*Bangladesh J. Sugarcane, 29 : 96--105* *July, 2007*

# Performance of Sugarcane Grown under Water-logging Stress Condition

**M. S. Islam, M. A. S. Miah, M. K. Begum, M. R. Alam and M. A. Hossain**
Bangladesh Sugarcane Research Institute,
Ishurdi, Pabna, Bangladesh.

## ABSTRACT

An experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm during 2003-2006 cropping seasons to study performance of sugarcane grown under water-logging stress conditions. Significant difference was recorded among different clones and varieties. Sugarcane clones/varieties were tested under water-logging stress conditions and data collected on dry and green leaf, tolerance rating scale, tiller production, millable canes production, cane yield, Brix, Pol % cane, purity, sugar recovery and estimated sugar yield. Highest number of green leaves was obtained in variety Isd 31 (49.5%) after 120 d water-logging stress and tolerance rating scale was found 2. Highest tiller production was obtained in variety Isd 34 (119.9 x $10^3$ $ha^{-1}$) and the highest number of millable cane production was recorded in clone I 202-97 (87.6 x $10^3$ $ha^{-1}$). Highest cane yield was obtained in clone I 137-96 (77.4 t $ha^{-1}$) followed by clone I 202- 97 (76.2 t $ha^{-1}$). Highest brix was obtained in clone I 98-98 (20.6 %) followed by clone I 82-98 (20.1 %). Highest pol % cane was obtained in clone I 98- 98 (14.4%). Highest purity was obtained in clone I 202-97 (90.1 %). Highest recovery per cent was obtained in clones I 98-98 (11.1 %) and I 82-98 (11.1 %), and estimated the highest sugar yield was obtained in clone I 202-97 (8.1 t $ha^{-1}$).

**Key word:** Water-logging, dry & green leaf production, Pol % cane, sugar recovery.

## INTRODUCTION

Sugarcane (*Saccharum officinarum* L) is an important industrial-cum-cash crop, and plays a vital role in national economy of Bangladesh. Sugarcane being a long duration crop occupies land for 12- 14 months. In Bangladesh, one of the important reasons of low yield of sugarcane is water-logging stress. Due to higher demand to vegetables and cereal crops, sugarcane is gradually pushed into marginal and low lying areas and local sugarcane varieties being cultivated do not have proven capabilities to grow under water-logging stress condition. As a result higher yield of cane could not be achieved. The crop is usually planted in winter months (November-January) and during monsoon heavy rainfall creates water-logging/flood stress. Long duration water-logging affects plant growth and development resulting ultimate yield loss. It is reported earlier that about 50% of sugarcane is planted on land where water remains stagnant for a longer period or become submerged due to flood (BSRI, 1992). It is therefore, important to develop sugarcane varieties built-in superior tolerance to water-logging and flood stress to ensure a reasonable productivity to met present national requirement of 0.3 million tons sugar and 0.6 million tons '*gur*' (Miah *et al.*, 1993 ).

Generally, water problem coincides with growth phase and maturity of sugarcane crops. In general, water-logging induces anaerobic condition in soil. It also leads to hamper root production resulting rapid moisture loss, increase fibre per cent and non-sugars and yellowing of leaves in anaerobic state during water-logging condition (Malik and Tomer, 2003). Therefore, present study, was undertaken to evaluate performance of nine sugarcane clones alone with three known water-logging tolerant commercial varieties under water-logging stress condition.

## MATERIALS AND MATHODS

Experiments were carried out at the Bangladesh Sugarcane Research Institute (BSRI) farm, with nine sugarcane clones viz I 137-96, I 202-97, I 98-98, I 142-98, I 82-98, I 110-98, I 139-98, I 245-99 and I 486-99 along with three known water-logging tolerant commercial varieties such as Isd 20, Isd 31 and Isd 34, during 2003-2006 cropping seasons. The experimental field was inundated and maintained at least 90 cm deep water for 120 d (15 July to15 October). The trials were conducted following Randomized Complete Block Design (RCBD) with three replications. Planting was done with polybag settlings in the month of November in each cropping season. Row to row distance was maintained 100 cm, while plant to plant distance was 45 cm. Recommended doses of commercial fertilizers were applied, and cultural practices were done as and when required. Morphological data as well as other quality parameters were recorded during inundation period. Dry and green leaf per cent (greenness), tolerance rating scale, tiller production, millable canes and estimated cane yield were recorded during water-logging stress. Brix pol cane, purity, recovery and ton sugar per hectare were also recorded. Juice analysis was done in the months of December, January and February. Data were analyzed statistically by Duncan's New Multiple Range (DNMR ) Test.

