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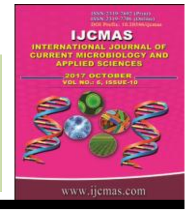

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# Effect of Slow Releasing Nitrogen Fertilizers on Growth and Yield of Sugarcane

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**A B S T R A C T**

An experiment was carried out during *Rabi* 2015-16 in deep black soil to study the effect of slow releasing nitrogen fertilizers on growth and yield of sugarcane at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur, Karnataka. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly maximum plant height (304.1 cm) and higher millable cane yield (125.3 t/ha) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (302.5 cm and 123.1 t/ha, respectively) and application of 125 % nitrogen through coal tar coated urea (300.2 cm and 121.4 t/ha, respectively). Further, these treatments also recorded significantly higher net returns and benefit cost ratio. Whereas, application of 100 % recommended dose of nitrogen through commercial urea recorded significantly least plant height (275.3 cm) and millable cane yield (102.5 t/ha). Results concluded that, application of 125% nitrogen through either neem coated area or sulphur coated urea or coal tar coated urea was best to increase the millable cane yield in sugarcane by increasing the nitrogen use efficiency and reducing the nitrogen losses.

## 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

A field study 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 ten 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 and $T_{10}$: 100 % N through commercial urea (250 kg 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*., plant height, number of tillers per meter, leaf area and dry matter accumulation and yield parameters *viz*., Cane length (cm), Number of internodes per cane, Length of internodes, millable cane yield (t/ha) and green top yield (t/ha). Leaf area (Length X Breadth) of third, fourth, fifth and sixth leaves from the top were determined in the five selected plant. The leaf area of individual leaves of the plant was calculated by multiplying with a factor, 0.6274. The mean leaf area of selected leaves was multiplied by number of leaves per plant to arrive at the leaf area per plant and expressed in deci-meter square. 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. The juice in millable cane was extracted based on the treatments. Twenty to twenty five canes from each treatment and in each replication were selected randomly and fresh weight of the canes was recorded. The juice was extracted using two roller sugarcane crusher and collected in a beaker. It was filtered through muslin cloth and then analyzed in the laboratory for various juice quality parameters *viz*., Brix (%): Brix reading was recorded by using the brix hydrometer. Corrected brix reading was worked out by recording temperature of juice and effecting temperature correction using Schmitz table and Pol or Sucrose (%): It was estimated by Horne's dry lead sub acetate clarification method using polariscope. The filtered (100 ml) juice was transferred to the conical flask to which two - three gram basic lead acetate was added.

The content was stirred well and allowed for half an hour until clear supernatant was obtained. The supernatant was filtered using Whatman no. 40 filter paper and the clarified juice was filled to a 20 mm polariscope tube and pol reading was recorded. The pol percent was recorded by comparing the pol readings measured with the corresponding corrected brix reading referring to Schmitz table. Purity (%): Juice purity is the ratio between sucrose per cent and corrected brix value expressed on per cent basis.

$$\text{Purity percentage (\%)} = \frac{\text{Pol or sucrose \%}}{\text{Corrected brix (\%)}} \times 100$$

### Commercial cane sugar (CCS %)

The amount of white commercial sugar that can be obtained from cane after removing total soluble solids was calculated by using following formula. CCS % = {Sucrose % - [(Brix % - Sucrose %) X 0.40]} X 0.73.

### Sugar yield (t/ha)

Sugar yield was calculated by using the following formula.

$$\text{Sugar yield (t ha}^{-1}\text{)} = \frac{\text{CCS (\%) X cane yield (t ha}^{-1}\text{)}}{100}$$

Where, CCS = Commercial Cane Sugar (%)

### Economics

The prices of the inputs that prevailed during the experimentation were considered to work out the cost of cultivation. Gross returns were calculated using the cane yield (t/ha) and the cane price paid by sugar mill at the time of experimentation. The net returns per hectare were calculated by deducting the cost of cultivation from gross returns per hectare. Benefit cost ratio was worked out by using the bellow mentioned formula.

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

### 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$^0$C to 43.4$^0$C and minimum temperature between 24.2$^0$C to 28.7$^0$C during the cropping period provide average condition for crop growth.

## Growth parameters of sugarcane

The growth parameters of sugarcane *viz.,* plant height, number of tillers per meter, leaf area (LA) and dry matter accumulation 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 taller plants (304.1 cm), maximum tillers per meter (15.4), higher leaf area per plant (72.5 dm$^2$) and dry matter accumulation (414.5 g/plant) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (302.5 cm, 15.1, 71.2 dm$^2$ and 410.5 g/plant, respectively) and application of 125 % nitrogen through coal tar coated urea (300.2 cm, 14.8, 70.5 dm$^2$ and 405.2 g/plant, 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, application of 100 % recommended dose of nitrogen through commercial urea recorded significantly least plant height (275.3 cm), tillers per meter (12.1), leaf area per plant (56.2 dm$^2$) and dry matter accumulation (381.2 g/plant).

