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Research Article

STUDY OF GENETIC DIVERSITY IN HIGH BIOMASS SORGHUM IN MARGINAL LANDS AS LIGNOCELLULOSIC FEED STOCK FOR BIOETHONOL PRODUCTION

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Abstract- Forty genotypes of high-biomass sorghum lines identified in the US-Indo Consortium for Development of Sustainable Advanced Lignocellulogic Biofuel Systems (JCERDC) project on characterizing high-biomass sorghum were evaluated at four locations in marginal lands of Madhya Pradesh to know the nature and magnitude of genetic diversity for biomass yield. The genotypes were grouped into four clusters. The cluster II and III were the largest cluster with fifteen genotypes each. Cluster I was represented by genotype IS16529 showing mean biomass yield of 44.3 t/ha over four locations with highest yield of 61.1t/ha at Dewas location. Cluster II was represented by genotype IS23101 showing mean biomass yield of 43.4t/ha with highest yield of 63.3 t/ha at Gwalior location. Cluster III was represented by genotype CMS x S630 showing mean biomass yield of 25.0 t/ha with highest biomass yield of 40.0 t/ha at Gwalior location. Cluster IV was represented by genotype GIRD39 showing mean biomass yield of 35.9 t/ha with highest yield of 44.6 t/ha at Gwalior location. Study found that considerable genetic diversity exist in the study material. Whereas Gwalior was the ideal location for all the genotypes as all three high yielder i.e. IS23101, CMS X S630 and GIRD39 in cluster I, II and III respectively were out yielded at Gwalior location.

Keywords- Sorghum, High-biomass, Biofuel, Bioethonol, Genetic diversity

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Introduction

Sorghum (*Sorghum bicolor*) is a C4 crop and is characterized by its high photosynthetic efficiency and is one of the fodder crops which is capable of yielding high levels of biomass with minimum inputs and presence of considerable genetic diversity reported earlier. Sorghum has tolerance to drought and salinity stress a capacity to grow in marginal land areas and is gaining increased research interest as an annual bio-energy crop [1]. Sorghum requires less fertilizer than corn to achieve high yield. In the absence of adequate water sorghums become dormant but do not wilt and can utilize phosphorus and potassium more efficiently compared to corn. These characteristics make sorghum suitable for cultivation in less favorable environmental conditions and marginal lands. Due to its wider adaptability sorghum can be a economically viable crop for biofule industry.

In search of efficient energy crops for conversion of biomass feed stock to energy lead for the consideration of crops like sorghum. Sorghum received attention as feed stocks for the bio-ethanol production also. The highest lignocellulose yield potential in sorghum exists in forage sorghums. Some sweet sorghum varieties have also been reported that produce similar yields to sugarcane [2].Sweet sorghum is 2nd generation bio-energy crop which can produce both grain and biofuel and could be a promising biofuel feedstock for ethanol production in India [2]. Sweet sorghum can be grown under moderate water stress conditions, on marginal lands with little or no external inputs [3]. It is an ideal crop, which can be grown in sugarcane growing areas to supplement molasses for ethanol production and also to use the existing sugarcane machinery in the off season [4]. Sweet sorghum has such high levels of sugar in the stems, fresh or dry stem may be fermented directly. Yu et al. [5] showed that this process yields 7.9 g of ethanol per 100 g of fresh stalks. Reddy et al.[6] reported the ethanol yields as 760 litres /ha from the grain, 1,400 litres/ha from the stalk juice and 1000 litres/ha from the residues. The crushed stalks of sweet sorghum contain similar levels of cellulose as sugarcane bagasse, which makes it as a suitable raw material for lignocellulosic biofuel. The diversion of cropland for cultivation of bio-ethanol crops does not arise with sweet sorghum as it meets food, fuel and fodder requirement.