## RESULTS AND DISCUSSION

### Dry and green leaf production

Data on dry and green leaf per cent were recorded at an interval of 30 d under water-logging stress. The results have been shown in Figures 1-4. It is seen from figure that dry leaf per cent gradually increased as stress period was increased except few exception. The results presented in the Figure 1 shows that during 30 d water-logging stress period the lowest dry leaf were recorded in clone I 82-98 (41.9%). The dry leaf per cent of clone I 82-98 is comparable to commercial variety Isd 31. The Figure 2 shows effects of 60 d water-logging stress on dry leaf production. Highest dry leaf per cent was obtained in clone I 245-99 (55.7%), while the lowest per cent dry leaf was recorded in clone I 82-98 (47.1%) which is comparable to variety Isd 31. The Figure 3 shows 90 d water- logging stress effects on dry leaf production. It is seen that the highest dry leaf per cent was obtained in clone I 245-99 (58.6%), and the lowest dry leaf per cent in variety Isd 31 (48.7%). The Figure 3 also shows the highest green leaf per cent in variety Isd 31 (51.3%) followed by clone I 82-98 (48.5%), and the lowest was in clone I 245-99 (41.4%). Highest dry leaf was obtained after 120 d water stress in clone I 245-99 (60.8%), followed by clone I 110-98 (57.9%) while the lowest in variety Isd 31 (50.5%). Highest green leaf was observed in variety Isd 31 (49.5% ) followed by clone I 137-96 (45.9%) and I 82-98 (45.8%) after 120 d water-logging stress period. Similar findings were reported earlier by Anon ( 2005 ) and the lowest green leaf was recorded in I 245-99 (39.2% ). It is also reported that clone I 245-99 showed tolerance rating scale 3 which agrees with our previous findings (BSRI, 2006). Malik and Tomer (2003) reported that generally water-logging problem coincides with growth phase (maturity) of sugarcane crops. In general, water-logging induces anaerobic condition in soil. It also leads to hamper real rooting, rapid moisture loss, increase in fibre and non-sugars per cent and yellowing of leaves.

Tolerance rating scale of the experiment have been presented in the Table 1. It is revealed from the Table 1 that clones I 137-96, I 202-97, I 98-98, I 142- 98, I 82-98, I 110-98, I 139-98, and I 486-99 as well as varieties Isd 20, Isd 31 and Isd 34 were found to be tolerant up to 120 d water-logging stress having tolerance rating scale 2. Miah *et al.* (1993) reported that tolerance rating scale 2 in the variety Isd 20 earlier which is supported by present findings. It is reported earlier that clones I 82-98, I 142-98 and I 137-96 are tolerant having tolerance rating 2 (BSRI, 2006) which is also supported by the present findings.

**Tiller production**

In the present investigation highly significant difference in tiller production was obtained in different clones as well as varieties, and results have been presented in the Figure 5. Significantly higher tiller was recorded in variety Isd 34 (119.9 x $10^3$ $ha^{-1}$) under water-logging stress condition followed by clones I 110 -98 (115.3 x $10^3$ $ha^{-1}$) and I 137-96 (113.7 x $10^3$ $ha^{-1}$), while the lowest tiller production was observed in clone I 245-99 (81.7 x $10^3$ $ha^{-1}$). Present findings agree with findings of Rahman (2006 ) where he also obtained the highest number of tiller in the variety Isd 34 (225.4 x $10^3$ $ha^{-1}$ ). The variation in number of tillers might be due to some other factors like water-logging duration, soil condition etc. Higher tiller production of variety Isd 34 (137.8 x $10^3$ $ha^{-1}$) was also reported earlier (BSRI, 2006). Joshi *et al.* (1994) reported that performance of sugarcane varieties is mostly dependent on climatological factors during different growth phases along with soil condition and agronomical management practices.

