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Screening Sugarcane Clones for Abiotic Stress

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ABSTRACT

The performance of nine sugarcane clones under drought stress was evaluated during 2003-2004 cropping season at Patuadangi farm of Regional Sugarcane Research Station (RSRS) Thakurgoan and at farmer's field, Jealmari (Rajshahi). Under drought stress greenness of plants, tillers, millable canes and yield were strongly correlated, indicating usefulness of these parameters in identifying drought tolerant clones. The clones I 110-98, I 139-98, I 137-96, I 131-97 and I 202-97 were recorded as highly tolerant against natural drought stress condition, and produced cane yields 111.2, 81.0, 113.7, 117.3 and 98.5 t ha^{-1} at Jealmari (Rajshahi) location while those clones showed tolerant reaction having tolerance rating 2 under farmer's field drought stress condition at Patuadangi (Thakurgaon) with cane yield 59.8, 51.7, 42.5, 44.7 and 45.9 t ha^{-1} respectively. Results indicated strong possibilities of present technique to screen sugarcane clones for superior tolerance to drought.

Key words: Sugarcane clones, abiotic stress, tolerance rating scale, yield.

INTRODUCTION

Drought stress is a serious problem that severely limits crop production worldwide and causes important agricultural losses particularly in arid and semi-arid areas (Boyer *et al.*, 1982). Drought induced osmotic stress triggers a wide range of perturbations ranging from growth and water status disruption to the modification of ion transport and uptake systems (Lutts *et al.*, 1996; Bajji *et al.*, 2000; Santos-Diaz and Ochoa-Alejo, 1994). Upon exposure to water deficit plants exhibit physiological, biochemical and molecular responses at both the cellular, and whole plant levels (Greenway and Munns, 1980; Hasegawa *et al.*, 2000). Moisture stress at tillering, and grand growth phase during March to June is one of the important constraint which limit millable canes production, cane height and unit stalk weight, and these yield contributing characters have affects on yield. Apart from low management with unavailable modern cultivars drought stress due to high evaporative demand during crops canopy development and reproductive phase is conceived as the most dominant factor for low yield (Boyer, 1982). Due to rapidly declining aquifer and rising cost of irrigation, development of modern drought resistant variety could be the most alternative solution of achieving higher yield of this crop. Sugarcane varieties show inherent differences in their yield potential under different degrees of stress condition (Bamber,1982; Humbert, 1963). The performance of sugarcane varieties is mostly dependent on climatological factors during different growth phases along with soil conditions and agronomical management. Thus, varieties performing best at one location may not have been same performance at another location. It is, therefore, highly essential to test some promising sugarcane varieties under a given set of agronomic condition. (Joshi *et. al.*, 1994). Direct screening in the field conditions is, therefore, very difficult, and in many cases, doubtful. Johnson (1980) suggested that a suitable screening technique should be rapid, should small quantities of plant material and be capable of screening large population. The present work was, therefore, carried out to gain information on performance of some sugarcane clones grown under drought stress condition.

MATERIALS AND METHODS

The experiments were conducted at drought prone locations such as Jealmari (Rajshahi) and Patuadangi farm, RSRS (Thakurgaon). Nine promising clones were tested at both Jealmari (Rajshahi) and at Patuadangi farm, RSRS (Thakurgaon) locations. The experiments were laid out in RCB design with three replications. The experiment was set up on 1st November at Jealmari (Rajshahi) and 3rd November at RSRS (Thakurgaon) locations. Two budded setts were planted at trenches following end to end method of planting. NPKS fertilizers were applied @ 325 kg urea, 250 kg TSP, 190 kg MP, 180 kg Gypsum and 9 kg $ZnSo_4$ per hectare. Urea was applied in 3 splits and MP was applied in two splits. All necessary cultural practices were done as and when required. Data on tiller count, millable canes and yield were recorded on tolerance rating at 15 d interval during drought period, Tolerance rating scale were recorded on greenness of leaves and other factors recorded. Soil p^H, Organic carbon (%), N (%), P (ppm), K (meq) and S (ppm) were 7.2, 0.66, 0.06, 11.0, 0.20 and 17.0 at Jealmari (Rajshahi) location and 5.3, 1.15, 0.08, 20.0, 0.12 and 18.0 at Patuadangi farm, RSRS (Thakurgaon) location respectively. Due to low p^H nutrients availability was lower at Patuadangi farm, RSRS (Thakurgaon) location. So, the soil was recorded as poor at Patuadangi farm, RSRS (Thakurgaon) location than Jealmari (Rajshahi) location.

