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Performance of some early maturing sugarcane genotypes under different nitrogen levels in central plain zone of Punjab

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ABSTRACT

A field experiment was conducted in central plain zone of Punjab at University seed farms of Ladhowal, Punjab Agricultural University, Ludhiana during the spring seasons of 2011-12 and 2012-13 to study the performance of three early maturing genotypes ('Co 06032', 'Co 07025' and 'Co 0118') against a standard check ('CoJ 83') under three different levels of N (75%, 100% and 125% of recommended N dose). The pooled data indicated that the genotype 'Co 07025' recorded significantly highest number of tillers (147100/ha), millable canes (99500/ha) and cane yield (80.5 t/ha). But the genotype 'Co 0118' recorded the maximum cane length (190.4cm), single cane wt. (911.4g) and cane diameters at top (2.45 cm), middle (2.62 cm) and at bottom (2.73cm) levels. The quality in terms of Pol % and CCS % of 'Co 0118' and 'CoJ 83' was significantly better than 'Co 07025'and 'Co 06032' but the sugar yield of genotypes 'Co 0118' (8.36 t/ha), 'Co 07025' (8.60 t/ha) and 'CoJ 83' (9.04 t/ha) were at par to each other. Application of 100% recommended N dose (150 kg N/ha) being at par to 125% recommended N dose (187.5 kg N/ha) produced significantly higher tiller count (144200/ ha), millable canes (93000/ha) , cane yield (77.2 t/ ha) and sugar yield (8.87 t/ ha) than the 75% recommended N.

Keywords : Genotypes, Nitrogen levels, Growth, Cane Yield, Sugar Yield

Sugar cane is the world's important and major cash crop. It is used as raw material for the production of sugar. According to an estimate 80% of the world's sugar production is based upon it. With increasing human population in the world, the per capita consumption is likely to increase and may go up to 35 kg (both white and gur) by 2030 AD. To meet the increasing demand of sugar and energy by 2030 AD in India, approximately 520 million tonnes of sugarcane with a recovery of 10.75% would be required (Yadav and Sharma, 2011). Under the current agricultural scenario, our country will hardly be able to meet 75% of the projected requirement.

The major agronomic intervention which can accelerate the adoption of a genotype in a particular agro-climatic region is identification of optimum dose of applied nutrient especially nitrogen (N). The optimum amount of N for the sugarcane genotypes should be such that it could meet the demand of crop at critical stages for potential cane yield and sugar accumulation and keep the unused N in the soil at a minimum level to minimize losses through leaching and volatilization. Except in some part of eastern region, Indian soils are universally deficient in N (Lal and Singh 2002) and sugarcane being a longer duration and highly exhaustive crop has higher demand for nitrogenous fertilizer. Hence, N application is the most important way to replenish the soil nitrogen and keep high productivity of sugarcane.

MATERIALS AND METHODS

Field experiments were conducted in central zone of Punjab at the research area of university seed farms at Ladhowal, Punjab Agricultural University, Ludhiana for two consecutive years during 2011-12 and 2012-13 with three early maturing sugarcane genotypes ('Co 06032', 'Co 07025', 'Co 0118') along with a standard check 'CoJ 83' under three nitrogen levels [112.5 kg/ha (75% of recommended N), 150.0 kg/ha (100% of recommended N) and 187.5 kg/ha (125% of recommended N)]. Twelve treatments were replicated thrice under factorial randomized block design. The soil of the experimental site during both the years was sandy loam in texture with normal in reaction.

Each year before planting, soil samples at 0–15 cm depth were collected from all the four corners and the center of the field and then pooled together to form a representative homogenous sample. The samples were then analyzed as per Jackson (1973) for determination of organic carbon (Walkley and Black's rapid titration method), available phosphorus ($NaHCO_3$ extractable P) and available K (NH_4OAc extractable K). The soil after chemical analysis tested low in organic carbon (0.31, 0.33%), medium in available P (16.2, 15.3 kg/ ha) and high in available K (333, 345 kg/ha).

Three bud setts of sugarcane @ 1,50,000 buds/ha of each genotype was planted in rows 75 cm apart in a plot size of 4.5m x 6.0m (27 m^2). Sugarcane planting of all the genotypes during both the years was done on 22 Feb. with full recommended package of practices (Anonymous 2012) except the treatment (N) application. Treatment N was applied through urea in two equal splits i.e. half N was top dressed alongside cane rows with first irrigation after germination around one month after planting and the other half in end May during both the years. Harvesting operations of all the genotypes were conducted in the 2nd fortnight of Dec. during both the years.