**Millable cane production**

The results on millable cane production have been shown in the Figure 6. It is seen from the Figure 6 that the highest number of millable cane was obtained in clone I 202-97 (87.6 x $10^3$ $ha^{-1}$) followed by clone I 98-98 (83.7 x $10^3$ $ha^{-1}$), while the lowest number of millable cane was obtained in clone I 245-99 (46.3 x $10^3$ $ha^{-1}$). In an earlier report the highest millable cane was obtained in the clone I 202-97 (99.4 x $10^3$ $ha^{-1}$) in the same field (BSRI, 2006). This variation might be due to different agronomical management practices and climatological variations in two cropping seasons.

**Yield**

Cane yield of the present trial has been shown in the Figure 7. It is seen that the highest cane yield was obtained in clone I 137-98 (77.4 t $ha^{-1}$) followed by clone I 202-97 (76.2 t $ha^{-1}$). The yield of varieties Isd 31 and Isd 34 were found to be much lower.

**Chemical analysis**

Chemical analysis data have been shown in the Figures 8-12. The Figure 8 shows that the highest Brix was found under water-logging stress condition in clone I 98-98 (20.6%) followed by clone I 82-98 (20.1%), and the lowest in clone I 137-96 (17.8%). Pol % cane in clones and varieties have been presented in the Figure 9. Highest Pol % cane was found in clone I 98-98 (14.4 %) followed by clones I 82-98 (14.2%) and I 486-98 (14.1%), while the lowest Pol % cane was recorded in clone I 137-96 (11.3%). It is also reported that Pol % cane in clones I 98-98(14.2%) and I 82-98 (14.0%) were reported earlier (BSRI, 2005) which was close to present findings. Purity has been shown in the Figure 10. It is seen that the highest purity was obtained in clone I 202-97 (90.1%) followed by variety Isd 34 (89.2), clones I 82-98 (89.1% and I 486-99 (89.1%), and the lowest was obtained in clone I 137-96 (80.3%). The results of recovery have been presented in the Figure 11. It is seen that the highest sugar recovery was obtained in clones I 98-98 (11.1%) and I 82-98 (11.1%) followed by clones I 486-99 (10.9%), I 202-97 (10.7%), I 245-99 (10.7%) and Isd 20 (10.5%). Lowest sugar recovery was obtained in clone I 137-96 (8.2%). Sugar yield has been presented in the Figure 12, and found that the highest sugar yield was obtained in clone I 202-97 (8.1 $tha^{-1}$), and the lowest was I 245-99 (2.6 t $ha^{-1}$).

It is concluded from the results obtained that advanced clones I 202-97, I 82-98, and I 98-98 would be superior in respect to total sugar production, clones I 137-96, I 202-97, and I 82-98 in respect to cane yield over water-logging tolerant commercial varieties Isd 20, Isd 31, and Isd 34.

**Table 1: Tolerance rating scale under water-logging stress condition.**

| Clones/ varieties | I 137-96 | I 202-97 | I 98-98 | I 142-98 | I 82-98 | I 110-98 | I 139-98 | I 245-99 | I 486-99 | lsd 20 | lsd 31 | lsd 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tolerance rating scale (1-5) * | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |

*Tolerance rating scale (1-5) is based on greenness of plants and other data collected, where 1 = Highly tolerant, 2 =Tolerant, 3 = Moderately tolerant, 4 = Intolerant and 5 = Highly intolerant.

