International Journal of Plant & Soil Science

18(5): 1-4, 2017; Article no.IJPSS.34838
ISSN: 2320-7035

Study on Root Characteristics of Sugarcane (*Saccharum officinarum*) Genotypes for Moisture Stress

T. Venu Madhav[1*], G. S. Madhu Bindu[1], M. Vijay Kumar[1] and Chavan Syamraj Naik[1]

[1]College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author TVM carried out the experiment. Authors GSMB and MVK helped in analysis and reviews. Author CSN gave the guidance. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2017/34838
Editor(s):
(1) Enrique Luis Cointry Peix, Department of Plant Breeding, Rosario National University, Argentina.
(2) Hakan Sevik, Faculty of Engineering and Architecture, Kastamonu University, Turkey.
Reviewers:
(1) Ahmed Medhat Mohamed Al-Naggar, Cairo University, Egypt.
(2) Aruna Rai, Mumbai University, India.
(3) Ciro Maia, Federal University of Viçosa, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/20943

Original Research Article

Received 14th June 2017
Accepted 3rd September 2017
Published 12th September 2017

ABSTRACT

The size and distribution of root system of Sugarcane genotypes in response to moisture stress during formative stage at Agricultural Research Station, Basanthpur, Medak, Telanagana was found significant. Deeper root system as seen in the form of rope roots was observed only with the varieties, Co 95020, Co 87025 and Co 94012 indicating their ability to explore more soil space. The other root parameters viz., shoot to root ratio, root volume, root length and root dry weight were significantly high for Co 95020 and low for Co 8014 categorizing them as drought tolerant and drought susceptible varieties, respectively.

Keywords: Root system; sugarcane genotypes; moisture stress; formative stage.

**Corresponding author: E-mail: venutanangi3@gmail.com;*

1. INTRODUCTION

Roots comprise the lesser known part of the soil-plant atmosphere continuum and yet are essential to the supply of sufficient water and nutrients to ensure a successful crop. By understanding the growth and distribution of sugarcane roots, yields can be optimized through improved strategic decisions. Sugarcane is a deep rooted crop owing to its long growth cycle and longevity of the root system through multiple rotations compared to other crops. Root system reaches to a depth of 1.5 meters and even 6 meters [1,2]. The roots that emerge from the nodes after planting are sett roots and are relatively thin and much branched. They turn dark, decompose rapidly and degrade within eight weeks of planting. Primary shoot roots become visible one week after planting, growing slowly initially but increasing the rate of growth later. Baran et al. [3] and Kingston [4] showed that short irrigation intervals prevent the surface soil from drying, encourage a higher percentage of roots to develop near the soil surface. Selection for physiological traits [5,6] associated with drought tolerance might increase the success of breeding of sugarcane for drought tolerance. The ability of a plant to modify its roots to capture water for transpiration may be an important mechanism to avoid drought stress [7,8] Plants with high levels of drought avoidance should stabilize yield under drought [9,10] In sugarcane, drought tolerance is higher in cultivars with a tendency to develop deep root systems and found that root system properties (root length, volume of the roots and root-shoot ratio) may be used as selection criteria for drought tolerance and water use efficiency (WUE).

Sugarcane root system generally comprises of highly branched superficial roots, downward oriented buttress roots and deeply penetrating agglomerations of vertical roots known as rope roots [11]. However, activity of such functional root types in modern sugarcane varieties was least attempted. Hence an investigation on distribution of functional root types of different genotypes was done (on fresh weight basis) under normal growth conditions with imposed stress at formative stage.

2. MATERIALS AND METHODS

The poly bag experiment was carried out during *rabi,* 2013-14 at Agricultural Research Station, Basanthpur, Medak district of Telangana state situated at 17° 47' East longitude and 77° 32' North latitude. It comes under peninsular India situated at an altitude of 645 m above mean sea level. The experiment was laid out in randomized-block design with eight Sugarcane genotypes (Co 86032, Co 87025, Co 8014, 2003 V 46, 97 R 129, Co 94012, 97 R 401 and Co 95020) in three replications. Bud chip seedlings of the above varieties were planted in poly bags of size 2 x 2 feet and were grown under normal conditions but exposed to stress for 20 days by with-holding irrigation at formative stage-i.e., at 120 DAP. After relieving of stress the plants were removed from the bag and observed for root characteristics as affected by stress at formative stage. The root characteristics and the functional root types of different Sugarcane genotypes were measured by standard procedures and analysed statistically.

