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Agronomic performance of new sugarcane (*Saccharum* spp. hybrid complex) genotypes as influenced by levels of nitrogen

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Abstract
A field experiment was conducted during 2015–16, to find out the response of three sugarcane (*Saccharum* spp. hybrid complex) genotypes to levels of nitrogen at Sugarcane Research Institute, Pusa, Bihar. Among the genotypes, 'CoP 11437' showed the highest germination (37.9%), plant population (1, 76,700/ha), dry matter accumulation (38.2 t/ha) and millable canes (1, 22,300/ha) followed by 'CoP 11438'. Similarly, genotype, 'CoP 14437' also recorded significantly higher cane yield (103.7 t/ha) and sugar yield (13.1 t/ha) followed by 'CoP 11438' (80.2 t/ha). The maximum pol (18.37%) in juice was obtained with 'CoP 14438', which was statistically similar that obtained with 'CoP 14437' (18.16%). Genotype 'CoP 14437' gave the highest gross returns (`2, 64,400/ha), net returns (`1, 69,600/ha), benefit: cost ratio (1.80) and N uptake (284.9 kg/ha). Application of 100% recommended dose of nitrogen significantly increased dry matter accumulation and cane yield; however, plant population and millable canes were significantly increased up to 125% recommended dose of nitrogen. Application of 75% recommended dose of nitrogen being at par with 100% recommended dose of nitrogen resulted in significantly higher pol (18.25%) content in juice over 125% recommended dose of nitrogen. Significantly maximum values of net returns (` 1, 50,100/ha), benefit: cost ratio (1.58) and N uptake (261.4 kg/ha) were recorded at 125% recommended dose of nitrogen. However, significantly higher values of available N (236 kg/ha) was obtained with 100% recommended dose of nitrogen. It was therefore inferred that genotype CoP 14437 along with 125% recommended dose of nitrogen to sugarcane was the most profitable options.

Keywords: Genotypes, Nitrogen levels, Sugarcane quality, Uptake, Yield

Introduction
Sugarcane is one of the most important commercial crop in India cultivated in an area of 4.9 million ha with total production of 303.6 million tonnes of cane with average productivity of 61.3 t/ha (ISMA, 2017) [2]. In Bihar, it is grown in an area of 0.3 million ha, producing 14.7 million tonnes with an average yield of 50.0 tonnes/ha (ISMA, 2017) [2]. The productivity of sugarcane depends on genetic potential of genotypes, soil fertility and agronomic practices. Choice of suitable genotype for a particular agro- ecological situation plays a vital role in enhancing sugarcane productivity. The availability of sugarcane genotypes with high sugar content early in the crushing season is an important strategy to fetch high sugar recovery in the mills. To achieve this goal development of early maturing high sugar genotypes is need of hour. The other most important factor is the ability of genotypes to utilization of applied nutrients because sugarcane is high nitrogen requiring crop. As a result the nutrient ability of soil to supply plant nutrient is declining day by day which leads to decline productivity of sugarcane. It is substantially required to fully exploit the production potential of genotypes, which not only influence the growth and development but also affect quality parameter of sugarcane (Singh and Kumar, 2008) [10]. Keeping in view the above facts, a study on effect of genotypes and nitrogen levels on yield and quality of spring sugarcane was conducted under Bihar conditions.

Materials and Methods
A field experiment was conducted at Sugarcane Research Institute Farm, Pusa, Bihar during the spring season of 2015-16. The soil was sandy loam, having 8.2 pH, 0.47% organic carbon, 25.8% free $CaCO_3$ and 223, 11.6 and 108 kg/ha available N, P and K respectively. Nine treatments comprising 3 genotypes of sugarcane, i.e 'CoP 11438', 'CoP 14436' and 'CoP 14437' and 3 levels of nitrogen (75, 100 and 125% of recommended dose) were evaluated in randomized bock design with three replications. Recommended dose of fertilizer was 150 kg N, 37.1 kg P and 49.8 kg K/ha. All the treatments received P and K @ 37.1 and 49.8 kg/ha

