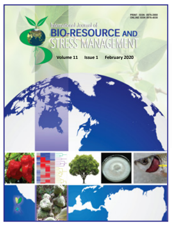

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Response of Sugarcane to Split Application of N and K Under Seedling Cultivation

M. Bharatha Lakshmi*, T. Srilatha, K. V. Ramanamurthy, T. Chitkala Devi, V. Gouri and M. B. G. S. Kumari

Regional Agricultural Research Station, Anakapalle, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh (522 034), India

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Corresponding Author

M. Bharatha Lakshmi

e-mail: bharathalakshmim@gmail.com

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Abstract

Sugarcane is one of the important agro industrial commercial crops grown in North Coastal Andhra Pradesh, India. Nutrient management play a key role in productivity enhancement of sugarcane. Among the nutrients, sugarcane respond well to split application of nitrogen and potassium especially under seedling cultivation which needs early manuring for fast growth and good tillering. Keeping this in view a field investigation was carried out for two consecutive years during 2016-17 and 2017-18 at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh, India on a sandy loam soil to recommend optimum time of application of nitrogen and potassium for sugarcane raised with single node seedlings. The experiment was laid out in Randomised Block Design with ten treatments consisting of split application of recommended N and K at different crop growth stages and replicated thrice. The experimental results indicated that application of 100% recommended N and K in four splits at planting, 30, 60 and 90 days after planting recorded significantly higher shoot population at 120 DAP, stalk population at 240 DAP and millable cane population at harvest. Higher cane yield (85.4 t ha^{-1}) was recorded with the application of 100% recommended N and K in 4 equal splits at planting, 30, 60 and 90 DAP and proved superior over recommended practice of 100% recommended N at 45 and 90 DAP and entire K at planting (71.5 t ha^{-1}). Quality parameters like brix, sucrose and CCS% were not influenced by split application of N and K significantly.

Keywords: Split application, cane yield, brix, sucrose

1. Introduction

Sugarcane is the most important sugar crop accounting for approximately 80% of sugar production in the World. (Islam et al., 2018; Sharma and Chandra, 2018). It is one of the important agro industrial commercial crops grown in North Coastal Andhra Pradesh, India. Nutrient management play key role in productivity enhancement of sugarcane. Among the nutrients applied to sugarcane nitrogen is the most important nutrient element limiting in sugarcane production throughout the World (Wiedenfeld and Enciso, 2008). Nitrogen application is one of the important agronomic practices which highly influence the initial vigour of the plants. A proper amount of N fertilizer can remarkably increase tillering and thus results in higher millable cane population with high yield (Gopalasundaram et al., 2012). In sugarcane number of millable canes per unit area, individual cane weight and cane girth contribute to cane yield in the order of 70, 23 and 3% respectively and adequate nutrition to improve the tiller

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survival and millable cane population are very essential for productivity enhancement in sugarcane (Thimmegowda et al., 2017). Insufficient or un-timely supply of N fertilizer applied to sugarcane would result in poor growth, thin stems and short nodes (Bell et al., 2014). Sugarcane farmers do apply fertilizers by broadcasting method of application resulting in low nutrient use efficiency. The major role of potassium is energy transfer and carbohydrates metabolism. It is required for maintaining cell turgidity, photosynthesis, root development, tolerance to drought and resistance to certain pests and diseases (Sallem and Akhtar, 1996). It also increases the percentage of brix in plant and ratoon crops (De Boer, 1999). With the introduction of high yielding varieties and intensive agronomic practices sugarcane crops is becoming more responsive (Khan et al., 2005) to higher levels of K fertilizer than recommended rates. A linear increase in sucrose percent with increasing dose of potassium was reported by Gupta and Prasad (1968) due to melassigenic behavior of potassium as one atom of K holds one sucrose atom. Potassium acts as an enzyme activator in plant metabolism such as photosynthesis, protein synthesis, starch formation, and translocation of proteins and sugars (Kwong, 2002). Under conditions of K deficiency, translocation of photosynthates in sugarcane can decrease substantially (Hartt, 1969). A sustained supply of K+ through out the growing season will facilitate greater shifting of dry matter from leaf to stem, enhancing the translocation of more assimilates from source to sink (Mengel and Haeder, 1977).