RESULTS AND DISCUSSION

The results obtained on yield contributing characters such as tillers production, millable canes and yield of nine promising sugarcane clones at drought prone Jealmari (Rajshahi) and RSRS (Thakurgaon) locations have been presented in Figures 1 and 2. It is seen from the Figure 1 that the clones I 110-98, I 139-98, I 137-96, I 202-97 and I 131-97 showed highly tolerant reaction having tolerance rating 1 against drought stress under farmer's field condition at Jealmari (Rajshahi), and produced 111.2, 81.1, 113.7, 98.5 and 117.3 t ha^{-1} cane yield respectively. The clones I 82-98, I 98-98, I 117-98, and I 142-98 showed tolerant reaction having tolerance rating 2 against field drought stress, and produced 93.3, 101.8, 91.3 and 91.1 t ha^{-1} cane yield respectively in the same location.

Figure 2 shows that the clones I 98-98, I 110-98, I 139-98, I 137-96, I 202-97 and I 131-97 showed tolerant reaction at field drought stress test at Patuadangi farm, RSRS, Thakurgoan location having tolerance rating scale 2 and obtained cane yield of 45.2, 59.8, 51.7, 44.7, 45.9 and 42.5 t ha^{-1} respectively. It is seen from the Figures 1 and 2 that there is no consistency in cane yield between highly tolerant and tolerant clones, and in several cases tolerant clones produced higher cane yield compared to highly tolerant clones. This indicates that stress tolerance is not the only factor for cane yield, and stress level was not too long to cause severe damage. It is also seen that clone I 98-98 performed equally good under both poor and fertile soils conditions, while I 110-98, I 139-98, I 142-98, I 131-97 and I 202-97 did better under fertile soils of Jealmari (Rajshahi) compared to poor soils of Patuadangi farm of RSRS (Thakurgoan). From the above facts it is seen that the clones which give highly tolerant reaction according to tolerance rating scale give better yield than other clones. Those clones which showed more freshness and greenness in stress period produced more photosynthate, and gave higher yield. According to Malik *et al.* (1992) photosynthesis may be reduced 90% when leaves are wilted. Varieties show different behaviour of growth and plant survival during moisture stress. Drought tolerant clones maintain near optimum growth for longer period of time show lesser yield reduction under moisture stress condition. This varietal adaptability is due to morphological and anatomical modification of plant parts and tissue and some physiological traits associated with plant survival (Malik *et al.,* 1992). Tolerance rating 2, clones I 98-98 produced cane yield 101.8 t ha^{-1}at Jealmari (Rajshahi) and 45.2 t ha^{-1} at RSRS (Thakurgaon) locations. Joshi *et al.* (1994)

reported that the performance of sugarcane varieties is mostly dependant on climatological factors during different growth phases along with soil conditions and agronomical management. Thus the varieties/clones performing better at one location may not be equally good at another location which is in agreement with our findings. Anon. (2003) obtained average yield 94.9, 94.2 and 92.8 tha^{-1} for the clone I 142-98, I 137-97 and I 202-97 respectively in different locations. The variations might be due to some other factors like soil condition, weather, fertilizer and drought stress condition etc. The climatic factors like temperature and rainfall which has direct effects on drought of these two locations is presented in Figures 3 and 4. Cane planted in poor soil face severe stress than organic matter rich soils (Malik *et al.*, 1992).

Clones I 142-98, I 131-97 and I 202-97 produced tillers (179.3 $x10^3$ ha^{-1}), (119.6 $x10^3$ ha^{-1}) and (132.9 $x10^3$ ha^{-1}) and millable canes (101.7$x10^3$ ha^{-1}), (90.6 $x10^3$ ha^{-1}) and (90.4x 10^3 ha^{-1}) at RSRS (Thakurgaon) location. Tillers (173.3 $x10^3$ ha^{-1}), (182.2$x10^3$ ha^{-1}) and (157.8 $x10^3$ ha^{-1}) and millable canes (117.8$x10^3$ ha^{-1}), (120.4$x10^3$ ha^{-1}) and (105.3 $x10^3$ ha^{-1}), at Jealmari (Rajshahi) location. According to anon (2003) clones I 142-98, I 137-97 and I 202-97 produced tillers (94.9$x10^3$ ha^{-1}), (94.2$x10^3$ ha^{-1}) and (92.8$x10^3$ ha^{-1}) respectively. These findings of the present study are in agreement with the report of Gill (1962) and Malik (1992). Tillering and growth of drought resistant varieties were less affected which is very close to our findings. The results of this study will help the breeders to improve drought resistant varieties, and might be recommended for release for cultivation in drought prone areas.