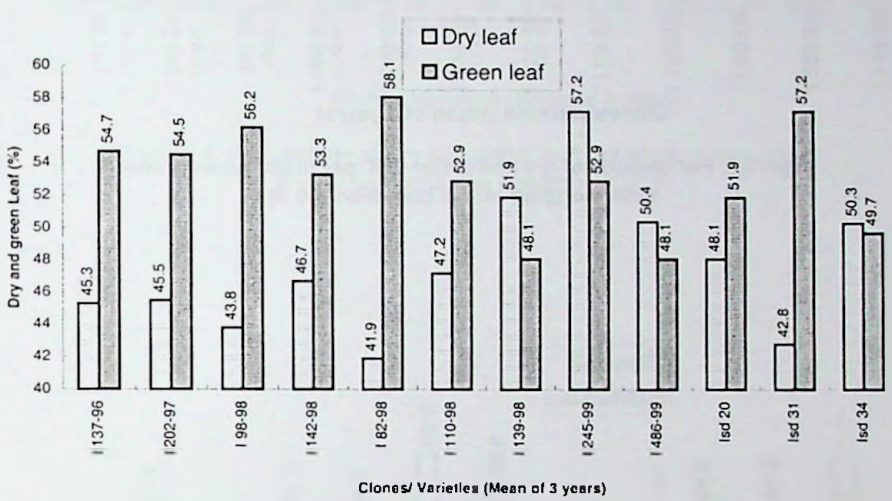


**Figure 1. Per centage of dry and green leaf per plant grown under water-logging stress condition (30 d)**

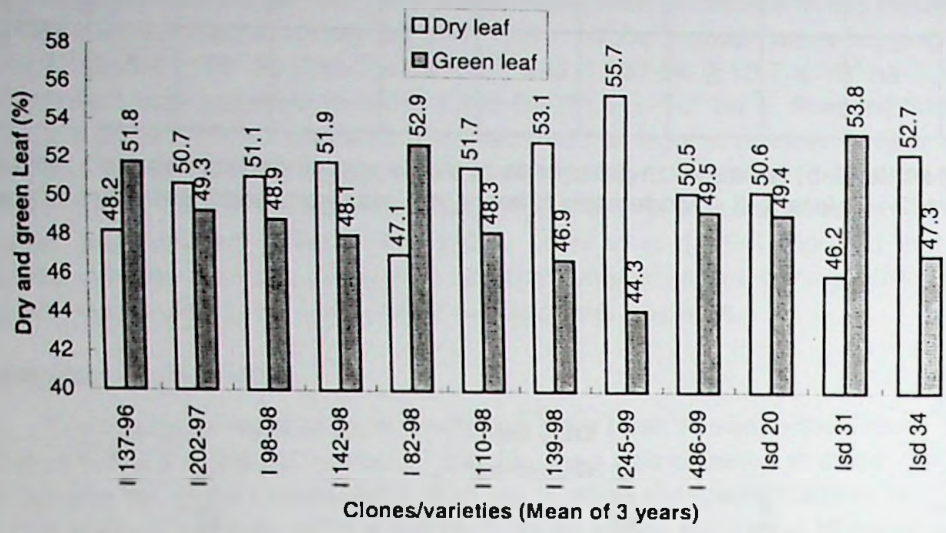


**Figure 2. Per centage of dry and green leaf per plant grown under water- logging stress condition (60 d)**

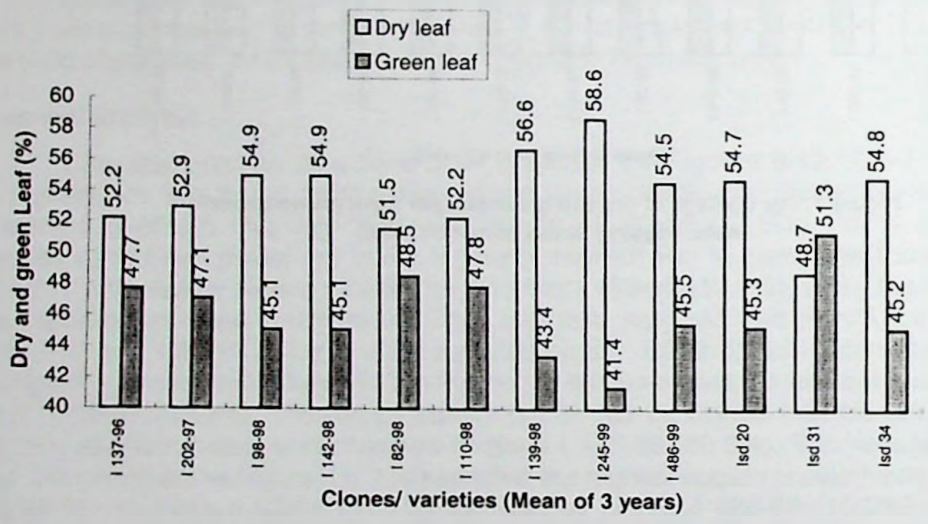


**Figure 3. Per centage of dry and green leaf per plant grown under water-logging stress condition (90 d)**

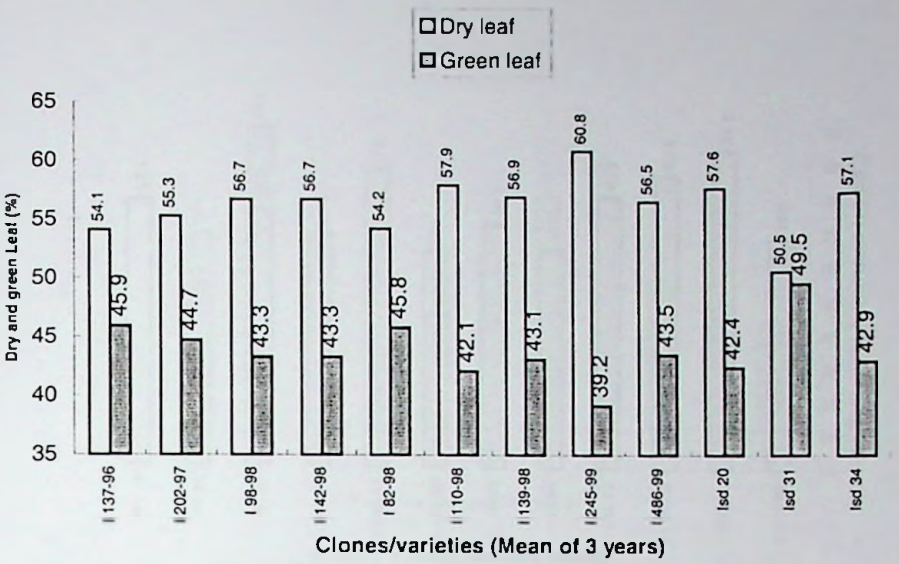