Generally sugarcane is grown by planting 3 budded setts in furrows spaced at 80 cm using a seed cane of 10 tons ha^{-1}. In recent years sugarcane cultivation with seedlings raised from single nodes is gaining momentum among sugarcane growers as it reduces seed cost (2.5 t ha^{-1} against 10 t ha^{-1}) and labour cost towards planting (10-12 labourers against 45-50 ha^{-1}) besides saving in time and critical inputs like water. Planting of seedlings under spaced transplanting enables the farmers to adopt placement of fertilizer thereby enhancing fertilizer use efficiency and cane productivity. Chitkaladevi et al., 2012 reported that planting of sugarcane seedlings in paired rows at 60/120 cm spacing with 30 days aged seedlings is advantageous for realizing higher yields under seedling cultivation with bud chip seedlings. Planting of 30 days to 45 days single node seedlings was found to be optimum age for cultivation of sugarcane with single node seedlings and decline in cane and sugar yield was observed with 60 days aged seedlings. Application of 200% recommended nitrogen at 45 and 90 days after planting gave higher yield than 150% RDF (Chitkaladevi et al., 2016). Standardization of agrotechniques like dose and time of application of N and K fertilizers under seedling cultivation with protray raised seedlings was felt essential and hence the present study was conducted.

2. Materials and Methods

A field experiment was carried out for two consecutive years during 2016-17 and 2017-18 at Regional Agricultural Research Station, Anakapalle under Acharya N.G.Ranga Agricultural University, Guntur, Andhra Pradesh, India. The soil of the experimental site (Latitude 17.38'N, Longitude 83.01'and) was normal in pH (7.36) and EC (0.263 dS/m^2), low in organic carbon (0.52%), available nitrogen (212 kg ha^{-1}), and high in available phosphorus (72.0 kg P_2O_5 ha^{-1}) and available potassium (243 kg ha^{-1}). The experiment was laid out in a Randomised Block Design with 10 treatments consisting of split application of 100% recommended N & K at different stages of crop growth (T_1: 100% Rec. N & K in 2 splits at 45 and 90 DAP, T_2: 100% Rec. N & K in 3 splits at 30, 60 and 90 DAP, T_3: 100% Rec. N & K in 4 splits at 15, 30, 45 and 60 DAP, T_4: 25% at planting and 75% in 2 splits at 45 and 90 DAP, T_5: 25% at planting and 75% in 3 splits at 30,60 and 90 DAP, T_6: 25% at planting and 75% in 4 splits at 15, 30, 45 and 60 DAP, T_7: 25% at planting, 50% in 2 splits at 45 and 90 DAP and 25% at earthing up, T_8: 25% at planting, 50% in 3 splits at 30, 60, 90 DAP and 25% at earthing up, T_9: 25% at planting, 50% in 4 splits at 15, 30, 45, 60 DAP and 25% at earthing up, T_{10}: 100% Nitrogen in two splits at 45 and 90 DAP and 100% potassium at planting – Recommended practice) and replicated thrice. Single node seedlings of early maturing variety 2001A 63 (Kanakamahalakshmi) raised in portrays were transplanted at the age of 30 days with a plant to plant spacing of 45 cm in furrows spaced at 90 cm. Entire dose of phosphorus (100 kg P_2O_5 ha^{-1}) in the form of single super phosphate was applied in planting furrows at the time of planting and nitrogen and potassium @ 168 kg N and 120 kg K_2O ha^{-1} in the form of urea and muriate of potash were applied by placement adjacent to the seedlings at different stages as per treatments. Other cultural practices like weeding, intercultivation, earthing-up, TT propping were carried out as per recommendation. Irrigations were given at closer interval during initial stages to ensure good establishment of seedlings. The data on seedling survival, growth, yield and quality parameters were recorded and analysed statistically as suggested by Panse and Sukhatme (1985) to draw conclusions.

3. Results and Discussion

3.1. *Growth parameters*

A perusal of the data given in Table 1 evince that seedling survival % did not differ significantly with split application of N and K to seedlings and it ranged from 95.6 to 99.0%. Galal (2016), observed more than 80% survival of bud chip seedlings raised through protrays in Egypt. Application of N and K in 4 equal splits at planting, 30, 60 and 90 days after planting (DAP) recorded maximum no. of tillers (73489 ha^{-1}) at 120 DAP while lowest number of tillers (58589 ha^{-1}) were observed in recommended practice i.e., application of recommended N in 2 splits at 45 and 90 DAP and entire K at planting. At the end of grand growth phase (240 DAP), split application of nitrogen in four equal splits at planting, 30, 60 and 90 DAP recorded highest stalk population of 80303 ha^{-1}.

