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Nutrient Uptake and Millable Cane Yield of Sugarcane as Influenced by Application of Slow Releasing Nitrogen Fertilizers

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A B S T R A C T

A field study was conducted during *Rabi* 2015-16 in deep black soil to study the nutrient uptake and millable cane yield of sugarcane as influenced by application of slow releasing nitrogen fertilizers at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur, Karnataka. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly higher millable cane yield (125.3 t/ha) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (123.1 t/ha) and application of 125 % nitrogen through coal tar coated urea (121.4 t/ha). Further, these treatments also recorded significantly higher uptake of nitrogen, phosphorus and potassium. However, zero application of nitrogen recorded significantly least millable cane yield (50.2 t/ha). Results concluded that, application of 125 % nitrogen through either neem or sulphur or coal tar coated urea was best to increase the millable cane yield in sugarcane by increasing the nitrogen use efficiency and by reducing the nitrogen losses.

Keywords

Neem coated urea, Sulphur coated urea, Uptake of nutrients, Cane yield.

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Introduction

Sugar is the main house hold essential commodity of India, At National level Uttar Pradesh contributing 28 per cent in sugar production from 47 per cent cropped area. Karnataka's sugarcane production during 2015 is likely to decline by 10 per cent to 30 million tonnes. The state's production of sugarcane touched 33.4 million tonnes. Sugarcane is largely grown in the districts of Belgaum, Bagalkot, Bidar, Mandya, Gulbarga and Bijapur. For the current year, the cane planting has been done in about 500,000 hectares across the state (Anon., 2016). The Productivity of sugarcane is low mainly due to use of imbalance fertilizers.

Despite having higher fertilizer inputs than most of the surrounding states (excluding Andhra Pradesh), nutrient application rates can be considered low and imbalanced with total nitrogen (N), phosphorus (P), and potassium (K). Besides NPK deficiencies, emerging secondary and micronutrient deficiencies also provide significant constraints to high yields in Karnataka.

Little to no consideration is given to anything beyond the basic NPK needs of sugarcane and it is apparent that the potential of its production systems is largely being overlooked (Singh *et al.,* 2006).

Slow-release fertilizers are excellent alternatives to soluble fertilizers. Because nutrients are released at a slower rate throughout the season, plants are able to take up most of the nutrients without waste by leaching. A slow-release fertilizer is more convenient, since less frequent application is required. Fertilizer burn is not a problem with slow-release fertilizers even at high rates of application; however, it is still important to follow application recommendations. Slow-release fertilizers may be more expensive than soluble types, but their benefits outweigh their disadvantages. Slow-release fertilizers are generally categorized into one of several groups based on the process by which the nutrients are released. Controlled- or slow-release fertilizers are broadly divided into uncoated and coated products. Uncoated products rely on inherent physical characteristics, such as low solubility, for their slow release. Coated products mostly consist of quick-release N sources surrounded by a barrier that prevents the N from releasing rapidly into the environment. Keeping the above aspects in the mind, the present proposal is put forth with the effect of slow releasing nitrogen fertilizers on growth and yield of sugarcane.

Materials and Methods

An experiment was conducted during *Rabi* 2015-16 on effect of slow releasing nitrogen fertilizers on growth and yield of sugarcane at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur, Karnataka. The soil of the experimental site was deep black and neutral in pH (8.04), EC (0.47 ds/m), medium in organic carbon content (0.41 %), low in nitrogen (192 kg/ha), medium in phosphorus (58.5 kg/ha) and potassium (287.5 kg/ha). They were eleven treatments *viz*., T_1:125 % N through neem coated urea, T_2:100 % N through neem coated urea, T_3:75 % N through neem coated urea, T_4:125 % N through sulphur coated urea, T_5:100 % N through sulphur coated urea, T_6:75 % N through sulphur coated urea, T_7:125 % N through coal tar coated urea, T_8:100 % N through coal tar coated urea, T_9:75 % N through coal tar coated urea, T_{10}: 100 % N through commercial urea (250 kg N) and T_{11}: Control (Zero N) and replicated thrice. The Co-86032 variety of sugarcane was planted with four feet spacing (between the rows) and randomized complete block design was adopted. Six to seven months old sugarcane sets were planted and applied slow releasing nitrogen fertilizers *viz*., neem coated urea, sulphur coated urea and coal tar coated urea and applied recommended dose of phosphorus (75 kg P_2O_5) through DAP (Diammonium phosphate) and potash (190 kg K_2O) fertilizer through MOP (muriate of potash) as per the treatment. The total actual rainfall received during crop growth period was almost good as compared to the average normal rainfall received over the last thirty years. The overall pest and disease incidence was least during this season. Five plants were randomly selected in each plot of each replication and were tagged for the purpose of recording the observations *viz.*, dry matter accumulation and millable yield. Sugarcane from each net plot in each replication was harvested and weighed and recorded as millable cane yield per net plot. Further, this net plot millable cane yield was converted to millable cane yield per hectare.

