17 kg/ha) with T_3 treatment (50% N through urea + 50% N through castor cake + 100% P_2O_5 + 100% K_2O) followed by T_1 (50% N through urea + 50% N through pressmud cake + 100% P_2O_5 + 100% K_2O). Phosphorus uptake was more with T_3 (122.18 kg/ha) and T_1 (120.70 kg/ha) was on par with it whereas non-significant results were obtained with potassium uptake (Table–2). Increased uptake of nutrients with the integrated use of organic and inorganic fertilizers might be due to the slow release of nutrients throughout the crop period. Organic sources of nutrients not only help in supplementing the nutrients to sugarcane but also maintain favorable physical, chemical and biological soil environment. This might have helped in augmenting the nutrient uptake and thereby resulting in increased cane and sugar yields. Sharma *et al.*, (2005) [11] reported that integration of FYM with fertilizers in 1:1 ratio was found better with respect to increased shoot population due to blending of organic and inorganic nutrient sources in equal ratio (50:50) leading to saving of 50% inorganics.

Conclusions

To conclude, integrated use of inorganic fertilizes (50% Nitrogen through urea) and organic fertilizers (Castor cake, pressmud cake, vermicompost, neem cake and combination of *Azospirillum* and green manure) resulted in more yield and quality compared to inorganic fertilizers (urea) alone. Among organic sources tested, castor cake and pressmud cake were proved superior over others. Hence, it can be concluded that 50% of recommended nitrogen can be substituted with organic sources such as castor cake and pressmud cake along with recommended doses of phosphorus and potassium for getting higher cane yield, CCS yield and higher nutrient uptake of nitrogen and phosphorus in sugarcane ratoon crop.

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