Table 1: Influence of split application of N and K on growth parameters and yield attributes of sugarcane under seedling cultivation (Mean of two years 2016-17 and 2017-18)

Treatment	Seedling survival %	Shoot population at 120 DAP	Stalk population at 240 DAP	LMC at harvest (cm)	Cane girth at harvest (cm)	No. of inter-nodes/ mill-able cane at harvest	NMC / ha at harvest
T_1: 100% Recommended N & K in two splits at 45 & 90 DAP.	96.60	63927	72500	241.3	2.75	28.6	63314
T_2: Recommended N & K in three splits at 30, 60 and 90 DAP.	98.40	67469	73021	234.9	2.65	27.4	65927
T_3: Recommended N & K in four splits at 15, 30, 45 and 60 DAP.	98.05	68276	72370	247.2	2.69	27.6	68705
T_4: 25 % Recommended N & K at planting and remaining 75% in two splits at 45 and 90 DAP.	99.00	69071	71849	245.4	2.63	29.4	68184
T_5: 25% Recommended N & K at planting and remaining 75% in three splits at 30, 60 and 90 DAP.	97.70	73489	80303	259.4	2.80	29.2	76517
T_6: 25 % Recommended N & K at planting and remaining 75% in four splits at 15, 30, 45 and 60 DAP.	96.15	70761	73323	255.8	2.75	27.8	69696
T_7: 25 % Recommended N & K at planting, 50% recommended N & K in two splits at 45 & 90 DAP and 25% N & K at earthing up	98.75	63927	72084	247.9	2.73	28.6	58215
T_8: 25% Recommended N & K at planting, 50% recommended N& K in three splits at 30, 60 and 90 DAP and 25% N and K at earthing up	96.90	70208	73177	248.0	2.86	28.4	61052
T_9: 25% Recommended N & K at planting, 50% N & K in four splits and 25% N & K at earthing up.	97.65	67639	72188	256.1	2.73	29.8	62311
T_{10}: N & K as per recommendation (N in two splits at 45 and 90 DAP and K at planting)	95.60	58589	68203	226.0	2.58	26.3	65638

3.2. Yield attributes

The data on yield attributes as influenced by split application of N and K at different stages are presented in table 1. Split application of N and K did not influence the length and girth of millable canes at harvest. Mean length of millable cane varied from 226.0 cm to 259.4 cm among different treatments. Average girth of millable canes did not vary appreciably and the mean average girth ranged from 2.58 cm to 2.86 cm. The data on number of internodes/millable cane at harvest as influenced by split application of nitrogen are furnished in table 1. No. of internodes/millable cane also did not differ significantly and the mean internode no./millable cane ranged from 26.3 to 29.2. Bikila et al. (2014) reported non-significant effect of time of nitrogen application on internodes per stalk.

Split application of N and K at different stages of crop growth had significant effect on millable cane population at harvest. N and K application in four splits at planting, 30, 60 and 90 DAP registered significantly higher millable cane population over recommended practice. Application of N and K at planting had favourable influence on early vigour and tiller production and ultimately resulted in higher millable canes at harvest. The data on millable cane density at harvest indicated that application of N and K in four splits at planting, 30, 60 and 90 DAP recorded higher millable cane density of 76517 ha^{-1}. Shukla et al. (2009) reported that agronomic value of potassium (K) helps in increased cane volume, girth and weight per cane, drought and disease resistance and reduced lodging.

3.3. Quality parameters

Quality parameters of cane juice at harvest *viz.,* brix, purity and sucrose content were estimated with sucrolyzer. CCS% was computed based on brix and sucrose %.

Brix indicates the total soluble solids that include sucrose in cane juice extracted from the cane samples. Brix content of cane juice at harvest did not vary with split application of N and K fertilizers and it ranged from 20.95 to 21.44 in different treatments. There was no significant effect of split application of N and K on sucrose % and mean sucrose ranged from 19.10 to 20.16% among different treatments (Table 2). Commercial cane sugar is the actual sugar content and refers to quality of cane. Based on sucrose and brix content of cane juice at harvest, the commercial cane sugar % was computed with the formula 1.02 S – 0.3 B. The CCS% was also not influenced by split application of N and K and it ranged from 14.1 to 15.4% in different treatments.

3.4. Yield

Cane yield is the outcome of genetic potential of the variety, environmental conditions prevailed during crop growth and management practices adopted to explore maximum potentiality of the variety.