Chemical analysis of plant sample

The plant samples used for recording dry matter production at harvest were used for analyzing nutrients present in the plant. After recording the dry weight from each treatment the samples were powdered in a micro Willey mill. The samples were analyzed for concentration of different nutrients (N, P and K) present in the plant parts. Nitrogen content of leaves and canes was estimated by modified micro-kjeldhal's method as outlined by Jackson (1967) and expressed in per cent. Nitrogen uptake (kg ha^{-1}) by crop was calculated for each treatment separately using the following formula.

$$\text{Nitrogen uptake (kg/ha)} = \frac{\text{Nitrogen concentration (\%)}}{100} \times \text{Dry matter yield (kg ha}^{-1}\text{)}$$

The phosphorus content of leaves and cane was determined by Vanadomolybodo phosphoric acid yellow colour method and absorbance of the solution was recorded at 430 nm using spectrophotometer (Jackson, 1967) and then computed the total uptake by crop as detailed under N uptake by the crop. Potassium content in plant sample (leaves and cane separately) was determined by flame photometer method (Jackson, 1967) and expressed in kg per ha as explained under N uptake by the crop.

Chemical analysis of soil

Representative soil samples from the experimental plot were drawn from the top 15 cm depth before sowing of the crop. Similarly, the surface soil samples from 0 to 15 cm depth were also collected from each experimental plot at harvest. Soil samples thus collected were air dried under shade, powdered with wooden mallet and passed through 2 mm sieve and analyzed for nitrogen, phosphorus and potassium content.

Available nitrogen was determined by alkaline permanganate method as outlined by Subbiah and Asija (1959). Available phosphorus was determined by Bray's method as outlined by Jackson (1967). Available potassium was determined by neutral normal ammonium acetate solution using flame photometer as outlined by Jackson (1967).

Statistical analysis and interpretation of data

Data recorded on various parameters of the experiment was subjected to analysis by using Fisher's method of analysis of variance (ANOVA) and interpreted as outlined by Gomez and Gomez (1984). The levels of significance used in 'F' and 't' test was P= 0.05. Critical difference values were calculated where F test was found significant.

Results and Discussion

Effect of weather on crop growth

Results of field investigations are affected by weather conditions. The effect of weather during the crop season is one of the most important factors which determine the extent of crop growth, development and overall performance. Every crop has its own cardinal temperature, humidity, rainfall, sunshine duration and other weather condition for higher yields. But, these optimal conditions seldom prevail. A slight alteration in weather condition may adversely affect overall growth and development. Sugarcane is basically a crop of warm regions of the tropics and sub tropics. Summerfield *et al.,* (1974) showed that temperature during cropping season have significant influence on vegetative and reproductive phases. The mean maximum temperature ranging from 23.6^0C to 43.4^0C and minimum temperature between 24.2^0C to 28.7^0C during the cropping period provide average condition for crop growth.

Growth parameters of sugarcane

The growth parameters of sugarcane *viz.,* dry matter accumulation in leaves and cane per plant as influenced by application of slow releasing nitrogen fertilizers was significantly differed and is presented in Table 1. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly higher total dry matter accumulation per plant (414.5 g) and per hectare (23.0 t/ha) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (410.5 g/plant and 22.8 t/ha, respectively) and application of 125 % nitrogen through coal tar coated urea (405.2 g/plant and 22.5 t/ha, respectively). This might be due to slow release of nitrogen throughout the crop growth period and reduced losses of nitrogen through leaching and volatilization. Similar results were recorded by Nash *et al.,* (2013); Pinpeangchan and Wanapu (2015). Nitrogen released from coated urea granules matching to plant nutrient demand improved plant height and induces better plant growth. Whereas, no application of nitrogen recorded significantly least dry matter accumulation (381.2 g/plant).