3. RESULTS AND DISCUSSION

3.1 Distribution of Functional Root Types

Genotypic variability was evident with respect to root characteristics as the data showed significant variations (Table 1). Exposure of different varieties to moisture stress had made them to express their inherent drought tolerant or susceptible characters with their root spread and existence of rope roots. All the varieties, except 97 R 401 exhibited more growth of superficial roots than buttress roots denoting lateral spread of active root zone under moisture sensitive conditions. The variety, 97 R 401 on the other side maintained more of buttress roots (61.21%) than superficial roots (36.62%) thus indicating its non-lodging character. However, rope roots were observed more in the varieties Co 87025, Co 94012 and Co 95020. The extent of rope root spread was significantly highest with Co 95020 alone (3.20%) indicating its ability to extract soil moisture from deeper soil layers through rope roots thus indicating its moisture stress tolerant nature.

3.2 Shoot-root Ratio

The shoot to root ratio of Sugarcane genotypes showed variation based on their varietal characters (Table 1). Significantly highest shoot root ratio (4.96) was noted in the variety Co 95020 which outperformed the other varieties. The higher root biomass of the variety Co 95020 was due to partitioning of more biomass towards root, at the expense of shoots especially under water limited condition at formative stage.

Table 1. Root characteristics of different sugarcane genotypes

S. no.	Variety	Superficial roots (%)	Buttress roots (%)	Rope roots (%)	Shoot-root ratio	Root length (mm)	Root volume (cc)	Root dry weight (gm)
1	Co 86032	63.47	36.56	0.00	3.67	84.42	138.2	223.1
2	Co 87025	55.59	43.69	1.23	3.98	74.18	145.2	269.2
3	Co 8014	54.66	45.96	0.00	2.27	55.47	92.6	68.4
4	2003 V 46	53.11	46.90	0.00	2.82	68.23	122.8	152.6
5	97 R 129	58.81	41.56	0.00	3.81	34.43	129.5	241.5
6	Co 94012	52.75	46.77	1.04	2.91	62.71	122.6	169.5
7	97 R 401	37.52	62.11	0.00	2.31	78.51	101.8	121.5
8	Co 95020	57.24	39.11	3.20	4.96	72.68	156.8	301.8
Mean		54.14	45.33	0.68	3.34	66.33	126.2	193.4
SEM		6.29	5.52	0.27	0.36	4.41	5.2	6.1
CD(0.05)		13.48	11.84	0.57	0.77	9.45	11.1	13.2

Further, the spread of functional root types was also maximum in this variety-indicating its ability to explore more soil space and supplying the plant with adequate nutrients to put up sufficient shoot and root biomass. This was supported by Mann J. J et al. [12], Venkataramana and Naidu [13] who observed a pronounced increase in shoot-root ratio of Sugarcane varieties as the stress became severe and the adaptation to drought would greatly depend on the balance between shoot and root development.

3.3 Root Length

Pronounced moisture stress at formative stage surely had impact on the root lengths of different Sugarcane genotypes. The genotypic variability ranged from 34.43 cm to 84.42 cm (Table 1). Among the sugarcane varieties, Co 95020 (84.42 cm) and Co 87025 (78.51 cm) recorded significantly highest root lengths compared to other varieties. Conversely, Co 8014 maintained lowest root length (38.75 cm) than the remaining varieties. These findings indicated that the moisture stress tolerance ability of Co 95020 and Co 87025 was due to their higher soil mining abilities. Deeper rooting reduces the vulnerability of the crops to the soil water deficit by providing increased capacity for uptake of soil moisture from deeper zones as demonstrated by Wood and Wood [2]. Evans [14] also reported that drought tolerance have a tendency to develop deep root system.

3.4 Root Volume

Root volume varied significantly among the Sugarcane clones from 92.6 to 156.8 c.c. Such genotypic variability was also reported in other field crops such as rice [15] and groundnut [16]. Among the sugarcane varieties tested, Co 95020 recorded highest root volume of 156.8 cc. This was followed by Co 87025 and Co 86032 which being on par and registered root volumes of 145.2 and 138.2 cc, respectively. The lowest root volume was observed in Co 8014 (92.6 c.c) and 97 R 401 (101.8 c.c).

