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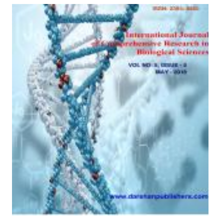

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Research Article

EFFECT OF RATE AND TIME OF NITROGEN APPLICATION ON THE QUALITY OF SEED CANE PRODUCED FROM TISSUE CULTURED PLANTLETS AT TANA BELES SUGAR DEVELOPMENT PROJECT, ETHIOPIA.

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Abstract

Nitrogen is the primary nutrient limiting in sugarcane production throughout the world. Improving seed cane production is the basis for satisfactory crop stand establishment. A field experiment was conducted to determine the optimum rate and time of N fertilizer application for the improvement of seed cane quality at Tana Beles sugar development project. The treatments were laid out in randomized complete block design with three replications. The seed cane (treatments) used for planting was treated with four levels of nitrogen fertilizer (0, 65,130,195 kg N ha^{-1}) applied into three equal split doses (0.5 months after transplanting, 2.5 months after transplanting and 5.0 months after transplanting), two equal split doses (2.5 months after transplanting and 5 months after transplanting) and a single application of the whole dose once (5 months after transplanting). The quality of Nitrogen treated (in different rate and time) seed cane was evaluated in its sprouting capacity which is the major quality parameter of seed cane. Sprout percent was significantly affected by applied Nitrogen fertilizer. Maximum sprout count was attained from plants treated with a lately single dose application of 195 kg N ha^{-1} at 5 months after transplanting. However, the result of sprout percent which received 195 kg N ha^{-1} applied in different time were not significantly different from the plants which received 130 kg N ha^{-1} applied in different time. Therefore, it is advisable to use 130 kg N ha^{-1} applied in two equal split doses at 2.5 months after transplanting and 5 months after transplanting to obtain good quality seed cane.

Keywords: Tissue cultured plantlets, Nitrogen fertilization and Sprouting percent.

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Introduction

Sugarcane (*Saccharum officinarum L.*) is a commercial crop grown in tropical and sub-tropical regions for sugar production in climates ranging from hot dry environment near sea level to cool and moist environment at high elevations (Plaut *et al*., 2000). It can be grown in a wide variety of soil types ranging from sandy loam to heavy clay (Nazir, 1994)**.** It accounts for about 70% of the worlds' total sugar production (Comstock and Miller, 2004). Today, the crop is cultivated on about 26.0 million hectares, in more than 90 countries, with a worldwide harvest of 182.2 million tons in 2013/14 (FAO, 2014). Introduction of sugarcane to Ethiopia is estimated sometimes during the early 18^{th} century. The crop is commercially cultivated during 1954 by Dutch Company, Handles-Vereening Amsterdam (HVA) (Yoseph, 2006). Currently sugarcane is cultivated in Ethiopia on about 70, 000 hectares of land with 4 million quintal of sugar production in 2015 (Girma Abejehu, 2016, Personal communication).

Sugarcane can produce seed under suitable conditions, but it is usually propagated vegetatively from axillary buds on stem (stock) cuttings. This method of planting has varios limitations. Whereas, tissue culture raised sugarcane plants are reported to give superior cane and sugar yield as compared to their donors from conventional seed source under similar climatic conditions and agronomic management practices (Lakshmanan, 2012).

Seed cane production, which is an integral component of sugar production, often receives less priority than the crop plant in many sugarcane plantations (Koehler, 1984). Sundara (2000) pointed out that planting sound seed pieces with high germination capacity is very essential in order to maintain a uniform stand of sugarcane that ultimately produces high cane and sugar yield. Apart from other cultural practices, the importance of fertilizer application to sugarcane has often been emphasized in sugarcane production (Kakde, 1985). According to Russell (1988) nitrogen occupies the highest position in the nutrition of sugarcane. Nitrogen fertilization enhances the growth of sugarcane and enables the plants to take up other nutrients (Barnes, 1974). Hebert (1956) asserted the level of nitrogen to the optimum requirements of the seed cane plants correspondingly increases the quality of setts. At Tana Beles sugar development project, no study has been made concerning the rate and time of nitrogen fertilizer application to seed cane for the improvement of its quality. Therefore the objective of this study was to determine the rate and time of nitrogen application for the improvement of seed cane quality.