Previous studies have indicated the significance of genotype × environment (G × E) interaction for biomass and related traits. Since the targeted project area is highly diverse in terms of agro-ecological conditions and the abiotic stresses (drought, salinity and low fertility), the same location may encounter more than one stress. Hence multi-seasonal MLTs were conducted to identify lines with >30 t/ha of dry biomass at 4 locations in Madhya Pradesh that are frequently prone to one or more of the above mentioned stresses.

Material and methods

Forty genotypes of high-biomass sorghum lines identified in the US-Indo Consortium for Development of Sustainable Advanced Lignocellulogic Biofuel Systems (JCERDC) project on characterizing high-biomass sorghums funded by Ministry of New and Renewable Energy (MNRE), Govt. of India were tested for biomass yield production in marginal lands in four environments each environment represented one location (Gwalior, Bhind, Dewas and Khargone) at Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, India, during *kharif* 2013.

Each genotype was grown in a 3 row plot of 4 m long with row to row 45cm and plant to plant 5 cm spacing. Cluster analysis was carried out to determine Euclidean distance based on paired group method to determine dissimilar groups of the genotypes. Two-dimensional principal component analysis (PCA) graph was constructed using PAST-multivariate software.

Results and Discussion

The analysis of variance for the experimental design showed highly significant differences among genotypes for fresh biomass yield t/ha [Table-1].

Table-1 *Combined ANOVA for fresh biomass yield t/ha in sorghum genotypes*

Source	DF	SS	MS	F	% of Total SS
Environment	3	14017.55	4672.51	43.28	52.0%
Genotype	39	6314.67	161.91	1.50	23.4%
G x E	117	6649.27	56.83		24.6%
Heterogenity	39	2157.33	55.31		32.4% (GSS)
Deviation	78	4491.93	57.58		67.6% (GSS)
Error	117	12629.35	107.94		
Total	159	26981.50			

Cluster analysis of fresh biomass t/ha grouped the genotypes into four main groups [Fig-1]. Cluster I and cluster III had 5 genotypes each while cluster II and IV had 15 genotypes each. The average cluster means for fresh biomass yield over locations revealed that genotypes included Cluster I consisted of genotypes with biomass yield of 41.71t/ha. (44.3-39.5 t/ha) on average. Group II averaged 36.31t/ha. (43.4 -31.5 t/ha).While genotypes in Cluster III characterized with lowest fresh biomass yield average of 21.6 t/ha.(25.0-16.6 t/ha.). Group IV averaged biomass yield of 31.5 t/ha (35.9 -27.9 t/ha.).This suggested the presence of high degree of divergence among genotypes.

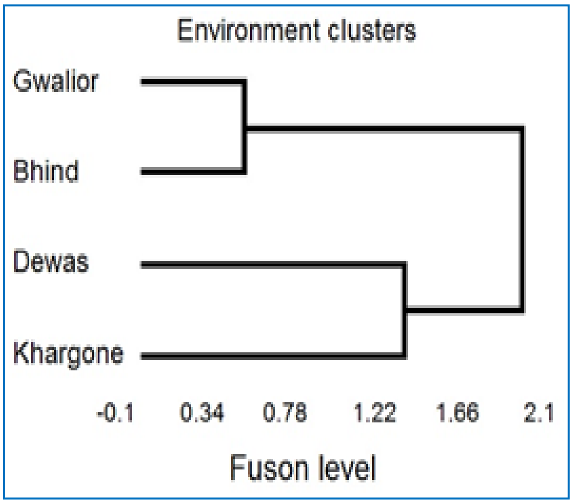

Fig-1 Cluster Dendogram for Environment

Cluster I was represented by genotype IS16529 showing mean biomass yield of 44.3t/ha over four locations with highest yield of 61.1t/ha at Dewas location. Cluster II was represented by genotype IS23101 showing mean biomass yield of 43.4t/ha with highest yield of 63.3 t/ha at Gwalior location. Cluster III was represented by genotype CMS x S630 showing mean biomass yield of 25.0 t/ha with highest yield of 40.0 t/ha at Gwalior location. Cluster IV was represented by genotype GIRD39 showing mean biomass yield of 35.9 t/ha over locations with highest yield of 44.6 t/ha at Gwalior location. The average cluster means for 4 clusters revealed that genotypes included in cluster I were good performer over locations. Whereas Gwalior was the ideal location for all the genotypes as all three high yielder i.e. IS23101, CMS X S630 and GIRD 39 in cluster I, II and III respectively were out yielded at Gwalior location. Genotype CSH22 SS reported as the highest biomass yielder giving 68.8 t/ha. over all four locations can also be ideal selection.

