SHORT COMMUNICATION

CHARACTERISING THE FACTORS THAT AFFECT GERMINATION AND EMERGENCE IN SUGARCANE

SMIT M A

South African Sugarcane Research Institute, P/Bag X02, Mount Edgecombe, 4300, South Africa
michiel.smit@sugar.org.za

Abstract

Good germination is a basic requirement for successful sugarcane production. To predict crop emergence and manage early crop development it is necessary to understand the factors that affect germination and early growth. The minimum temperature for bud germination used in the CANEGRO and APSIM crop models is 10ºC, based on leaf emergence studies. As the base temperature for emergence for South African cultivars has not been documented previously, a study was initiated to examine the effect of temperature, soil moisture, soil fertility and seed lot on the emergence of cultivars NCo376, N16, N27 and non-fertilised N27. Carefully selected setts were planted in trays filled with soil of 0, 7 and 21% clay content, in glasshouse cubicles which were set at 30ºC, 25ºC, 20ºC and 15ºC respectively. A set of planted trays was kept dry while the rest was irrigated according to evaporative demand.

Bud emergence from a 60 mm planting depth peaked at 14, 22 and 56 days in the 30, 25 and 20ºC cubicles, respectively. Germination in the 15ºC environment was very poor and could not be used to determine base temperatures. Using linear extrapolation of the response to temperature, the results indicated that emergence did not take place below 18.1ºC for NCo376, 17.8ºC for N16 and 16.8ºC for N27. Seedcane of unfertilised origin germinated significantly more poorly than that of fertilised origin and sets planted in fertilised soil demonstrated significantly higher emergence counts (p=0.05) compared to unfertilised soil. Setts planted in sun-dried soil did not grow roots or show signs of bud swelling and differentiation.

Results from this study may help explain the poor emergence under cool winter conditions or poor ratoonability experienced under trash. Results also indicated differences in cultivar sensitivity, and the methodology could be used to screen for better adaptation to the cooler Midlands or southern production areas.

Keywords: sugarcane, base temperature, cultivars, soil type, seed lot, soil moisture

Introduction

Germination under low temperatures is a concern in the South African sugar industry as much of the cutting is done during winter. Particularly the Midlands and most southern sugarcane producing areas can experience low temperatures at the time of crop ratooning.

Sugarcane germination and growth is closely related to temperature (Glasziou *et al.,* 1965) and is more sensitive to relatively low temperatures than annual grain crops. It has been established that the optimum temperature for germination occurs between 30ºC and 35ºC (Ingamells, 1989) but there is significant variation in the base temperatures reported for sugarcane. Whiteman *et al.* (1963), for example, found germination to be optimal at 30ºC, but virtually zero at 16ºC or below. Romero *et al.* (2001) however, reported base temperatures for germination ranging from 10.7 to 13.5ºC for some Brazilian cultivars. The minimum temperature for bud germination used in the CANEGRO (Singels *et al*., 2008) and APSIM (Keating *et al*., 1999) crop models is 10ºC based on leaf emergence studies. In a study by Singels and Smit (2002), 40% emergence was recorded 67 days after a 28th May planting. Simulation of this and other winter started trials indicated that temperature effects on germination and emergence of South African sugarcane cultivars need to be investigated.

Methodology

A glasshouse with temperature controlled cubicles (2.5 m x 5.5 m) at the South African Sugarcane Research Institute at Mount Edgecombe, were used for the study. Cooling capacity is 35,000 British Thermal Units (BTU), and heating 36,000 BTU per cubicle. Four cubicles were set to 30, 25, 20 and 15ºC constant temperatures, respectively. The mean hourly temperatures achieved at seedling height in these cubicles for the duration of the trial were 30.33 ±5.35ºC, 25.4 ±8.59ºC, 19.38 ±2.60ºC and 16.33 ±4.44ºC.

Seedcane from cultivars NCo376, N16, N27 and non-fertilised N27 were used. Setts of 8 cm in length were cut from the mature central section of the stalk, and inspected for bud quality before being dipped for 10 minutes in a solution of 5 ml Eria fungicide in 10 L water. The setts were planted in trays with the bud facing up and covered with 50 mm growth medium. Emergence was recorded twice daily when the emerging spindle reached 60 mm from the base of the bud.