Materials and Methods

Description of the study site

Study on effect of rate and time of nitrogen application on growth and quality of seed cane produced from tissue cultured plantlets was carried out at Tana Beles sugar development project. Tana Beles sugar development project is located at $11^{0}07$'N and $36^{0}20$'E latitude with an altitude of 1119 m.a.s.l, in Amhara regional state, Awi Zone, Jawi Woreda, at a distance of 650 km far from Addis Ababa. The study area is bounded by Belaya mountain Aboygara mountain, Bakussa escapement and Fendika ridge from the South, North, West and East directions respectively. The study area receives average annual rainfall of 1490 mm, mean minimum and maximum temperatures of 16.4 ^{0}C and 32.5^{0}C, respectively(Zeleke and Netsanet, 2015).

Soil analysis of the study Area

A single composite soil samples were collected for both experiments, phase one and two. Nine samples of soil were collected initially (before transplanting) from one depth (0-30cm) (Jackson, 1965), by X-shape sampling method and composited into 1kg. Total N and available p was determined by the modified micro kjeldahl method (Jackson, 1965) and Olsen method (Olson *et al.,* 1954) respectively. Available K, organic carbon and CEC was determined according to the procedure given by Doll (1973), Jackson (1965), respectively. p^{H} was determined by the glass electrode (1:5 soils–water) method (Sahlemedhin and Taye 2000).

Treatments and experimental design

Treatments are described below:

T1-Seed cane treated with no fertilizer (control), T2- Seed cane treated with 65 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T3- Seed cane treated with 65 kg N ha-1applied in two equal split doses at 2.5 and 5 months of cane age; T4- Seed cane treated with a full dose of 65 kg N ha-1 applied at 5 months of cane age; T5- Seed cane treated with 130 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T6- Seed cane treated with 130 kg N ha-1 applied in two equal split doses at 2.5 and 5 months of cane age; T7- Seed cane treated with a full dose of 130 kg N ha-1 applied at 5 months of cane age; T8- Seed cane treated with 195 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T9- Seed cane treated with 195 kg N ha-1 applied in two equal split doses at 2.5 and 5 months of cane age; T10- Seed cane treated with a full dose of 195 kg N ha-1 applied at 5 months of cane age.
The treatments were arranged in randomized complete block design (RCBD) and replicated three times.

Experimental materials and land management
Experimental materials

Materials used for conducting the experiment were: Dap and urea fertilizer, rope, spade, seed setts, herbicide and insecticide chemicals, weighing balance, cane knives, plastic bags and sacs.

Land preparation

The land was ploughed, harrowed and leveled well. Planting furrows were prepared and the land was divided to three blocks and thirty plots each block having ten plots. The size of experimental plots was 8 m in length consisting of four furrows each 1.45 m apart and with the path of 1.50 m and 2.90 m between plots and blocks, respectively. The field was irrigated before planting.

Field management

The plots were irrigated immediately after planting and application of irrigation water was continued based on the standard of irrigating sugarcane crop. At all times of fertilizer application, the treatments were applied manually along the either sides of each plant row, covered with a thin layer of soil followed by a light irrigation.

Seed set preparation and planting

Three budded seed setts were prepared from N treated 8 months of age seed cane plants and mixing of sett samples was properly done. Planting was done in end to end way. DAP fertilizer was applied during planting to all plots uniformly as starter with the rate of 250 kg ha^{-1}. All other cultural practices were done according to the practices of the plantation project.

Data collection

Sprout count: is the major seed cane quality parameter and it was counted from the two middle rows of each plot at 45 days of plant age after planting of seed setts cut from fertilized seed cane.

Data analysis

Data collected from experiment were subjected to analysis of variance using proc GLM technique with SAS soft ware (SAS, 2002). Means of the treatments was separated using DMRT (Duncan's Multiple Range Test).

Results and Discussion

Soil physical and chemical characteristics of the study area

Some soil chemical properties of the study area are presented in Table 1. The amount of total N, available P and organic carbon of the soil laid on the optimum, low and optimum ranges for total N, available P and organic carbon respectively. The laboratory result of total N and Organic carbon indicating that a substantial release of mineral nitrogen is expected during decomposition process. As reported by Benton and Jones, (2001), available P is rated as low when it is between 15-30 ppm. IFA (1992) reported that if available P is within this range, there could be certain response to applied fertilizer. On the other hand Soil available K (558 ppm) was laid on the adequate range (>100ppm) according to Benton, and Jones, (2001). Hence, the potassium value, 558 ppm, of the study area indicating no fertilizer requirement and adequate to support growth and development of cane production. Of soil analysis, soil p^H (6.55) was on the range of slightly acidic (6.1-6.8) (Benton, and Jones, 2001). According to these authors the optimum level of CEC is on the range of 29 to 40 Meq/100 g soils which implies the value of CEC on the study area was above these optimum level (Table 1).