**Figure 4. Per centage of dry and green leaf per plant grown under water-logging stress condition (120 d)**

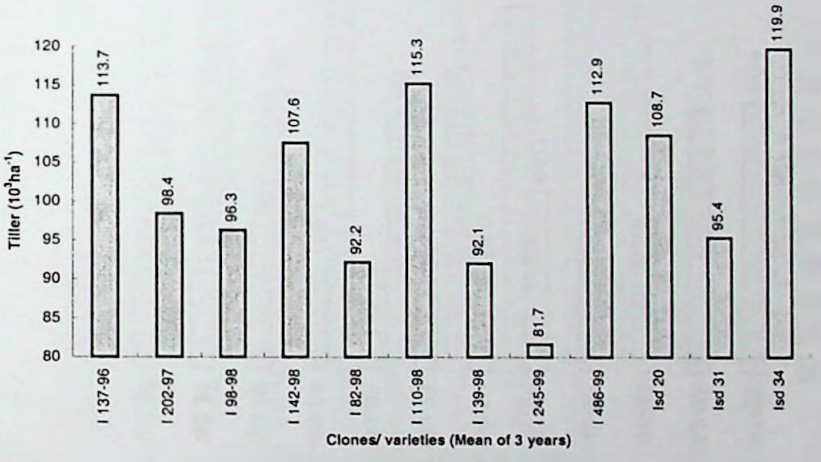


**Figure 5. Tiller production ($10^3$ha$^{-1}$ ) in different clones/ varieties under water-logging stress condition**

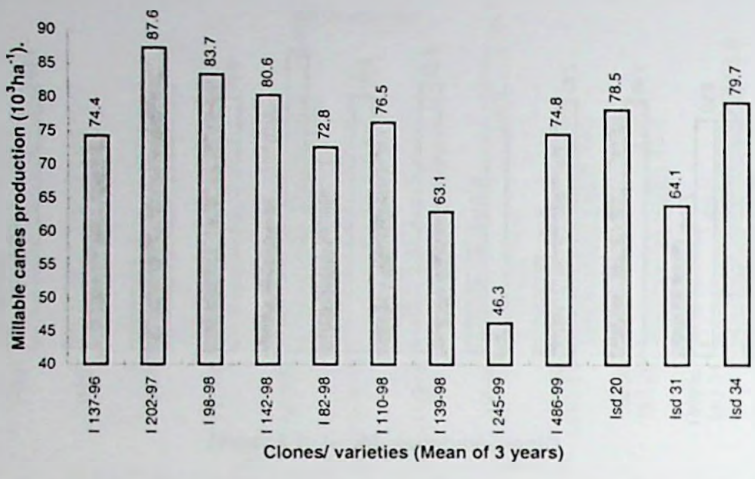


**Figure 6. Millable canes production ($10^3$ ha$^{-1}$) in different clones/ varieties under water-logging stress condition**