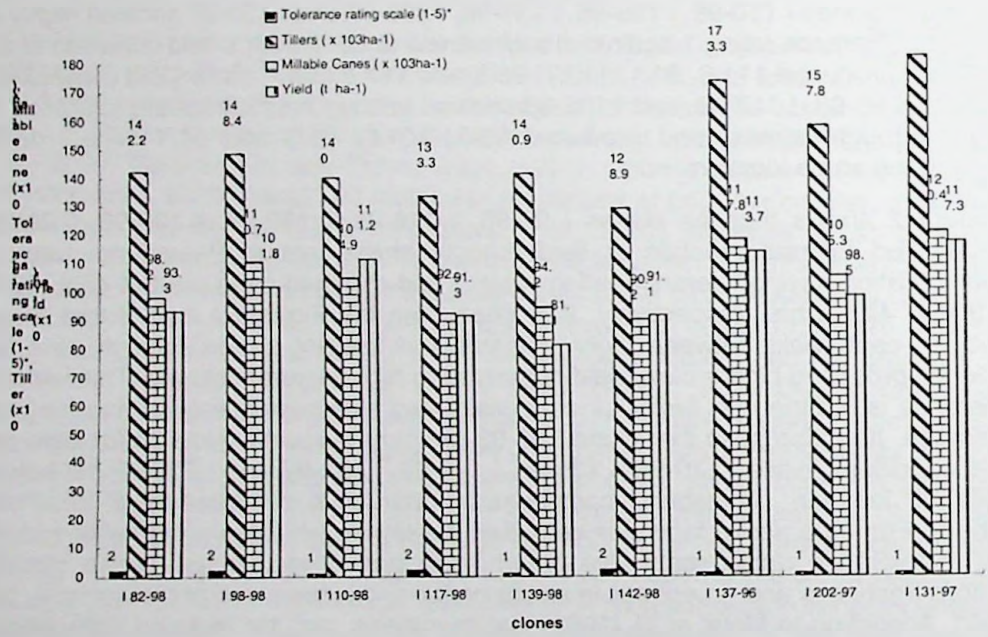

Figure 1. Performance of some BSRI bred sugarcane clones under field drought stress at Jealmari, Rajshahi.

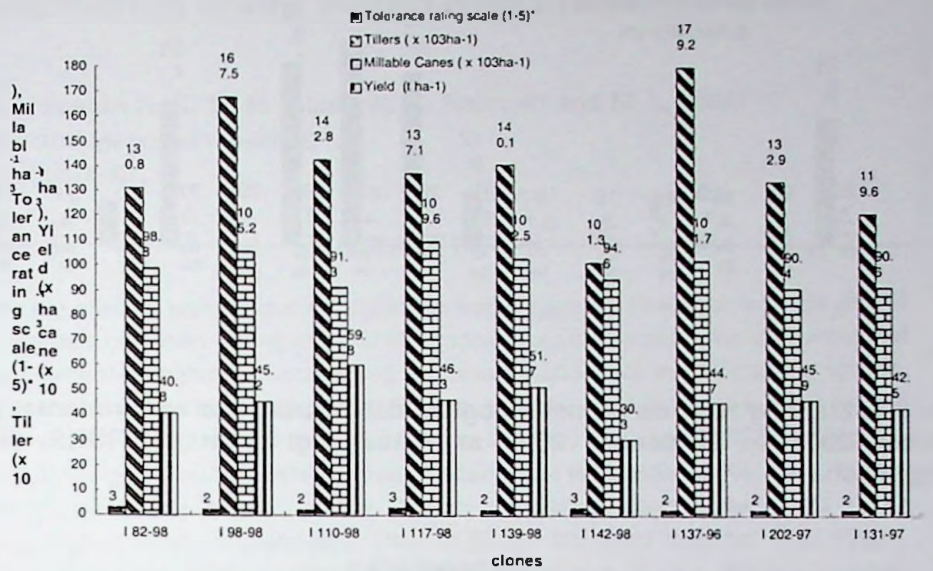

Figure 2. Perfoprmance of some BSRI bred sugarcane clones under field drought stress condition at Patuadanqi farm of RSRS, Thakurgaon.