The germination percentage was determined 45 days after planting. Tiller counting was done in sample rows at maximum tillering stage in June. The other attributes like millable canes, cane height, internodes per cane, cane girth, single cane wt. were recorded from five plants selected at random at harvest from each plot. For determination of percent sucrose in juice by standard methods (Chen 1985) at least ten canes were selected randomly. The clarified juice was analysed with sucromat (digital automatic saccharimeter) for quality parameters. The data recorded during 2011-12 to 2012-13 on various growth, yield and quality parameters were pooled and the results so obtained are discussed as under.

RESULTS AND DISCUSSION

Growth

Genetic variability for germination % not recorded in the genotypes but genotypes showed significant differences among themselves in terms of growth and cane yield. A perusal of the pooled data presented in table 1 revealed that genotype 'Co 07025' recorded significantly higher tiller number (147100/ha) than the genotypes 'Co 06032' (134900/ha) and 'Co 0118'(129100/ha) but was at par to the standard check 'CoJ 83' (143700/ha). However, the standard check 'CoJ 83' produced significantly higher number of internodes per cane than genotype 'Co 07025' but were at par to genotypes 'Co 06032' and 'Co 0118'. In contrary to this, the longest cane was observed to be that of genotype 'Co 0118' which being at par to 'Co 06032' was significantly higher than genotype 'Co 07025'and 'CoJ 83'. This highest number of internodes and the lowest cane length indicated the presence of shorter internodes in 'CoJ 83'. The genotypes differed in the diameter of cane too. The genotype 'Co 0118' was the top performer in recording significantly the highest cane diameters at top, middle and bottom levels over all the other tested genotypes 'Co 07025', 'Co 06032' and the standard check 'CoJ 83'.

Except for the number of tillers, all other growth attributes like germination %, number of internodes per cane, cane length and diameter could not show any significant improvement with the application of graded doses of nitrogen. Application of either 100% (150 kg N/ha) or 125% recommended N dose (187.5 kg N/ha) to the early maturing genotypes helped in significantly improving the pooled number of tillers by 14.4 % and 15.8% respectively over the genotypes supplied with 75% recommended N (112.5 kg N/ha). The role of nitrogen in chlorophyll formation and carbohydrate metabolism is well known. Hence, the improvement in tiller count at higher doses of N might be due to more availability and absorption of the nutrient. A similar finding was reported by Singh *et al* (2008).

Yield attributes and Cane Yield

The data on millable canes formed from the existing tillers were more encouraging and indicated that the maximum number of millable canes was recorded in genotype 'Co 07025' (99.5 thousand/ha) which was significantly better than all the genotypes under study. The genotype 'Co 0118' produced lowest number of millable canes (72.3 thousand/ha) and it was significantly less than even the standard check 'CoJ 83' (87.4 thousand/ha). On the contrary, the same genotype 'Co 0118' gave the maximum weight of single cane (911.4 g) which was significantly more than the single cane weight of genotypes 'Co 07025' (813.2 g) and 'CoJ 83' (809.1 g) but was at par to the single cane wt. of 'Co 06032' and this may be attributed to lesser number of millable canes in genotype 'Co 0118' Kumar *et al.* (2009) too reported that the genotypes with fewer millable canes may end in developing heavier canes. Yield is a major parameter to find out the economic potential of the variety. The effect of low number of millable canes was more reflected in the cane yield where genotype 'Co 0118' recorded significantly lowest mean cane yield (65.9 t/ ha than the genotype 'Co 07025' being at par to genotype 'Co 06032' and standard check 'CoJ 83'.The genotype 'Co 07025' recorded the highest pooled cane yield of 80.5 t/ha and it was significantly 22.2% higher than the genotype 'Co 0118' and 14.5% higher than the standard check 'CoJ 83'. The inherent capacity of genotype might have favoured the growth of 'Co 07025' over the other genotypes. Shukla (2007b) also observed that the optimal agro techniques might help a genotype to exhibit it's inherited ability for higher yield attributes and cane yield.

Incremental increase in N dose from 112.5 kg N/ha to 187.5 kg N/ ha helped in increasing the pooled number of millable canes and ultimately the cane yield. Reducing the dose of N by 25% from the recommended (112.5 kg N/ha) significantly reduced the millable canes by 28.0 – 28.5 % and cane yield by 25.3 – 26.0% when compared to 100% and 125% of the recommended N dose respectively. Higher number of millable canes was directly related to significantly higher tiller number obtained with application of 100% and 125% recommended N dose. The differences between the application of 100% and 125% recommended N dose for yield attributing characters and yield of sugarcane genotypes were non–significant. The increase in cane yield at higher N doses (150 kg N ha^{-1} and 187.5 kg N/ha) might be attributed to the increase in millable canes. Singh *et al.*(2009) also recorded higher cane yield with increasing fertilizer doses. Similar findings were also reported by Ali *et al.*(2000), Singh (2000) and Dev *et al* (2012).