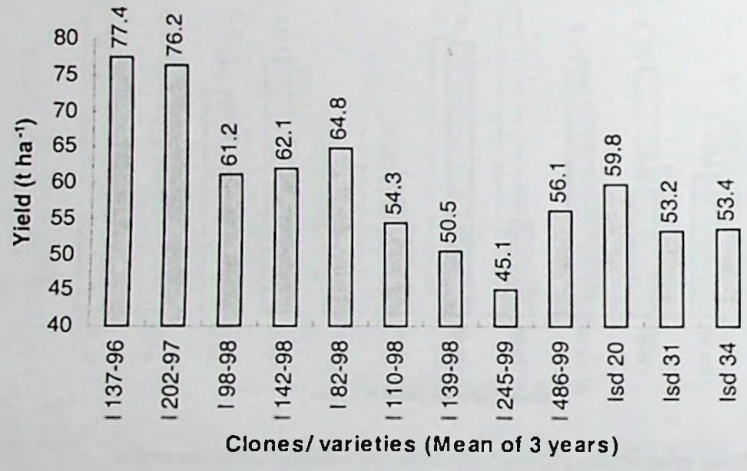


**Figure 7. Yield of cane (t ha$^{-1}$) in different clones/ Varieties under water-logging stress condition**

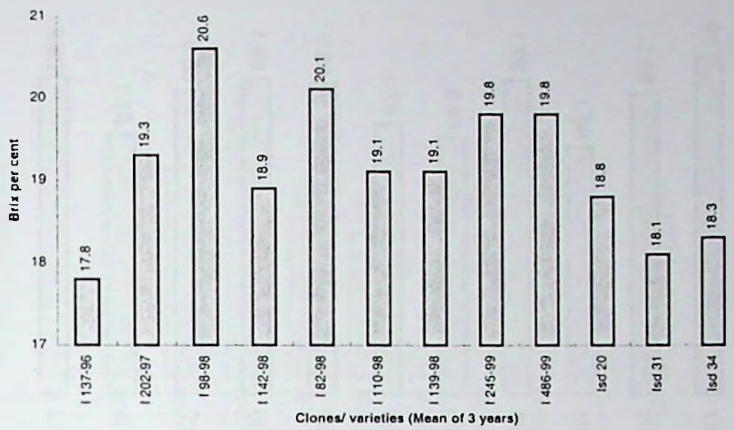


Figure 8. Brix (%) in different clones/ varieties under water-logging stress condition

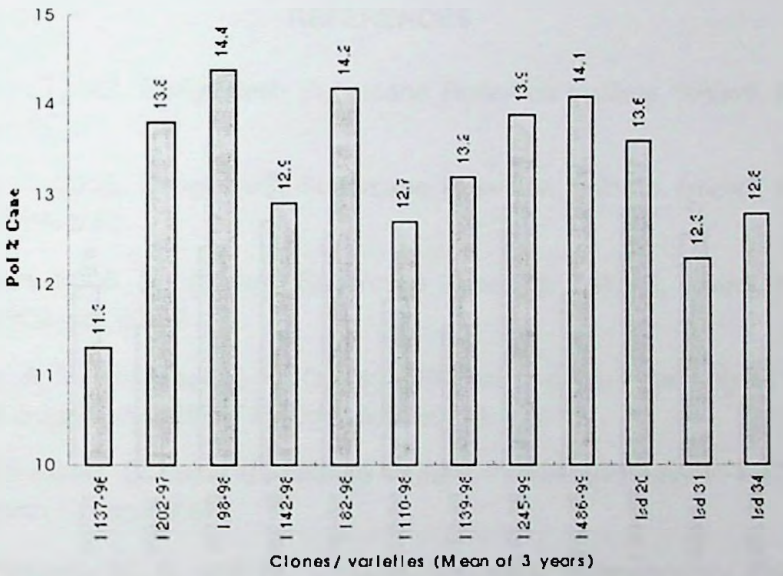


Figure 9. Pol % cane in different clones/ varieties under water-logging stress condition