In the present study, cane yield differed with split application of Nitrogen and Potassium (Table 2). Higher cane yield of 85.4 t ha^{-1} was recorded with the application of 100% recommended N and K in 4 splits at planting, 30, 60 and 90 DAP and proved superior over recommended practice of 100% recommended N at 45 and 90 DAP and entire K at planting (71.5 t ha^{-1}). Application of 25% recommended N and K at planting influenced the vigour and growth of seedlings favorably and resulted in higher cane yield compared to no application of N & K at planting indicating the need of adequate nutrition at early stages of crop establishment and growth. Similar results were reported by Bharathalakshmi et al. (2017), and Sarala et al. (2017). Significant response of sugarcane to split application of potassium (50% basal and 50% at earthing up) has been reported by Madhu et al. (2017) and Ghaffar et al. (2013). Wubale and Girma (2018) observed higher sett yield with split application of 130 kg N ha^{-1} in two equal splits at two and half months and five months after transplanting of tissue cultured plantlets. Singh et al. (2009) reported that application of 125 % of recommended nitrogen (187.5 kg ha^{-1}) in four splits at planting, 60, 90 and 120 DAP and 40 kg P_2O_5 along with 40 kg K_2O ha^{-1} as basal application at planting improved seed cane yield of spring planted sugarcane. Venkateswara Rao and Rammohan Rao (2017) reported that application of 150% recommended dose of P and K as basal and N in 3 splits at 45, 90 and 150 DAP was proved effective over farmer practice of broadcasting of the fertilizer for increasing the cane yield of sugarcane.

Table 2: Influence of split application of N and K on quality parameters, cane and sugar yields of sugarcane under seedling cultivation (Mean of two years 2016-17 and 2017-18)

Treatment	Brix	Sucrose %	CCS %	Cane yield (t ha^{-1})	Sugar yield (t ha^{-1})
T_1: 100% Recommended N & K in two splits at 45 & 90 DAP.	21.27	19.58	14.35	69.9	10.83
T_2: Recommended N & K in three splits at 30, 60 & 90 DAP.	21.00	19.43	14.10	78.3	11.16
T_3: Recommended N & K in four splits at 15, 30, 45 & 60 DAP.	20.95	20.12	15.04	76.5	11.89
T_4: 25 % Recommended N & K at planting and remaining 75% in two splits at 45 & 90 DAP.	21.24	19.75	14.72	79.9	11.91
T_5: 25% Recommended N & K at planting and remaining 75% in three splits at 30,60 & 90 DAP.	21.29	20.16	14.96	85.4	12.87
T_6: 25 % Recommended N & K at planting and remaining 75% in four splits at 15, 30, 45 & 60 DAP.	20.98	19.36	14.38	83.0	12.04
T_7: 25 % Recommended N & K at planting, 50% recommended N & K in two splits at 45 & 90 DAP & 25 % N & K at earthing up	21.20	19.44	14.43	73.3	10.54
T_8: 25 % Recommended N & K at planting, 50 % recommended N& K in three splits at 30,60 and 90 DAP and 25% N & K at earthing up	21.60	19.57	14.95	73.7	10.98
T_9: 25 % Recommended N & K at planting, 50% N & K in four splits and 25% N & K at earthing up.	20.97	19.10	14.12	74.0	10.46
T_{10}: N & K as per recommendation (N in two splits at 45 and 90 DAP and K at planting)	21.44	19.82	14.56	71.5	10.92

In general, sugarcane responds to K fertilizers by an increase in cane yield without any change in sucrose concentration in the cane (Shukla et al., 2009). Whereas, Ashraf et al. (2008) reported that application of fertilizer potassium can increase both cane yield and quality in sugarcane.

Sugar yield followed similar trend as that of cane yield wherein split application of recommended N and K in four splits at planting, 30, 60 and 90 DAP (12.87 t ha^{-1}) recorded relatively higher sugar yields than recommended practice (10.92 t ha^{-1}).

4. Conclusion

Response of sugarcane to split application of nitrogen and potassium under seedling cultivation indicated that application of recommended nitrogen (168 kg ha^{-1}) and potassium (120 kg ha^{-1}) in four equal splits at planting, 30, 60 and 90 DAP recorded higher cane yield (85.4 t ha^{-1}) than recommended practice of nitrogen application in two splits at 45 and 90 DAP and entire dose of potassium as basal at the time of planting (71.5 t ha^{-1}).

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