International Journal of Agricultural Sciences
Volume 13 | Issue 2 | June, 2017 | 311-314 ■ e ISSN-0976-5670
DOI:10.15740/HAS/IJAS/13.2/311-314
Visit us : *www.researchjournal.co.in*

RESEARCH PAPER

Characterization of finger millet (*Eleusine coracana* L.) recombinant inbred lines for total biomass

S. MOHAN KUMAR*, S.J. PRASHANTH[1], H.R. MANU KUMAR[2], SHAILAJA HITTALAMANI[3] AND M. UDAYA KUMAR[3]
Department of Biotechnology and Crop Improvement, College of Horticulture (U.H.S.Campus), G.K.V.K., BENGALURU (KARNATAKA) INDIA

Abstract : Crop productivity is very much dependent on the biomass and its partition to economic parts in the plant system. In the present study, 150 recombinant lines were characterized for variability in total biomass. The mapping population was classified on the basis of biomass as low and high biomass types. Except SLA, other biometric traits varied significantly. Assessment of contribution of physiological traits other than the canopy cover that determine the variability in biomass is best done when genotypes with similar leaf area but differing in biomass are compared. All the traits varied significantly between low and high biomass types. To know the interrelationship among traits that contribute to the total biomass of the plant was also ascertained through correlation studies. A positive correlation was observed between various root, shoot associated traits and the total biomass but root to shoot ratio showed a negative relationship with biomass. Apart from root and shoot dry weight, a strong positive correlation was observed between the leaf area and the biomass suggesting that the photosynthetic surface area contributes significantly to the biomass production.

Key Words : Biomass, Finger millet, Mapping population

View Point Article : Kumar, S. Mohan, Prashanth, S.J., Kumar, H. R. Manu, Hittalamani, Shailaja and Kumar, M.Udaya (2017). Characterization of finger millet (*Eleusine coracana* L.) recombinant inbred lines for total biomass. *Internat. J. agric. Sci.*, **13** (2) : 311-314, **DOI:10.15740/HAS/IJAS/13.2/311-314.**

Article History : Received : 01.03.2017; **Revised :** 23.04.2017; **Accepted :** 07.05.2017

INTRODUCTION

Finger millet, [*Eleusine coracana* (L.) Gaertn.] Subsp. *coracana*, is an important cereal predominantly grown in India and East Africa. Finger millet is grown mainly by subsistence farmers and serves as a food security crop because of its high-nutritional value and excellent storage qualities. Under irrigated conditions in field trials, yields upto 5–6 metric tonnes/ha have been obtained (National Research Council, 1996). However, yields in farmers' fields, usually sown with unimproved varieties, are commonly between 1,000 and 2,000 kg/ha.

Finger millet is an important crop grown predominantly under rainfed conditions where drought stress is the major constraint for productivity. Though finger millet is a drought tolerant C_4 species, with

*** Author for correspondence:**
[1]College of Horticulture (U.H.S.Campus), G.K.V.K., BENGALURU (KARNATAKA) INDIA
[2]College of Horticulture, Sirsi, UTTARA KANNADA (KARNATAKA) INDIA
[3]University of Agricultural Sciences, BENGALURU (KARNATAKA) INDIA

increased biomass associated with increased productivity. Identification of genotypes which can accumulate more biomass in turn enhancing crop productivity for which characterizing the lines for variability for biomass accumulation is important hence with this background present study was conducted in a set of 150 recombinant inbred lines of finger millet.

MATERIAL AND METHODS

During *Kharif* 2005, instead of normal direct sowing, transplanting was taken up for which individual recombinant inbred line along with parents was sown in individual pots. RILs were grown upto 25 days in the pots after 25 days of sowing the seedlings were transplanted in the specialized root structures with a dimension of 10 x 60 sq. ft. in three replications and the individual lines were replicated in a row in each structure. Plant nutrition was taken care by providing N: P: K (50:40:25 kg/ha recommended dose) in two split doses. The transplanted RILs were evaluated for total biomass.

Total biomass (BM) :

Entire plants including roots were harvested and oven dried at 70°C for three to five days. The total biomass accumulated was calculated expressed as gram per plant.

Statistical analysis :

The data obtained from experiments were analyzed using statistical software packages like MSTATC and MS EXCEL, etc. The genotypic variability of physiological traits were assessed using analysis of variance as per Fisher's method. The level of significance was tested at 0.05 and 0.01 probability level in 'F' test. The genotypic means were compared with the critical difference values. This analysis was performed using MSTATC.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physiological traits that explain the observed variations in total biomass (TBM):

The total biomass is the sum of the root and shoot dry matter produced by a plant. Further, the biomass produced by a plant is known to be influenced by genetic makeup of the plant, its physiological behaviour as well as the external influences like environmental factors. Several generic models have been proposed to explain the observed variations in BM. Among these Duncan's model and Pasioura's model are widely accepted. As per the Duncan's model BM is the function of LA and NAR, while Passioura suggested that BM is dependent on the variations in WUE and Transpiration (Root traits). Hence, examining the variations in these traits and assessing the influence on BM is crucial in crop improvement efforts. To decipher the influence of these important physiological traits, the recombinant inbred lines were classified based on different approaches.