Topsoil with 50% clay (Arcadia), 3% clay (Fernwood) and vermiculite were used as growth mediums. Topsoil with 50% clay (Arcadia) which had not been fertilised for more than 60 years was also included in the trial. A set of trays with sun-dried sandy soil was kept dry while the remainder were irrigated according to evaporative demand.

The base temperature (Tb) was determined as the point where the linear line representing the relationship between the inverse of number of days to 50% emergence on the y axis and the mean temperature for the same period on the x axis, intersected the x axis.

Results and Discussion

Bud emergence peaked at 10, 19 and 56 days in the 30, 25 and 20ºC cubicles, respectively (Figure 1). Germination and emergence was above 90% for the fertilised seed lots in the 30ºC environment but decreased as temperature decreased. Germination in the 15ºC environment was very poor and could not be used to determine base temperatures. Seedcane from non-fertilised origin recorded germination of 69, 60 and 79% in the 30, 25 and 20ºC cubicles, respectively. No setts germinated in the dry soil under any temperature, and an inspection indicated that the setts dehydrated without any sign of root or bud development. Germination percentage was also significantly lower in the unfertilised soil.

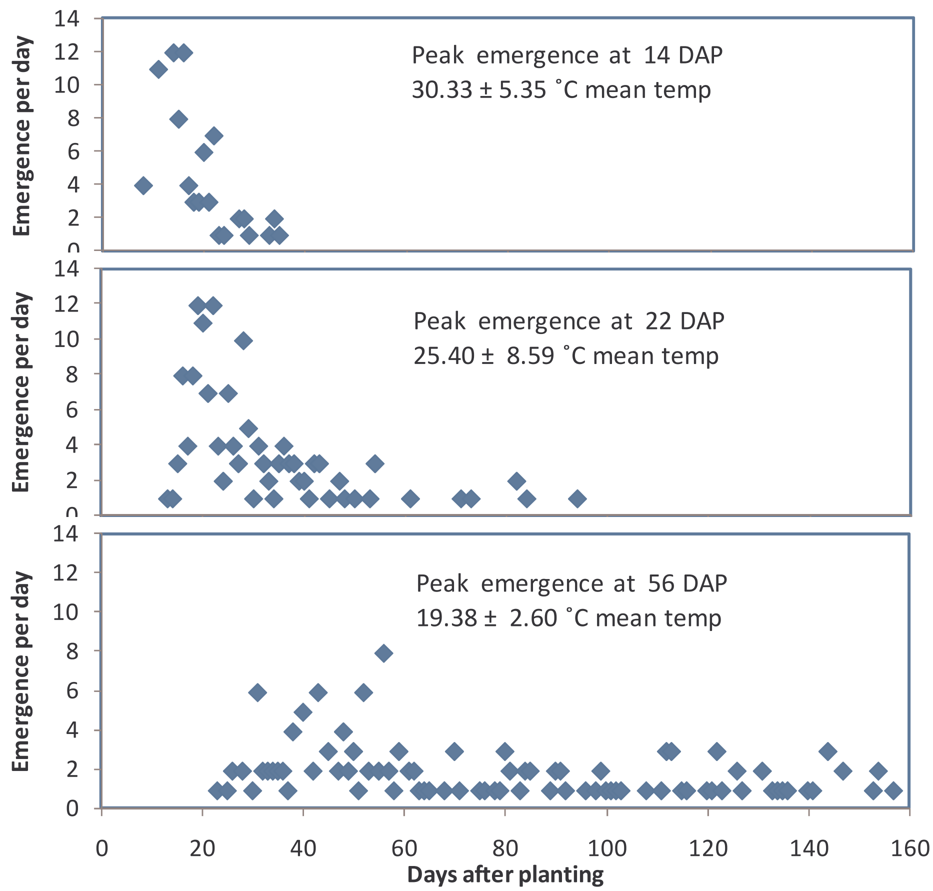

Figure 1. Daily emergence for sugarcane cultivar NCo376 under three temperature regimes.

When a linear line is fitted to the inverse of time to 50% emergence, the base temperatures were determined to be 18.1ºC, 17.8ºC and 16.8ºC respectively for NCo376, N16 and N27 (Figure 2). These relatively high base temperatures confirm the observation that crop start is slow and ratoonability is poor in winter when mean daily temperatures are at or below 20ºC. In field trials Zhou (2003) found a base temperature of 16ºC to be more likely than 10ºC for Zimbabwean cultivars.