Quality and Sugar Yield

The quality aspect of sugarcane as indicated by Pol % and CCS% was significantly influenced by the variation in genotypes (table 2). The genotype 'Co 0118' and standard check 'CoJ 83' recorded almost comparable Pol% (18.33, 18.48) and CCS% (12.72, 12.86) but both the genotypes

Table 1 Growth, yield attributes and cane yield of promising early maturing sugarcane genotypes under different levels of nitrogen (pooled data of 2011-12 and 2012-13)

Treatments	Germination %	Tiller count (000/ha)	Internodes per cane	Cane length (cm)	Cane diameter / Cane girth (cms)			Millable canes (000/ha)	Single cane wt. (g)	Cane yield (t/ha)
Genotypes					Top	Middle	Bottom			
'Co 06032'	36.7	134.9	18.0	185.8	2.11	2.29	2.40	84.9	855.8	71.8
'Co 07025'	36.6	147.1	17.3	177.3	2.26	2.43	2.51	99.5	813.2	80.5
'Co 0118'	39.8	129.1	18.1	190.4	2.45	2.62	2.73	72.3	911.4	65.9
'CoJ 83'	39.2	143.7	18.6	171.7	2.22	2.38	2.48	87.4	809.1	70.3
CD(P=0.05)	**NS**	**10.6**	**0.9**	**8.8**	**0.16**	**0.14**	**0.16**	**8.2**	**78.1**	**8.5**
Nitrogen levels (kg/ha)										
112.5 (75% of rec. N)	37.2	126.0	18.0	179.6	2.32	2.48	2.56	72.4	854.0	61.6
150.0 (100% of rec. N)	38.3	144.2	18.0	181.3	2.20	2.37	2.47	93.0	837.5	77.2
187.5 (125% of rec. N)	38.7	145.9	18.1	183.0	2.26	2.43	2.55	92.7	850.6	77.6
CD(P=0.05)	**NS**	**9.1**	**NS**	**NS**	**NS**	**NS**	**NS**	**7.1**	**NS**	**7.4**

Rec. - Recommended Note : Genotype x Nitrogen interactions were found to be non significant.

Table 2 Cane quality and sugar yield of promising early maturing sugarcane genotypes under different levels of nitrogen (pooled data of 2011-12 and 2012-13)

Treatments	Pol % juice	*CCS (%)	Sugar Yield (t/ha)
Genotypes			
'Co 06032'	14.35	9.77	7.00
'Co 07025'	15.70	10.69	8.60
'Co 0118'	18.33	12.72	8.36
'CoJ 83'	18.48	12.86	9.04
CD(P=0.05)	**0.71**	**0.54**	**1.16**
Nitrogen Levels (Kg / ha)			
112.5 (75% of rec. N)	16.68	11.49	7.03
150.0 (100% of rec. N)	16.80	11.56	8.87
187.5 (125% of rec. N)	16.66	11.47	8.85
CD(P=0.05)	**NS**	**NS**	**1.00**

* CCS - Commercial Cane Sugar

significantly recorded higher Pol% and CCS% values over the genotypes 'Co 07025'(Pol-15.70%, CCS-10.69%) and 'Co 06032' (Pol-14.35%, CCS-9.77%). The genotype 'Co 06032' showed significantly minimal values for all the juice quality characteristics. However, the higher cane yield of genotypes 'Co 07025' and 'CoJ 83'led to significantly higher commercial cane sugar yield as compared to the genotype 'Co 06032'.

The genotypes fed with higher doses of nitrogen could not establish any significant effect in improving the Pol% and CCS %. Duraiswamy and Ramaiah (1991), Sathyavelu *et al.* (1999) and Shukla (2007a) have reported that higher levels of N did not influence the cane quality significantly. However commercial cane sugar yield being a function of cane yield and CCS% showed significant improvement with the increase in application of N from 75% (7.03 t/ha) to 100% (8.87 t/ha) and 125% (8.85 t/ha) of the recommended N dose. Shekinah *et. al* (2012) too reported that higher cane yield at higher doses of N led to higher sugar yield although the Pol% and CCS% remained unaffected by N application. Enhanced application of N by 25% from the recommended one could not exhibit any significant change in the commercial cane sugar yield. The interaction effect of genotypes and nitrogen doses for all the parameters remained non – significant.

On the basis of overall performance of the genotypes in the trial it is concluded that genotype 'Co 07025' may be a good yielder but low in quality while genotype 'Co 0118' is a low yielder due to fewer formation of millable canes but high in quality. However, before commercialization, the performance of these genotypes needs to be tested under different agroclimatic conditions to draw out certain substantial conclusions.

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