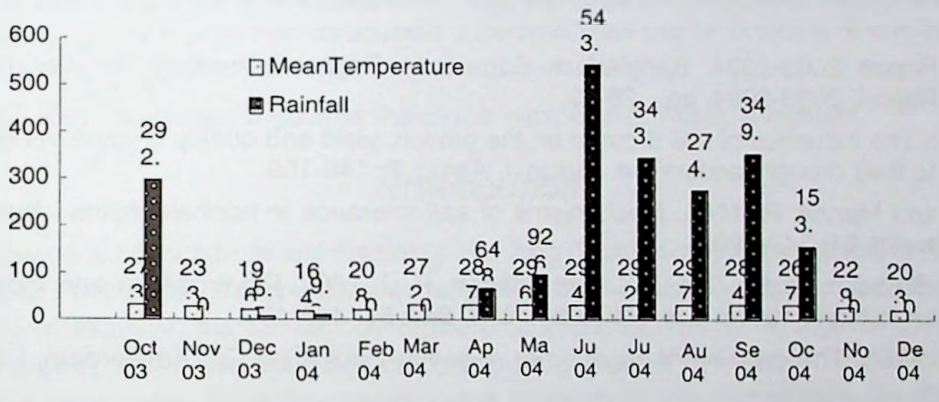

Figure 3. Monthly records of meterological data during the experimental period from October 2003 to December 2004 at Jealmari (Rajshahi), Bangladesh.

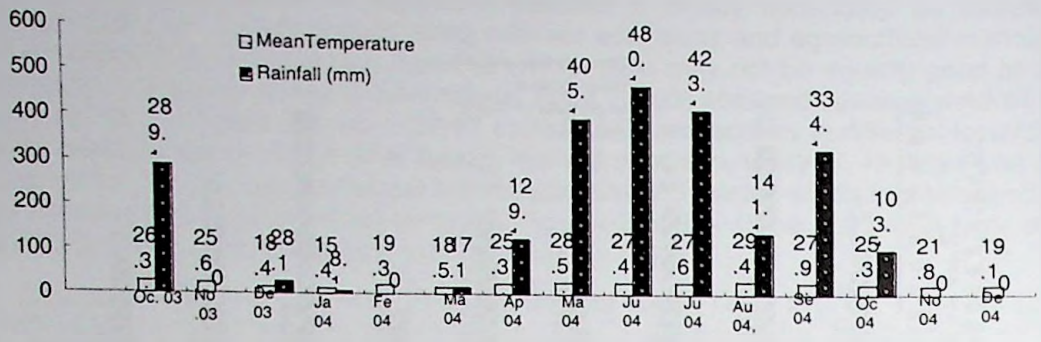

Figure 4. Monthly records of meterological data during the experimental period from October 2003 to December 2004 at Patuadangi farm of RSRS (Thakurgaon) Bangladesh

REFERENCES

Bamber, N. G. I. 1982. Drought tolerance of commercial varieties in South Africa. *Proc. Ann. Congress. S. Africa Sugar Tech. Assoc.* **56:** 112-117.

Boyer, J. S. 1982. *Plant Productivity and Environmental Science*, **218:** 443-448.

Bajji, M.; Lutts, S. and Kinet, J. M. 2000. Physiological changes after exposure to and recovery from polyethylene glycol induced water deficit in callus cultures issued from durum wheat (*Triticum durum* Dest.) cultivars differing in drought resistance. *J. Plant. Physiol*, **156:** 75-83.

BSRI Annual Report 2003-2004. Bangladesh Sugarcane Research Institute, Ishurdi, Pabna. Annual Report, 2003-2004. pp. 28-29.

Gill, H. S. 1962. The influence of soil drought on the growth, yield and quality of cane varieties in relation to their drought endurance. *Indian J. Agron*, **7:** 148-159.

Greenway, H. and Munns, R. 1980. Mechanisms of salt tolerance in nonhalophytes. *Ann. Rev. Plant Physiol*, **31:** 149-190.

Hasegawa, P.; Bressan, R. A.; Zhu, J. K. and Bohnert, H. J. 2000. Plant cellular and molecular responses to high salinity. *Ann. Rev. Plant Mol. Biol.* **51:** 463-499.

Humbert, R. P. 1963. The growing of sugarcane . Elsevier Publishing Co. Amsterdam, London, New York. pp. 312, 51.

Joshi, S.; Bendigeri, A.V. and Hapase, D. G. 1994. Studies on some physiological parameters in six varieties of sugarcane. *SISSTA Sugar J*, **20**(1): 168-171.

Johnson, D. A. 1980. Improvement of Perennial herbaceous plants for drought stressed western range lands. In: Adoption to water and high temperature stress. N. C. Turnen and P. J. Knamer (Ed.) Wiley Interscience, New York. pp. 419-435.

Malik, B. K. 1992. Effect of drought stress on the yield and recovery of sugarcane. *Pakistan Sugar Journal*, **6**(1):17-23.