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Drought Management in Sugarcane at Formative Stage during Pre-monsoon Period

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ABSTRACT: Sugarcane is an important commercial crop of Andhra Pradesh, next to cotton crop with industrial support. Sugarcane research under moisture stress/drought was carried out at R.S. & RRS, Rudrur & RARS, Anakapalle, period from 1993 to till date. Soil moisture stress/drought situation commonly occurs in sugarcane crop growth period coinciding with summer season for December – January planted crop. Due to severity of the moisture stress the yield penality accounts up to 50% as the formative phase of the sugarcane crop a critical phase for tiller production and later tranformation in to stalk population. If formative stage coincides with summer and experiences with drought situation by yield reduction is more when compared to normally irrigated crop. Since two decades of sugarcane cultivation in Andhra Pradesh, the productivity was stagnated at 76 to 78 t/ha except one or two years. One of the reasons for stagnation of cane productivity in A.P. is oil moisture stress/drought during formative stage and cane cultivation under soil moisture stress/rainfed situation. Identification of drought management package as a tool is a great boon to the sustainable cane cultivation under stress conditions. Based on this, trials were conducted to identify the package for drought management. It is clearly evident that soil moisture stress/drought effects on cane yield and cane quality. Especially formative stage of this crop (45-150 DAP) is most sensitive stage to moisture stress and coinciding with summer period, depending on planting time (December/January). It is evident that, time of planting, selection of tolerant varieties, close planting, soaking setts in 10% lime solution prior to planting, foliar spraying of urea + KCl 2.5%, protective irrigation with skip furrow, drip irrigations and Trash mulching were identified as an agro technique package for cane cultivation under moisture stress/drought under limited irrigated conditions.

Keyword: Soil moisture stress, cane yield (t/ha), cane quality, % Sucrose, Lime solution, Trash mulching, Skip furrow irrigation, Drip irrigation.

INTRODUCTION

Sugarcane is the country's chief sugar source and also a major commercial cash crop. In Andhra Pradesh, it is cultivated in 1.26 lakh hectares with a production of 95.93 lakh tonnes and productivity of 76.14 t/ha (Anonymous, 2020). For irrigation purpose, farmers depend on canals, wells, tube wells, which are the prime source for irrigation. In peak summer, there is an acute shortage of irrigation water due to power shortage and closing of canals because of shortage of water in reservoirs and repairs to canals, by which moisture stress both in soil and plant system arises. This situation leads to the shortage of irrigation water to sugarcane, thus affecting the cane yields. Similar yield reduction in summer months due to moisture stress was also reported in Tamilnadu by Mohan Naidu and Srinivasan, (1983); Rajkumar and Kambar, (1999).

Moisture stress is one of the important and wide spreading limiting factors for successful sugarcane cultivation in any part of the country. Important causes for moisture stress are (1) Limited availability of water for irrigation in lift irrigated areas (2) Canal closing during summer months in canal ayacut areas (3) Occurrence of drought in cyclic manner.

MATERIALS AND METHODS

Drought management of sugarcane studies was conducted at RS & RRS and RARS, Anakapalle, Andhra Pradesh 1993 to till the date. A healthy crop

was raised by following package of practices pertaining to zones. Drought was imposed with withholding irrigations to sugarcane from March 15th to June 15th (Formative stage) later leave it to nature, compared with normal irrigations of monthly one irrigation. Drought management practices were imposed as per the treatments. Data on ancillary parameters, cane yield and quality was recorded by following standard procedures sucrolyzer (Meade and Chen, 1971). Data was analyzed statistically by Panse and Sukhatme, (1978).

RESULTS AND DISCUSSIONS

A. Effect of soil moisture stress on sugarcane

Depending on the time of planting, sugarcane crop suffers in its different growth stages. Generally planting of sugarcane takes place in the month of November-December. *Kharif* planted crop suffers due to water stress in its grand growth stage. November-December planted crop suffers in its tillering phase. Germination and tillering are the two important and sensitive phases to soil moisture in sugarcane. If once, these two stages are exposed to soil moisture stress, ultimately it effects cane and sugar yield. Large areas of Andhra Pradesh suffer from moisture stress in these stages because planting takes place in December-January months by which the two stages coincide with severe summer period (Table 1).

Table 1: Effect of moisture stress on cane growth and irrigation management.