Millable cane yield of sugarcane

Yield is the result of coordinated interplay of various growth characters. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly maximum millable cane yield (125.3 t/ha) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (123.1 t/ha) and application of 125 % nitrogen through coal tar coated urea (121.4 t/ha). However all coated urea had significant effect in increasing the millable cane yield due to availability of nitrogen in adequate amount for longer duration. Ma *et al.,* (2012) also reported 10.4-16.5% increase in grain yield with sulphur and polymer coated urea over traditional urea. Carreres *et al.,* (2003), Slaton *et al.,* (2009) and Golden *et al.,* (2009) observed significant increase in grain yield with Polymer coated urea (PCU) than conventional urea. The results of experiments conducted on potato revealed an increase in tuber yield with PCU over control/conventional N fertilizers like urea, ammonium sulfate and ammonium nitrate (Zvomuya *et al.*, 2003 and Pack *et al.,* 2007). Whereas, zero application of nitrogen recorded significantly least millable cane yield (102.5 t/ha).

Nutrient concentration and uptake by the sugarcane

The nutrient concentration *viz.,* nitrogen, phosphorus and potassium content in plants were didn't differ significantly as influenced by the application of slow releasing nitrogen fertilizers is presented in Table 2.

However, application of 125 % nitrogen through neem coated area recorded significantly higher nitrogen, phosphorus and potassium uptake of sugarcane (361.5, 71.4 and 405.3 kg/ha, respectively) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (355.8, 70.7 and 399.1 kg/ha, respectively) and application of 125 % nitrogen through coal tar coated urea (348.9, 69.8 and 393.9 kg/ha, respectively).

Similar findings were reported by Patel (2003). Further, zero application of nitrogen recorded significantly least nitrogen, phosphorus and potassium uptake (201.9, 55.4 and 326.7 kg/ha, respectively).

Fertilizer recovery (NUE) in sugarcane

The nutrient use efficiency was significantly influenced by the application of slow releasing nitrogen and is presented in Table 3. Results revealed that, application of 75 % nitrogen through neem coated area recorded significantly higher nitrogen, phosphorus and potassium use efficiency (65.6, 18.7 and 35.7 %, respectively) and which was onpar with the application of 75 % nitrogen through sulphur coated urea (62.3, 17.1 and 32.4 %, respectively) and application of 75 % nitrogen through coal tar coated urea (52.5, 16.0 and 29.7 %, respectively).

Table.1 Growth and yield parameters of sugarcane as influenced by application of slow releasing nitrogen fertilizers

Treatments	DMA in leaves (g/plant)	DMA in cane (g/plant)	Total DMA (g/plant)	DMA in leaves (t/ha)	DMA in cane (t/ha)	Total DMA (t/ha)	Millable cane yield (t/ha)
T_1:125 % N through neem coated urea	72.5	342.0	414.5	4.03	19.0	23.0	125.3
T_2:100 % N through neem coated urea	67.2	334.9	402.1	3.73	18.6	22.3	118.5
T_3:75 % N through neem coated urea	64.2	331.0	395.2	3.57	18.4	22.0	113.2
T_4:125 % N through sulphur coated urea	70.2	340.3	410.5	3.90	18.9	22.8	123.1
T_5:100 % N through sulphur coated urea	66.5	333.6	400.1	3.69	18.5	22.2	115.4
T_6:75 % N through sulphur coated urea	63.8	326.4	390.2	3.54	18.1	21.7	112.5
T_7:125 % N through coal tar coated urea	68.5	336.7	405.2	3.81	18.7	22.5	121.4
T_8:100 % N through coal tar coated urea	65.1	333.1	398.2	3.62	18.5	22.1	114.3
T_9:75 % N through coal tar coated urea	63.2	323.0	386.2	3.51	17.9	21.5	110.5
T_{10}: 100 % N through commercial urea	61.0	320.2	381.2	3.39	17.8	21.2	102.5
T_{11}: Control (Zero N)	58.0	300.1	358.1	3.22	16.6	19.8	50.2
C.D. at 5 %	**4.21**	**5.43**	**9.45**	**0.23**	**0.31**	**0.52**	**3.95**

Note: Recommended dose of phosphorus and potassium are common for all the treatments DMA: Dry matter accumulation

Table.2 Nutrient concentration and uptake of sugarcane as influenced by the application of different nitrogen sources