## Yield parameters 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 internodes per cane (29.2), weight per cane (1.41 kg), cane length (258.1 cm), green biomass yield (15.1 t/ha) and millable cane yield (125.3 t/ha) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (28.1, 1.32 kg, 255.1 cm, 14.5 t/ha and 123.1 t/ha, respectively) and application of 125 % nitrogen through coal tar coated urea (27.4, 1.30 kg, 254.3 cm, 14.2 t/ha and 121.4 t/ha, respectively). However all coated urea had significant effect in increasing green biomass and millable cane yields 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 & ammonium nitrate (Zvomuya *et al.,* 2003 and Pack *et al.,* 2007).

Whereas, application of 100 % recommended dose of nitrogen through commercial urea recorded significantly least internodes per cane (22.5), weight per cane (1.18 kg), cane length (210.5 cm), green biomass yield (11.8 t/ha) and millable cane yield (102.5 t/ha) (Table 2).

**Table.1** Growth parameters of sugarcane as influenced by application of slow releasing Nitrogen fertilizers

| **Treatments** | **Plant height (cm)** | **No. of tillers per meter** | **Leaf area ($dm^2$ $plant^{-1}$)** | **Dry matter accumulation (g/plant)** |
|---|---|---|---|---|
| $T_1$:125 % N through neem coated urea | 304.1 | 15.4 | 72.5 | 414.5 |
| $T_2$:100 % N through neem coated urea | 297.5 | 14.6 | 68.5 | 402.1 |
| $T_3$:75 % N through neem coated urea | 292.5 | 13.8 | 64.2 | 395.2 |
| $T_4$:125 % N through sulphur coated urea | 302.5 | 15.1 | 71.2 | 410.5 |
| $T_5$:100 % N through sulphur coated urea | 298.5 | 14.5 | 67.1 | 400.1 |
| $T_6$:75 % N through sulphur coated urea | 291.3 | 13.5 | 63.2 | 390.2 |
| $T_7$:125 % N through coal tar coated urea | 300.2 | 14.8 | 70.5 | 405.2 |
| $T_8$:100 % N through coal tar coated urea | 295.4 | 14.2 | 65.1 | 398.2 |
| $T_9$:75 % N through coal tar coated urea | 290.1 | 13.2 | 60.2 | 386.2 |
| $T_{10}$: 100 % N through commercial urea | 275.3 | 12.1 | 56.2 | 381.2 |
| **C.D. at 5 %** | **4.25** | **0.65** | **2.25** | **9.45** |

Note: Recommended dose of phosphorus and potassium are common for all the treatments

**Table.4** Economics of sugarcane as influenced by application of slow releasing Nitrogen fertilizers

| **Treatments** | **Cost of cultivation (Rs/ha)** | **Gross returns (Rs/ha)** | **Net returns (Rs/ha)** | **B:C ratio** |
|---|---|---|---|---|
| $T_1$:125 % N through neem coated urea | 115000 | 325780 | 210780 | 2.83 |
| $T_2$:100 % N through neem coated urea | 114000 | 308100 | 194100 | 2.70 |
| $T_3$:75 % N through neem coated urea | 112000 | 294320 | 182320 | 2.63 |
| $T_4$:125 % N through sulphur coated urea | 115000 | 320060 | 205060 | 2.78 |
| $T_5$:100 % N through sulphur coated urea | 114000 | 300040 | 186040 | 2.63 |
| $T_6$:75 % N through sulphur coated urea | 112000 | 292500 | 180500 | 2.61 |
| $T_7$:125 % N through coal tar coated urea | 115000 | 315640 | 200640 | 2.74 |
| $T_8$:100 % N through coal tar coated urea | 114000 | 297180 | 183180 | 2.61 |
| $T_9$:75 % N through coal tar coated urea | 112000 | 287300 | 175300 | 2.57 |
| $T_{10}$: 100 % N through commercial urea | 112000 | 266500 | 154500 | 2.38 |
| **C.D. at 5 %** | **NA** | **NA** | **10148** | **0.092** |