Age of the crop	Stage of the crop	Effect of Stress	Irrigation Management
0 – 45 days	Seedling stage	Seedling death	Life irrigation at 7-10 DAP
45 – 150 days	Tillering stage	Tiller Mortality	Black soils : Irrigation at 10 to 15 days interval Light soils: : Irrigation at 7 days interval
150 – 270 days	Grand growth stage	Reduction in NMC, growth reduction in cane	Black soils : Irrigation at 10 to 15 days interval Light soils: : Irrigation at 7 days interval
270 – 360 days	Maturity stage	Reduction in sucrose, poor juice quality	Black soils : Irrigation at 3 weeks interval Light soils: : Irrigation at2 weeks interval

(Mukunda Rao *et al*., 2018)

In general, moisture stress in soil affects cane yield by reducing photosynthetic leaf area, number of tillers, number of millable canes, length and girth of cane and finally the weight of individual cane (Table 2). Drying of leaves, tiller mortality and stunted growth are the common features of moisture stress affected sugarcane. Characteristic features of moisture stress on sugarcane are described in the form of short inter-nodal length. Generally drought tolerant canes maintains high relative water content than susceptible canes (Rayes *et al.,* 2021). Soil moisture stress affects cane quality in terms of percent sucrose and purity, besides aggravating certain pests and disease problems.

Table 2: Effect of soil moisture stress during formative phase on growth and cane yield of sugarcane (93 R 44).

Treatment	Millable canes	Sucrose (%)	Purity (%)	Cane yield (t/ha)	CCS (t/ha)	Node length (cm)	Cane girth (cm)
Normal Irrigation	104.81	15.63	83	123.43	13.46	13.13	2.93
Soil moisture stress	94.67	12.37	77	97.34	7.65	12.90	2.36

Sugarcane is a long duration crop, requiring lot of water for cane growth. Sugarcane requires 125 and 1400 tonnes of water to produce 1 tonne of cane and sugar respectively (Kanakaprasada Rao 1988). Considering only dry matter production, it requires 322 g of water to produce 1 g of dry matter (Rajkumar and Kambar, 1999): It shows the importance of irrigation to sugarcane in its growth stages. This gives greater scope in managing the sugarcane crop under soil moisture stress/drought especially in summer months by following some cultural practices.

B. Package of practices for sugarcane grown under areas of soil moisture stress/drought

Deep ploughing: In areas where crop is likely to be subjected to moisture stress, deep ploughing has to be done. Deep ploughing is essential to have better crop stand, which helps in deeper penetration of root system, easy absorption of water and nutrients form deeper layers of soil.

Time of planting: Planting sugarcane early in the season (October-November) helps cane to grow sufficiently before the moisture stress sets in. Early planting helps sensitive stages of crop to escape soil moisture stress. So, planting has to be done in October-November, by which sensitive stages of crop i.e. germination and tillering stages complete before onset of severe summer and thereby escape from exposing to the moisture stress conditions. Late planting after December, results in crop exposure to severe summer condition having adverse affect on the cane and sugar yield (Table 3).

Table 3: Effect of time of planting on cane yield and quality of sugarcane (95 R 186).

Planting Date	Plant height (cm)	No. of Millable canes (000/ha)	Cane yield (t/ha)	Sucrose (%)	CCS (t/ha)
November 1996	321.10	113.80	135.20	17.96	17.42
December 1996	304.30	105.50	124.23	17.80	16.20
January 1997	263.00	87.60	95.54	16.10	11.90

Varieties: In sugarcane, selection of variety is the most important factor for the management of moisture stress. A variety is drought tolerant, if the yield reduction is less than 10% under moisture stress conditions (Rajkumar and Kambar, 1999). These varieties posses deeper root system, close the stomata early under stress conditions and open quickly upon dewatering and more shoot to root ratio (Rajkumar and Kambar, 1999). Some of the drought tolerant varieties are Co 7219, Co 6907, 85 R 186, 83 R 23, CoA 7602, 83 A 30, CoT 8201, 97A85, 87A298, 83V15 and 2003V46 etc. The sugarcane variety 85 R 186 (Haritha) is highly tolerant to soil moisture stress and survive well with good number of tillers, even if we withhold moisture even up to 50 to 60 days also. But Co 8014 is highly susceptible to soil moisture stress which will show wilting symptoms in case of failure to give irrigation for even 15 days (Table 4).

Table 4: Influence of variety on moisture stress during formative phase in sugarcane.

Sugarcane variety	Plant height (cm)	No. of tillers (000/ha)	Number of Millable canes (000/ha)	Cane yield (t/ha)	Sheath moisture %	Sucrose (%)	CCS (t/ha)
DS* variety Co 8014	215.33	158.23	104.84	77.39	68.66	12.23	7.36
DT* variety Co 7219	245.00	178.18	130.66	112.27	73.75	13.64	10.83

DS* = Drought Sensitive; DT* = Drought Tolerant

Close planting: The objective of close planting or higher seed rate is to establish a higher stalk population to makeup the growth loss of individual stalks under moisture stress. Close planting has to be followed to get thick canopy of the crop by which evaporational losses can be minimized besides suppressing weed growth. Normal furrow spacing for sugarcane crop in Northern Telangana Zone of Andhra Pradesh is 90 cm. In areas where crop is likely to be subjected to moisture stress, a spacing of 60 to 70 cm with higher seed rate should be followed to get thick canopy and more plant population/unit area. Setts from mature crop with sound buds should be used as seed material to establish better crop stand.