3.5 Root Dry weight

The variety Co 95020, has noted a root dry weight of 301.8 g per clump which was superior to other varieties. This was followed by Co 87025 and 97 R 129 with root dry weights of 269.2 and 241.5 respectively. On the other hand, significantly lowest root dry weight (68.4 g per clump) was observed in Co 8014-indicating its poor rooting ability, root spread and soil mining characters, Hence it is more susceptible to moisture stress.

4. CONCLUSION

Based on all the parameters, it can be concluded that sugarcane genotypes viz., Co 95020 and Co 87025 could be categorized as drought tolerant while the genotype Co 8014 could be referred to as drought susceptible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ball-Codho, Sampaio, Tiessen H, Stewart JWB. Root dynamics in plant and ratoon crops of sugarcane. Plant & Soil. 1992;142: 297-305.
2. Evans H. The root system of sugarcane. II some typical root systems. Empire. J. Exp. Agric. 1936;4:208-221.

3. Baran R, Basserean D, Gillet N. Measurement of available water and root development on an irrigated sugarcane crop in the Ivory Coast. Proc. Int. Soc. Sugarcane Technol. 1974;15:726-735.
4. Kingston G. The influence of accessibility on moisture extraction by sugarcane. In: Proceedings of the XVI Congress of the International Society of Sugar Cane Technologists, Sao Paulo, Brazil. 1977;1239-1250.
5. Grover M, Madhubala R, Ali SZ, Yadav SK, Venkateswarlu B. Influence of *Bacillus* spp. strains on seedling growth and physiological parameters of sorghum under moisture stress conditions. Journal of Basic Microbiology. 2014;54(9):951-961.
6. Zang U, Goisser M, Häberle KH, Matyssek R, Matzner E, Borken W. Effects of drought stress on photosynthesis, rhizosphere respiration, and fine-root characteristics of beech saplings: A rhizotron field study. Journal of Plant Nutrition and Soil Science. 2014;177(2):168-177.
7. Fukai S, Cooper M. Development of drought-resistant cultivars using physio-morphological traits in rice. Field Crop Research. 1995;40:67-86.
8. Songsri P, Jogloy S, Holbrook CC, Kesmala T, Vorasoot N, Akkasaeng C, Patanothai A. Association of root, specific leaf area and SPAD chlorophyll meter reading to water use efficiency of peanut under different available soil water. Agric Water Manage. 2009;96:790-798.
9. Pinto RS, Reynolds MP. Common genetic basis for canopy temperature depression under heat and drought stress associated with optimized root distribution in bread wheat. Theoretical and Applied Genetics. 2015;128(4):575-585.
10. Serraj R, Krishnamurthy L, Kashiwagi J, Kumar J, Chandra S, Crouch JH. Variation in root traits of chickpea (*Cicer arietinum* L) grown under terminal drought. Field Crop Res. 2004;88:115-127.
11. Evans H. Investigation on the root system of sugarcane varieties. Sugarcane Res. Stational Mauritius, Bull. No. 6. 1935;44.
12. Mann JJ, Barney JN, Kyser GB, Di Tomaso JM. *Miscanthus*× *giganteus* and *Arundo donax* shoot and rhizome tolerance of extreme moisture stress. GCB Bioenergy. 2013;5(6):693-700.
13. Venkataramana S, Naidu KM. Root growth during formative phase in irrigated and water stressed sugarcane and its relationship with shoot development and yield. Indian Journal of Plant Physiology. 1989;32:43-50.
14. Wood GH, Wood RA. The estimation of cane root development and distribution using radio phosphorus. Proc. S. Afr. Sug. Technol. Ass. 1967;41:160-168.
15. Pranusha P. Evaluation of pre-release groundnut (*Arachis hypogaea* L.) genotypes for high water use efficiency, temperature tolerance and root mining traits. M.Sc. (Ag) Thesis Submitted to Acharya N. G. Ranga Agricultural University; 2011.
16. Zumo-Altoveros C, Loresto GC, Obein M, Cnag TT. Differences in root volume of selected upland and low land rice varieties. International Rice Research Newsletter. 1990;15(2):8.

© 2017 Venu et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20943