Table 1. Laboratory result of some chemical properties of the soil of the study area (Tana Beles sugar development project) prior to initiation of the experiment.

Soil chemical characteristics	Result (quantity)
Total N	0.185 %
Available P	15.95 ppm
Available K	558 ppm
Organic Carbon	2.17 %
CEC	55 Meq/100g soil
p^H	6.55

Sprout count

Sprout in percent of seed cane as affected by different rates and times of N fertilizer is presented in the Table 2.

Use of N fertilized planting material for commercial cane production showed significant difference ($p \leq 0.01$) in sprouting ability of the cane in Luvisol (light soil) of Tana Beles. Similar result was obtained by Sime (2013) at Finchaa sugar estate. The highest percentage of sprouting was recorded on plants treated with a full dose of lately (5 MATP) applied 195 kg N ha^{-1} designated as T_{10} and its sprouting percentage was 89.31 % (Table 3). On the other hand the lowest percentage of sprouting (60.067%) was recorded for plants treated with no N fertilizer (control) which was designated as T_1. Plant treated with 195 kg N ha^{-1} applied at 5 MATP (T_{10}) showed 29.24% increase over the control (untreated).

At all the three levels of N tested, the application of late (5 MATP), single and full dose of N fertilizer resulted the best sprouting percentage than two and three equally split dose of N fertilizer application. This result was supported by Gurura.J.H. (2001), as well fertilized setts germinate rapidly with vigorous seedlings and a high proportion of roots and shoots. Sime, (2013) also reported that, application of N at early growing stage, regardless of the rate, it could be utilized for vegetative growth and may have not been enough to produce reserve nutrients for the sprouting buds as compared to late application. On the other hand, late application of N fertilizer, the seed cane for planting might have made available the applied N before it was used up for other metabolic activities.

In late applications, N is found stored temporarily in the nodes just below the buds Takahashi (1959) and Cornelison and cooper (1994). Therefore, the sprouting buds might have easily utilized this N for emergence and successive growth. That is why the lately single dose of N application has given the best result of sprouting compared to other

Table 2. Sprouting (%) of buds on planting material obtained from seed cane crops grown with different levels and times of N application on light soil of Tana Beles

Trt. No.	Percent sprout count at 45 DAP
T1	60.067^{d}
T2	62.543^{c}
T3	67.8^{d}
T4	69.9^{cd}
T5	79.14^{bcd}
T6	80.8^{abc}
T7	86.443^{ab}
T8	82.21^{a}
T9	82.69^{a}
T10	89.31^{a}
Mean	76.09
CV (%)	8.49
MSE	6.465

Means followed by the same lower case letter along columns are statistically non significant according to DMRT; DAP = Days After Planting; CV = Coefficient of variation; MSE = Mean square error.

T1-Seed cane treated with no fertilizer (control), T2- Seed cane treated with 65 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T3- Seed cane treated with 65 kg N ha-1applied in two equal split doses at 2.5 and 5 months of cane age; T4- Seed cane treated with a full dose of 65 kg N ha-1 applied at 5 months of cane age; T5- Seed cane treated with 130 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T6- Seed cane treated with 130 kg N ha-1 applied in two equal split doses at 2.5 and 5 months of cane age; T7- Seed cane treated with a full dose of 130 kg N ha-1 applied at 5 months of cane age; T8- Seed cane treated with 195 kg N ha-1 applied in three equal split doses at 15 days after transplanting, at 2.5 and 5 months of cane age; T9- Seed cane treated with 195 kg N ha-1 applied in two equal split doses at 2.5 and 5 months of cane age; T10- Seed cane treated with a full dose of 195 kg N ha-1 applied at 5 months of cane age.