Table-2 Distribution of 40 genotypes into different clusters

S. No	Cluster No.	No. of genotypes	Name of genotype
1	I	5	IS22686,IS16611,IS 22879, IS16529,IS 27246
2	II	15	MP 2, Gwalior 2, CSH24MF, CSH 13, SSV 74, IS15957, SPSSV30, CSV 24SS, IS23101, IS 8813, ICSSH28, CSH 22SS, IS25234, IS26204, GIRD 12
3	III	5	IS6750, CMSXS630, CHOHATIA,IS 23120, IS25186
4	IV	15	IS13554, IS 13762, IS 17349, MP 1, ICSV 93046, Sel B Pop, GIRD 8, IS 13526, IS16529, IS 22670, IS21983, IS13540, 25234, GIRD 39

Conclusion

It can be concluded from present study that considerable genetic variability was exist in the present material. Based on phenotypic performance of biomass yield factors indicates that genotypes IS23101, CMS X S630 and GIRD39 having diverse genetic base for biomass feed stock yield were promising for utilization in marginal soils of Gwalior.

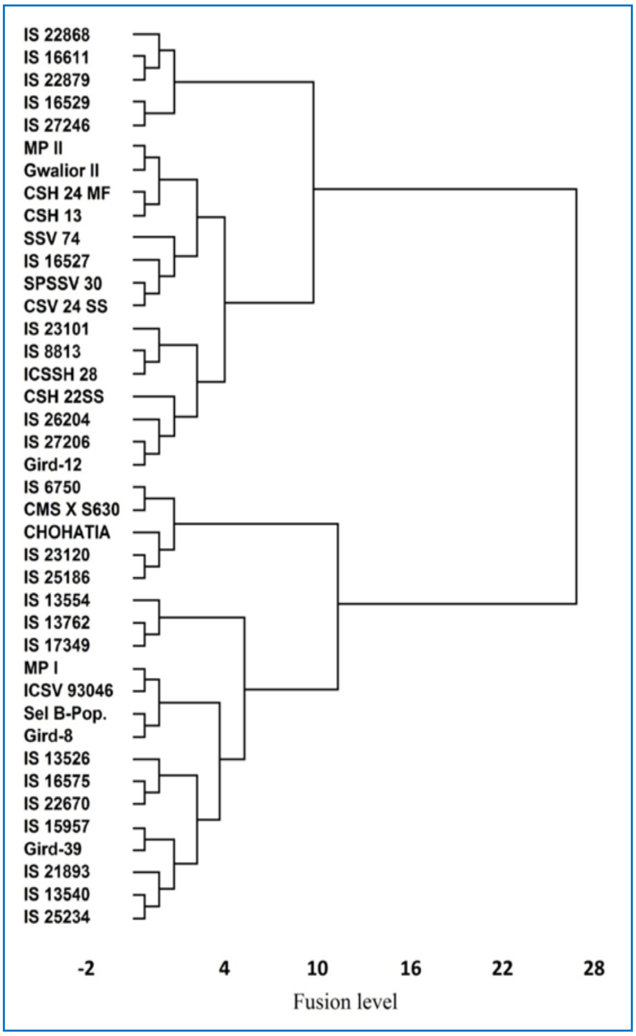

Fig- 2 Dendogram showing diversity in genotypes of sorghum tested in marginal land

Author Contributions: None declared

Abbreviations: None declared

Conflict of Interest: None declared

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Conflict of Interest: None declared

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