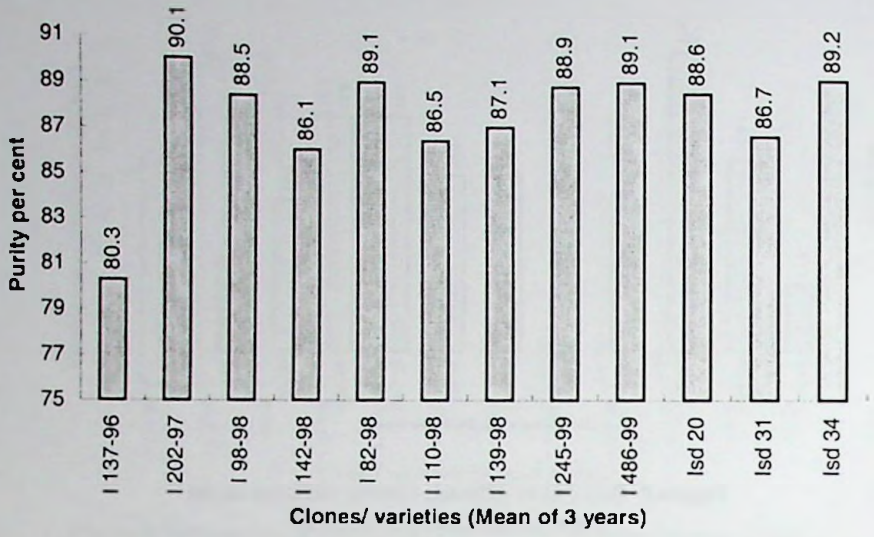


**Figure 10. Purity (%) in different clones/varieties under water-logging stress condition**

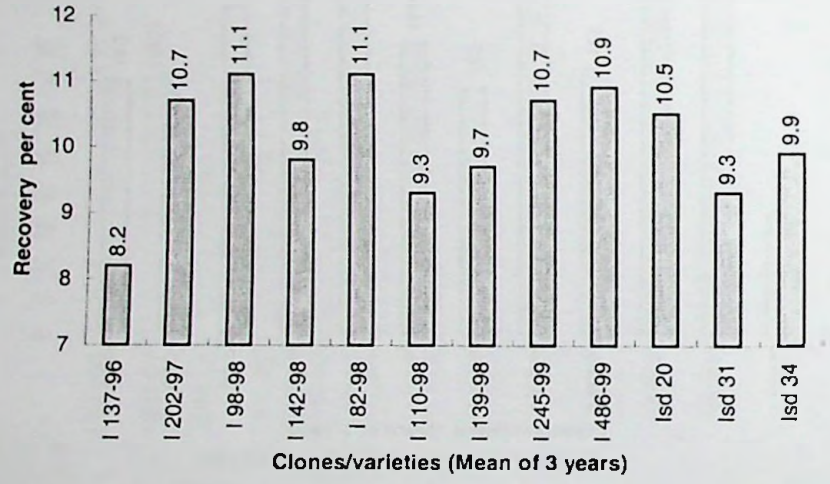


**Figure 11. Recovery (%) in different clones/ varieties under water-logging stress condition**

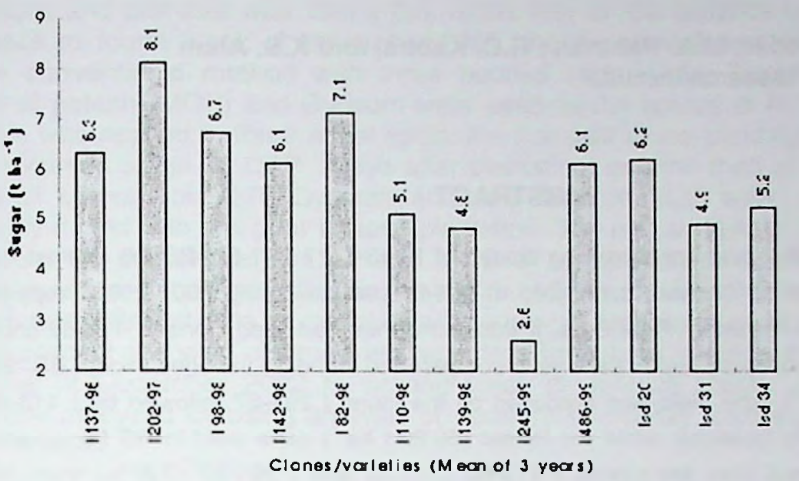


**Figure 12. Sugar (t ha$^{-1}$) in different clones/ varieties under water-logging stress condition**

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