Conclusion and Recommendations

The sprouting capacity of N fertilizer treated seed cane was significantly affected by different rates of N in quality wise. Late (5.0 MATP) application of 195 kg N ha^{-1} in a single dose showed increased sprout count of the planting material produced. However, the result of sprout percent which received 195 kg N ha^{-1} in full dose (5.0 MATP) was not significantly different from the plants which received 130 kg N ha^{-1} in two equal split doses at 2.5 MATP and 5 MATP.

Since this type of experiment was conducted for the first time at this place, the result of the experiment provides a good foundation for the project to produce quality seed cane. Fertilization of seed cane plants by using high dose of N has a potential to increase quality of seed setts, which play a significant role on commercial sugar cane production. Therefore, it is advisable to use 130 kg N ha^{-1} in two equal split doses at 2.5 MATP and 5 MATP in order to attain good quality seed cane. Further research is required on the rate and time of N fertilizer application including rate of P fertilizer for seed cane production raised through tissue culture plantlets in different sugar cane verities, locations and soil types of Tana Beles sugar development project.

References

Barnes, A.C. (1974). *The sugarcane* . London. Leonard Hill Books.

Benton, J. and Jones, Jr. (2001). *Laboratory guide for conducting soil tests and plant analysis.* Washngton D.C. CRC Press.

Comstock, J. C. and Miller, J. D. (2004) yield comparison: Disease free tissue cultures versus bud propagated planted sugarcane plants and healthy versus yellow leaf virus infected plants. *Journal American Society Sugarcane Technologies*, 24:31-32.

Cornelison , A. H. and Cooper, H. F. (1994). Time of application of nitrogen test. *Hawaiian plant. Rec.,* 45: 115-118.

Doll, C. E. Lucas (1973). Testing soils for potassium, calcium and magnesium, in soil testing and plant analysis. *Soil sci. soc Am.Inc.*, 65:133-151.

Food and agriculture organization (FAO). (2014). Food out looks. Biannual report on global food markets. Octtober, 2014.

Gururaj. H. (2001). *Sugar cane in agriculture and industry*. Banglore, Prism Books Pvt Ltd.

Hebert, L. P. (1956). Effect of seed pieces and rate of planting on yield of sugarcane. *Congress of International Society of Sugar and Cane Technologist*, 1: 301-310.

IFA (International Fertilizer Industry Association), 1992. World Fertilizer Use Manual, Paris.

Jakson, M. L. (1965). *Soil chemical analysis*. USA. Wood cliffs press.

Kakde. J. R. (1985). *Sugarcane production*. New Delhi: Renu printers.

Koehler, P.H. (1984). Seed cane production at the lihue plantaion company. *Hawiian sugar technology*. 14: 12-13.

Lakshmanan (2012). *A Clonics-A BSES sugarcane micro-propagation Innovation*. India.

Olsen, S, R, V, Cole, F, S. Watanabe and Dean L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of agric., circ. 939.

Plaut, Z, Meinzer, FC and Federman, E (2000). Leaf development, transpiration and ion uptake and distribution in sugarcane cultivars grown under salinity. *Plant Soil*. 218: 59-69.

Russell EW. (1988). *Soil condition and plant growth.* London. Long man press.

Sahlemedhin, Sertsu., and Taye, Bekele. (2000). *Procedures for Soil and Plant* Analysis.Technical Paper No. 74. National Soil Research Center. EARO. AddisAbaba.

Sime, Mengistu. (2013). Effect of Different Nitrogen Rates and Time of Application in Improving Yield and Quality of Seed Cane of Sugarcane (Saccharum spp. L.) VarietyB41/227. *International Journal of Scientific and Research Publications*, 3(1): 3-6.

Sundara, B. (2000). *Sugarcane cultivation*. New Delhi: Vicas publishing House Pvt. Ltd.

Takahashi, D. T. (1959). Six years studies on nitrogen utilization by sugar cane plant using N as a trace. *ISSCT.*, 5: 378-381.

Yoseph Assefa. (2006). *Sugarcane stalk borer in Ethiopia: Ecology and Phytogeography*. Ph.D. thesis, University of Kwazulu- Natal, South Africa.

Zeleke, Teshome; and Netsanet, Ayele. (2015). Soil fertility assessment for fertilizer recommendation for sugarcane plantations at Tana Beles sugar development project in Ethiopia. *African Journal of Agricultural Science and Technology* (AJAST). 3 (11): 245-246.

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