Soaking setts in lime solution: Setts can be hardened by dipping in the saturated lime solution for 60 minutes (prepared by dissolving 8 kg klin lime in 400 litres of water). It enhances germination % and also gives ability to withstand moisture stress. Standing crop can also be hardened by withholding irrigation water for 30 days at 90 days planting by which crop suffers less when it is required to face actual moisture stress during summer months (Rajkumar and Kambar 1999) (Table 5).

Table 5: Effect of dipping setts in 10% lime solution before Sugarcane planting on cane yield.

Sr. No.	Name of the Technology	Cane yield (t/ha)	Sucrose (%)
1.	Control/Check	75.2	17.8
2.	Dipping setts in 10 % lime solution	81.2	17.5

(Mukunda Rao *et al*., 2018)

Fertilizer application: As a management practice for sugarcane under moisture stress, basal application of total phosphorus and half dose of potash followed by early nitrogen and half potash top dressing is desirable. This may be followed by another top dressing with the last irrigation before moisture stress period sets in summer. Potash application plays an important role in drought management of sugarcane. Potassium in plant system regulates stomatal opening and closing by which it governs the transpirational losses. During periods of prolonged drought the sugarcane crop can be sprayed with Urea + MOP each at the concentration of 2.5% (2.5 kg urea + 2.5 kg Kcl in 10 litres of water) at 15-20 days interval (Table 6).

Table 6: Effect of foliar spraying (Urea+Kcl) during stress period on cane yield and quality of sugarcane.

Sr. No.	Name of the Technology	Cane yield (t/ha)	Sucrose (%)
1.	Control/Check	76.1	17.69
2.	Foliar spray of 2.5 % urea + 2.5 % Kcl during stress period	88.4	18.52

Trash mulching: To conserve soil moisture it is necessary to cover the soil with cane trash. Trash mulching helps in preventing evaporational loss of water and thereby reducing soil moisture stress besides suppressing weed growth. Trash mulching creates a favourable environment for crop growth by which it improves germination per cent of the crop. Trash mulching (3 t/ha) recommended as a management practice for soil moisture stress (Table 4). Trash

mulching increased the cane yield by 26 to 40% in Maharashtra (Durai, 1997). Folidol/Chloripyriphos dust should be dusted on trash @ 25 kg/ha to prevent white ants damage. After cessation of rains, it is again necessary to conserve soil moisture by giving mulch with the older sugarcane leaves and other waste materials (Table 7).

Table 7: Effect of trash mulching on cane yield and quality of sugarcane (Co 8014) under moisture stress during formative phase.

Treatment	Cane yield (t/ha)	Sucrose (%)
No irrigation during formative phase (control)	90.23	17.14
Trash mulching 8 days after planting	99.07	18.25

Protective irrigation: If only sufficient water for one irrigation is available after planting, it should be accorded 30 days after planting and if water sufficient for two irrigation is available, it should be given 60 days after planting. Protective irrigations by means of alternate furrow or skip furrow irrigation can also be followed to sustain cane yield under limited irrigation source of drought prone areas.

Drip irrigation: Even though, drip irrigation involves more investment, it helps in saving of irrigation water under limited irrigation sources. It nearly saves 40% of irrigation water besides improving the cane yield upto 20% (Selvaraj *et al*., 1997).

Table 8: Effect of drip irrigation in sugarcane.

Treatment	No. of Millable canes (000'/ha)	Cane yield (t/ha)	Juice Sucrose (%)
Surface drip	91.71	126.88	18.09
Sub Surface drip	94.93	127.32	18.13
Furrow Irrigation	85.00	98.89	17.67

(Mukunda Rao *et al*., 2007)

In addition to above practices, reclamation of saline and alkali soils by powdered gypsum 3 to 8 t/ha by mixing with FYM, spraying of reflectant Kaolin at 6% wt/volume (Sundara, 1998), control of early shoot borer by spraying with Monocrotophos (1.6 ml/1 of water) can also be followed to reduce yield loss under moisture stress. Similar research finding were published by Veerabhadra Rao *et al*., (2015); Mukunda Rao *et al*., (2021).

CONCLUSION

It is highly necessary that immediately after cessation of drought period, sufficient irrigation and fertilizers, particularly nitrogen and potash should be applied to put forth rapid growth and make up the loss suffered because of moisture stress, at least, partially. Similar type of soil moisture stress/drought mitigating techniques was also observed in sugarcane by Solomon, (2015). By adopting the above illustrated drought management practices, the loss due to soil moisture stress/drought can be overcome by satisfactorily and yield can be enhanced to an extent of 10 to 15%.

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