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

**Table.2** Yield parameters of sugarcane as influenced by application of slow releasing nitrogen fertilizers

| **Treatments** | **No. of internodes per cane** | **Inter nodal length (cm)** | **Cane diameter (cm)** | **Weight per cane (kg)** | **Cane length (cm)** | **Green biomass yield (t ha$^{-1}$)** | **Cane yield (t ha$^{-1}$)** |
|---|---|---|---|---|---|---|---|
| $T_1$:125 % N through neem coated urea | 29.2 | 11.2 | 2.81 | 1.41 | 258.1 | 15.1 | 125.3 |
| $T_2$:100 % N through neem coated urea | 26.3 | 10.5 | 2.55 | 1.28 | 251.2 | 13.9 | 118.5 |
| $T_3$:75 % N through neem coated urea | 24.2 | 10.3 | 2.42 | 1.21 | 242.3 | 12.8 | 113.2 |
| $T_4$:125 % N through sulphur coated urea | 28.1 | 10.8 | 2.74 | 1.32 | 255.1 | 14.5 | 123.1 |
| $T_5$:100 % N through sulphur coated urea | 25.2 | 10.4 | 2.51 | 1.25 | 248.5 | 13.5 | 115.4 |
| $T_6$:75 % N through sulphur coated urea | 23.1 | 10.2 | 2.41 | 1.20 | 241.5 | 12.5 | 112.5 |
| $T_7$:125 % N through coal tar coated urea | 27.4 | 10.6 | 2.61 | 1.30 | 254.3 | 14.2 | 121.4 |
| $T_8$:100 % N through coal tar coated urea | 25.1 | 10.4 | 2.45 | 1.24 | 245.3 | 13.1 | 114.3 |
| $T_9$:75 % N through coal tar coated urea | 22.8 | 10.2 | 2.31 | 1.19 | 225.3 | 12.3 | 110.5 |
| $T_{10}$: 100 % N through commercial urea | 22.5 | 10.1 | 2.21 | 1.18 | 210.5 | 11.8 | 102.5 |
| **C.D. at 5 %** | **1.85** | **NS** | **NS** | **0.12** | **3.95** | **0.95** | **3.95** |

Note: Recommended dose of phosphorus and potassium are common for all the treatments

**Table.3** Quality parameters of sugarcane as influenced by application of slow releasing nitrogen fertilizers

| **Treatments** | **Brix (%)** | **Sucrose (%)** | **Purity co-efficient (%)** | **CCS (%)** | **Sugar yield (t ha$^{-1}$)** |
|---|---|---|---|---|---|
| $T_1$:125 % N through neem coated urea | 18.1 | 15.6 | 86.2 | 10.7 | 13.4 |
| $T_2$:100 % N through neem coated urea | 18.8 | 16.3 | 86.7 | 11.2 | 13.2 |
| $T_3$:75 % N through neem coated urea | 19.2 | 16.8 | 87.5 | 11.6 | 13.1 |
| $T_4$:125 % N through sulphur coated urea | 18.0 | 15.4 | 85.6 | 10.5 | 12.9 |
| $T_5$:100 % N through sulphur coated urea | 18.6 | 16.1 | 86.6 | 11.0 | 12.7 |
| $T_6$:75 % N through sulphur coated urea | 19.1 | 16.5 | 86.4 | 11.3 | 12.7 |
| $T_7$:125 % N through coal tar coated urea | 18.0 | 15.3 | 85.0 | 10.4 | 12.6 |
| $T_8$:100 % N through coal tar coated urea | 18.5 | 16.0 | 86.5 | 11.0 | 12.5 |
| $T_9$:75 % N through coal tar coated urea | 19.0 | 16.4 | 86.3 | 11.2 | 12.4 |
| $T_{10}$: 100 % N through commercial urea | 18.3 | 15.8 | 86.3 | 10.8 | 11.1 |
| **C.D. at 5 %** | **0.21** | **0.45** | **1.23** | **0.42** | **0.85** |

Note: Recommended dose of phosphorus and potassium are common for all the treatments

## Quality parameters of sugarcane

The quality parameters of sugarcane *viz.*, Pol %, Brix, purity coefficient, commercial cane sugar and sugar yield as influenced by application of slow releasing nitrogen fertilizers was significantly differed and is presented in Table 3. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly higher sugar yield (13.4 t/ha) and which was onpar with the application of 100 % nitrogen through neem coated urea (13.2 t/ha) and application of 75 % nitrogen through coal neem coated urea (13.1 t/ha). Whereas, application of 100 % recommended dose of nitrogen through commercial urea recorded significantly least sugar yield (11.1 t/ha) compared to other treatments.

Further, application of application of 75 % nitrogen through neem coated area recorded significantly higher brix (19.2 %), pol (16.8 %), purity coefficient (87.5) and CCS (11.6 %) and which was onpar with the application of 75 % nitrogen through sulphur coated urea (19.1, 16.5, 86.4 and 11.3 %, respectively) and application of 75 % nitrogen through coal tar coated urea (19.0, 16.4, 86.3 and 110.2 %, respectively). Whereas, application of 125 % nitrogen through coal tar coated urea recorded significantly least brix (18.0 %), pol (15.3 %), purity coefficient (85.0) and CCS (10.4 %) compared to other treatments.

## Economics of sugarcane

The data on cost of cultivation, gross returns, net returns and B: C ratio were significantly influenced by the application of slow releasing nitrogen and is presented in Table 4. Results revealed that, application of 125 % nitrogen through neem coated area recorded significantly higher net returns (Rs.2,10,780/ha) and B: C ratio (2.83) and which was onpar with the application of 125 % nitrogen through sulphur coated urea (Rs.2,05,060/ha and 2.78, respectively) and application of 125 % nitrogen through coal tar coated urea (Rs.2,00,640/ha and 2.74, respectively). 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 net returns (Rs.1,54,500/ha) and B:C ratio (2.38).

On the basis of results summarized above, it can be concluded that, application of coated urea either neem coated or sulphur coated or coal tar coated has significant effect on growth, development and production on sugarcane crop.

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