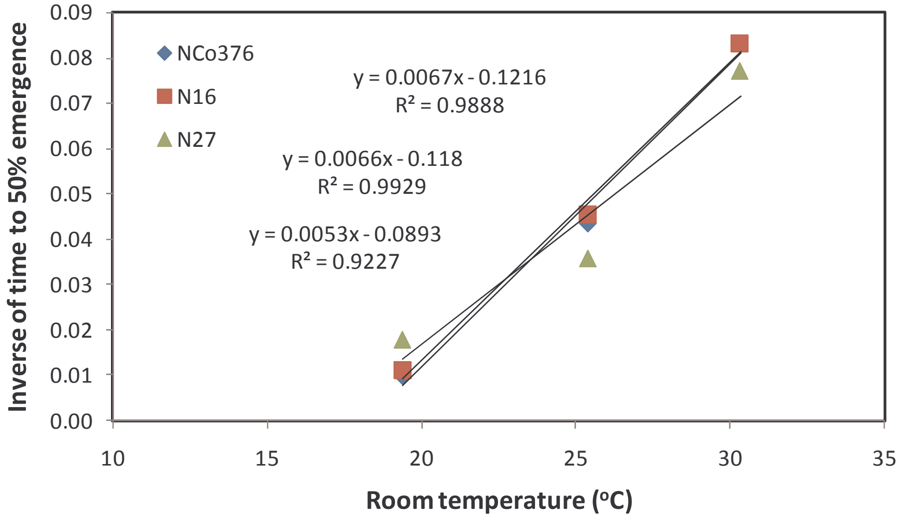

Figure 2. Relationship between rate of emergence and temperature for three sugarcane cultivars.

Conclusion

Shoot emergence was affected by soil fertility, soil moisture content and temperature. Germination was poor below 20ºC, and the apparent base temperatures were calculated to be 18.1ºC, 17.8ºC and 16.8ºC for cultivars NCo376, N16 and N27 respectively. This is higher than that currently used in the CANEGRO crop model and may explain some of the discrepancies between simulated and observed data for crops initiated at times when the mean daily temperatures are above 10ºC but below the reported base temperatures.

Controlled environment facilities are well suited to conduct screening for germination in response to temperature. Identification of genotypes with good germination and/or ratoonability under relatively low temperatures is necessary in developing cultivars better adapted to the most southern sugarcane producing areas in the world.

Acknowledgement

Permission to use the pathology research glasshouse and technical assistance by George Kanniappen and Njabulo Mkhize is gratefully acknowledged.

REFERENCES

Clements HF and Nakata S (1965). Minimum temperatures for sugar cane germination. Proc Int Soc Sug Cane Technol 12:554-560.

Glasziou KT, Bull TA, Hatch MD and Whiteman PC (1965). Physiology of Sugar-Cane: VII. Effects of temperature, photoperiod duration, and diurnal and seasonal temperature changes on growth and ripening. *Aust J Biol Sci* 18: 53-66.

Ingamells JL (1989). Nursery practices for sugarcane transplants. *Ann Rep Haw Sug Technol* 18-21.

Keating BA, Robertson MJ, Muchow MC and Huth, N.I., (1999). Modelling sugarcane production systems I. Development and performance of the sugarcane module. *Field Crop Research*, 61, 253-271.

Romero ER, Scandaliaris J, Rufino M and Perez Zamora F (2001). Biothermal models to predict plant cane emergence. *Proc Int Soc Sug Cane Technol* 24: 95-100.

Singels A and Smit MA (2002). The effect of row spacing on an irrigated plant crop of sugarcane variety NCo376. *Proc S Afr Sug Technol Ass* 76: 94-105.

Singels A, Jones M and van den Berg M (2008). DSSAT V4.5 Canegro Sugarcane Plant Module: Scientific Documentation. International Consortium for Sugarcane Modelling.

Whiteman PC, Bull TA and Glasziou KT (1963). The Physiology of Sugar-Cane VI. Effects of temperature, light, and water on set germination and early growth of *Saccharum spp*. *Aust J Biol Sci* 16(2): 416-428.

Zhou MM (2003). Modelling variety differences in canopy growth and development of sugarcane (*Saccharum Officianarum L.*) using Canegro. MSc Agric thesis, University of Natal, South Africa.