through diammonium phosphate and muriate of potash, respectively. Nitrogen doses as per treatment were applied through urea, after adjusting the N supplied through DAP. Full dose of phosphorus and potassium and half of N were drilled at the time of planting and remaining N was top-dressed in two equal splits after first irrigation and just before of earthing-up. The sugarcane genotypes were planted in rows at 90 cm distance on 10th March 2015 and harvested on 8th February 2016. The crop received a total of 932.6 mm rain in 50 rainy days. All standard agronomic practices were followed to harvest good crop yield and the crop was adequately protected from insect, pests and diseases. Observations on growth, yield attributes and cane yield was recorded. Whole cane sample were taken at the time of harvest and analyzed for sucrose (%) in juice (Spencer and Meade, 1955) [11]. Sugar yield was calculated as; sugar yield (t/ ha) = [S – 0.4 (B - S) x 0.73] x cane yield (t/ ha)/ 100; where, S and B are sucrose and brix per cent in cane juice, respectively. Plant samples were analysed for uptake of nitrogen and post- harvest soil samples collected from 0 – 30 cm depth for analysis of N status using standard laboratory procedure (Jackson, 1973) [3].

Results and Discussion

Growth and yield components of sugarcane

The growth and yield attributes of sugarcane were significantly affected by genotypes and levels of nitrogen (Table 1). Among the genotypes, 'CoP 14437' recorded significantly higher germination (37.9%) which was statistically similar to 'CoP 11438' (34.5%) and significantly superior to 'CoP 14436' (31.7%). The significant variation in germination count may be attributed to chemical composition of soluble solids in juice as well as enzymes and hormones present in cell sap, which varies from genotype to genotype. These results confirm the findings of Kumar *et al.* (2014) [6]. 'CoP 14437' produced maximum plant population of 1, 76,700/ha was significantly superior by 28% to next best genotype 'CoP 11438' which may be attributed to its tillering habit governed by genetic traits. Similar observations were made by Kumar *et al.* (2012) [4]. Genotype, 'CoP 14437' produced the maximum dry matter (38.2 t/ha) and millable canes (1, 22,300/ha), while 'CoP 11438' and 'CoP 14436' were at par to each other. These results were supported by Kumar *et al*. (2012) [4].

Germination count was not affected by nitrogen levels, however, comparatively higher values was obtained with 100% recommended dose of nitrogen. These results are similar with the findings of Singh *et al.* (2011) [8]. Increasing the levels of nitrogen from 75 to 125% recommended dose significantly increased the plant population (1, 74,300/ha) and millable canes (1, 20,300/ha) of sugarcane (Table 1). The increase in plant population and millable canes was probably due to better crop growth with higher nitrogen availability. The results are in conformity with those of Singh and Kumar (2008) [10] and Singh *et al.* (2010) [9]. The higher dry matter accumulation (35.5 t/ha) was recorded under 125% recommended dose of nitrogen was statistically similar to 100% recommended dose of nitrogen and significantly superior over 75% recommended dose of nitrogen (Table 1).

Cane yield and quality

The highest cane yield (103.7 t/ha) was produced by the genotype 'CoP 14437' which was significantly higher than that of all other genotypes taken for study (Table 1). The cane yield of 'CoP 11438' and 'CoP 14436' were comparable and the lowest cane yield of 78.6 t/ha was recorded with 'CoP 14436'. Effective translocation of assimilates to the sink might have resulted in higher cane yield under 'CoP 14437' as evidenced by the dry matter accumulation and millable canes count. Variation in cane yield with different varieties in a given environment has been amply documented by Kumar *et al*. (2015) [5] and Chakrawal and Kumar (2014) [1]. The data on quality parameter, viz., brix, pol, purity and CCS per cent of the genotype indicated the superiority of CoP 14437 over CoP 14436. Variety CoP 11438 recorded significantly higher brix (20.4%), pol (18.36%) and CCS (12.80%) than CoP 14436 and statistically comparable to CoP 14437. While sugar yield was significantly higher (13.1 t/ha) in CoP 14437 followed by CoP 11438 and the least (9.7 t/ha) was in CoP 14436.

Increasing levels of nitrogen significantly enhanced the cane yield up to 100% recommended dose of nitrogen and thereafter the yield increase was in decreasing order. The response at the highest levels of nitrogen was lesser as the levels were above the optimal dose required for the potential crop production. Our results confirm those of Singh and Kumar (2008) [10] and Laxmi *et al.* (2013) [7]. Nitrogen application did not influence the brix, purity and CCS per cent of sugarcane and with the application of nitrogen it started decreasing till the highest level of nitrogen were used. However, lower doses of nitrogen (75% recommended dose) recorded significantly higher pol (18.25%) as compared to 125% recommended dose. The sugar yield which is mainly the function of CCS per cent and cane yield under different treatments showed significant increment upto 100% recommended dose of nitrogen.