Treatments	Nutrient concentration (%)			Nutrient uptake (kg/ha)		
	N	P	K	N	P_2O_5	K_2O
T_1:125 % N through neem coated urea	1.57	0.31	1.76	361.5	71.4	405.3
T_2:100 % N through neem coated urea	1.52	0.31	1.74	339.6	69.3	388.7
T_3:75 % N through neem coated urea	1.48	0.30	1.72	324.9	65.9	377.6
T_4:125 % N through sulphur coated urea	1.56	0.31	1.75	355.8	70.7	399.1
T_5:100 % N through sulphur coated urea	1.51	0.31	1.74	335.6	68.9	386.8
T_6:75 % N through sulphur coated urea	1.47	0.30	1.72	318.7	65.0	372.9
T_7:125 % N through coal tar coated urea	1.55	0.31	1.75	348.9	69.8	393.9
T_8:100 % N through coal tar coated urea	1.50	0.31	1.74	331.8	68.6	384.9
T_9:75 % N through coal tar coated urea	1.40	0.30	1.72	300.4	64.4	369.0
T_{10}: 100 % N through commercial urea	1.37	0.30	1.72	290.1	63.5	364.3
T_{11}: Control (Zero N)	1.02	0.28	1.65	201.9	55.4	326.7
C.D. at 5 %	**NS**	**NS**	**NS**	**25.2**	**1.59**	**8.71**

Note: Recommended dose of phosphorus and potassium are common for all the treatments NS: Not Significant

Table.3 Fertilizer applied and recovery of sugarcane as influenced by the application of different nitrogen sources

Treatments	Fertilizer applied (kg/ha)			Fertilizer recovery (NUE) %			Soil available nutrients after harvest of crop (kg/ha)		
	N	**P_2O_5**	**K_2O**	**N**	**P**	**K**	**N**	**P_2O_5**	**K_2O**
T_1:125 % N through neem coated urea	312.5	93.8	237.5	51.1	17.1	33.1	165.4	38.2	267.5
T_2:100 % N through neem coated urea	250.0	75.0	190.0	55.1	18.5	32.6	168.5	40.1	270.5
T_3:75 % N through neem coated urea	187.5	56.3	142.5	65.6	18.7	35.7	171.2	41.2	271.8
T_4:125 % N through sulphur coated urea	312.5	93.8	237.5	49.2	16.3	30.5	166.2	39.1	268.5
T_5:100 % N through sulphur coated urea	250.0	75.0	190.0	53.5	18.0	31.6	169.3	40.5	270.9
T_6:75 % N through sulphur coated urea	187.5	56.3	142.5	62.3	17.1	32.4	172.5	41.5	272.5
T_7:125 % N through coal tar coated urea	312.5	93.8	237.5	47.0	15.4	28.3	167.8	39.8	269.5
T_8:100 % N through coal tar coated urea	250.0	75.0	190.0	52.0	17.6	30.6	170.2	40.6	271.2
T_9:75 % N through coal tar coated urea	187.5	56.3	142.5	52.5	16.0	29.7	173.5	41.9	272.9
T_{10}: 100 % N through commercial urea	250.0	75.0	190.0	35.3	10.8	19.8	174.5	42.2	273.5
T_{11}: Control (Zero N)	0	75.0	190.0	-	-	-	175.2	42.5	274.2
C.D. at 5 %	**NA**	**NA**	**NA**	**3.45**	**1.72**	**2.65**	**3.52**	**1.25**	**1.65**

Note: Recommended dose of phosphorus and potassium are common for all the treatments NA: Not analyzed

This might be higher millable cane yield recorded by these treatments. Whereas, application of 100 % recommended dose of nitrogen through commercial urea recorded significantly least nitrogen, phosphorus and potassium use efficiency (35.3, 10.8 and 19.8 %, respectively).

Available nutrients in soil after harvest of crop of sugarcane

The data on soil available nutrients after harvest of crop has significantly influenced and presented in Table 3. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly lower soil available nitrogen, phosphorus and potassium after harvest of sugarcane (165.4, 38.2 and 267.5 kg/ha, respectively) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (166.2, 39.1 and 268.5 kg/ha, respectively) and application of 125 % nitrogen through coal tar coated urea (167.8, 39.8 and 269.5 kg/ha, respectively). This might be higher crop removal in the soil. However, zero application of nitrogen recorded significantly higher soil available nitrogen, phosphorus and potassium after harvest of crop (175.2, 42.5 and 274.2 kg/ha, respectively).

Results indicated that, application of urea either neem or sulphur or coal tar coated was increased the nutrient use efficiency and it has significant effect on growth, development and production on sugarcane crop.

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