Economics, N uptake and available N in post-harvest soil

Gross returns, net returns, benefit: cost ratio, N uptake by sugarcane and available N in post- harvest soil differed significantly with genotypes and levels of nitrogen (Table 2). The highest gross and net returns and benefit: cost ratio was realized with the genotype 'CoP 14437', which were significantly higher than rest of the genotypes. Similarly, the highest uptake (284.9 kg/ha) of nitrogen was recorded with genotype 'CoP 14437', which was significantly higher than all other genotypes. The uptake of nitrogen was higher under 'CoP 14437' due to its higher tonnage leading to greater uptake. Among the genotypes, available nitrogen of 'CoP 14436' was significantly higher over 'CoP 14437', this in turn was comparable with 'CoP 11438' while the lowest available nitrogen was recorded with 'CoP 14437'.

Nitrogen application proved instrumental and each successive increase in rate of nitrogen brought about corresponding increase in net returns, benefit: cost ratio and nitrogen uptake by sugarcane. Maximum values of net returns (` 1, 50,100/ha), benefit: cost ratio (1.58) and nitrogen uptake (261.4 kg/ha) were recorded with higher dose of nitrogen viz., 125% followed by 100% and minimum values of above parameters were obtained with 75% recommended dose of nitrogen. Available nitrogen with the highest nitrogen level of 125% recommended dose was comparable with 100% recommended dose of nitrogen, while the lowest available nitrogen was recorded with 75% recommended dose of nitrogen.

It may be concluded that sugarcane genotype CoP 14437 is superior to CoP 14436 and CoP 11438. Application of 125% recommended dose of nitrogen (187.5 kg N/ha) results in significantly higher net returns and benefit: cost ratio, hence it may be considered optimum for sugarcane.

Table 1: Effect of genotypes and nitrogen levels on growth, yield attributes, yield and quality of sugarcane

Treatment	Germination (%) at 45 DAP	Plant population at 120 DAP ($x10^3$/ha)	Dry matter accumulation at harvest (t/ha)	Millable canes ($x10^3$/ha)	Cane yield (t/ha)	Quality				
						Brix (%)	Pol (%)	Purity (%)	CCS (%)	Sugar yield (t/ha)
Genotypes										
CoP 11438	34.5	137.9	29.8	98.5	80.2	20.4	18.36	89.87	12.80	10.3
CoP 14436	31.7	118.0	28.5	90.0	78.6	19.9	17.84	89.52	12.42	9.7
CoP 14437	37.9	176.7	38.2	122.3	103.7	20.3	18.15	89.28	12.62	13.1
SEm±	1.37	5.23	0.96	3.37	2.56	0.10	0.070	0.586	0.08	0.34
CD (P=0.05)	4.1	15.7	2.9	10.1	7.7	0.3	0.21	NS	0.24	1.0
Nitrogen level (% recommended dose)										
75	32.9	109.3	28.3	84.1	77.4	20.3	18.25	89.89	12.72	9.9
100	36.8	149.0	32.8	106.4	89.0	20.2	18.10	89.59	12.60	11.2
125	34.4	174.3	35.5	120.3	96.1	20.2	18.02	89.19	12.51	12.0
SEm±	1.37	5.23	0.96	3.37	2.56	0.10	0.070	0.586	0.08	0.34
CD (P=0.05)	NS	15.7	2.9	10.1	7.7	NS	0.21	NS	NS	1.0

Table 2: Effect of genotypes and nitrogen levels on economics, N uptake and available N status in post harvest soil

Treatment	Gross returns ($x10^3$ `/ha)	Cost of cultivation ($x10^3$ `/ha)	Net returns ($x10^3$ `/ha)	B: C ratio	N uptake (kg/ha)	Available N (kg/ha)
Genotypes						
CoP 11438	204.5	94.5	110.0	1.16	210.5	234
CoP 14436	200.3	94.5	105.8	1.12	192.3	249
CoP 14437	264.4	94.5	169.6	1.80	284.9	211
SEm±	7.24	-	3.75	0.037	7.43	6.1
CD (P=0.05)	21.7	-	11.2	0.11	22.3	18
Nitrogen level (% recommended dose)						
75	197.3	94.0	103.3	1.10	191.4	207
100	226.9	94.5	132.4	1.40	234.9	236
125	245.1	95.0	150.1	1.58	261.4	251
SEm±	7.24	-	3.75	0.037	7.43	6.1
CD (P=0.05)	21.7	-	11.2	0.11	22.3	18

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