Classification of recombinant inbred lines based on total biomass (BM) :

Of the 150 RILs examined in the investigation, 20 genotypes each representing extreme values of BM were identified. The biomass of the high total dry matter category was 3 fold higher than the low total dry matter

Table 1 : Differences in various physiological traits among the low and high biomass groups of RILs

Trait	Low BM (g pl^{-1})	High BM (g pl^{-1})	% increase in high BM types
Root weight (g pl^{-1})	7.80	14.00	79.40
Shoot weight (g pl^{-1})	59.80	144.00	140.80
Total leaf area (cm^2 pl^{-1})	3553.00	5521.00	55.30
Total biomass (g pl^{-1})	67.70	158.10	133.50
Specific leaf area ($cm^2 g^{-1}$)	201.80	202.90	0.70
$\Delta^{13}C$ (%)	5.39	5.45	1.10
Root volume (cm^3)	16.10	26.00	61.40
Leaf weight (g pl^{-1})	17.60	27.20	54.50

From the mapping population 20 RILs representing extreme values were identified and classified as low and high biomass types among them different physiological traits have been analysed category. The mean BM of low BM types was 67.7 g plant^{-1}, while it was 158.1 g plant^{-1} for high BM types (Table 1). Similarly leaf weight, leaf area, root weight, root volume and shoot weight were significantly higher in the high BM category to ascertain the influence of several parameters on BM, correlation co-efficient for the relationship between BM and these traits were determined separately for the genotypes coming under high and low BM types (Table 2). In both high and low BM genotypes shoot weight root weight and leaf area, showed significant positive relationship with BM.

Classification of recombinant inbred lines based on total biomass (BM) with similar leaf area :

Assessment of contribution of physiological traits other than the canopy cover that determine the variability in BM is best done when genotypes with similar leaf area but differing in BM are compared. The genotypes that had a mean leaf area of around 4800 cm^2 pl^{-1} were selected in both low and high BM groups. The two groups despite little differences in leaf area, differed significantly for BM (Table 3). The high biomass groups had 134.65 g plant^{-1} of BM, while it was 82.88 g plant^{-1} in low biomass group, representing a 62 per cent difference. Traits such as root weight, root volume, shoot weight and leaf weight were found significantly higher in high BM types than low BM types which contributed to differences in BM.

Characterization of mapping population :

Although significant success was achieved in breeding for yield improvement, most of those efforts were based on selection for yield *per se*. This approach, however, is encountering increasing difficulties in achieving further improvement. A narrow variability in yield among the already improved cultivars, a large G x E interaction for yield have often been quoted as the reasons for slow progress in breeding for yield (Araus *et al.*, 2002 and Richards *et al.*, 2002). To achieve further breakthrough in productivity, it is opined that the constituent physiological or morphological traits need to be improved. So the challenge of drought breeding can be addressed through "Trait based breeding approaches".

The total biomass is the sum of the root and shoot dry matter produced by a plant. Further, the biomass produced by a plant is known to be influenced by genetic makeup of the plant, its physiological behaviour as well as the external influences like environmental factors. Hence, examining the variations in these traits and assessing the influence on biomass is crucial in crop improvement efforts. Hence, mapping population was classified on the basis of biomass as low and high biomass types (Table 1). Except SLA, other biometric traits varied significantly.

Assessment of contribution of physiological traits other than the canopy cover that determine the variability in biomass is best done when genotypes with similar leaf area but differing in biomass are compared. All the traits varied significantly between low and high biomass types (Table 3).

Table 2 : Correlation values for various physiological traits among the low and high biomass groups of RILs

Traits	Low BM types (r values)	High BM types (r values)
Shoot wt Vs BM	0.952	0.923
Root wt Vs BM	0.342	0.171
Leaf area Vs BM	0.281	0.434

From the mapping population 20 RILs representing extreme values were identified and classified as low and high biomass types among them different physiological traits have been correlated with biomass

Table 3: Differences in various physiological traits between the two groups of recombinant inbred lines of finger millet with similar leaf area but differing in biomass

Trait	Low BM (g pl^{-1})	High BM (g pl^{-1})	% Increase in high BM types
Root weight (g pl^{-1})	9.48	12.99	37.02
Stem weight (g pl^{-1})	52.60	96.12	82.37
Total leaf area (cm^2 pl^{-1})	4803	4935	2.70
Total biomass (g pl^{-1})	82.88	134.65	62.46
Root volume (cm^3)	17.10	27.30	59.60
Leaf weight (g pl^{-1})	20.80	25.54	22.78

From the mapping population 20 RILs representing extreme values were identified and classified as low and high biomass types which are having similar leaf area, among them different physiological traits have been analysed

Relationship between biometric traits in the mapping population of finger millet :

Being quantitative in nature, the physiological and biometric traits recorded in the mapping population are influenced not only by the environmental factors but also the plant's genetic constitution. Hence, it is important to know the interrelationship among these traits that contribute to the total biomass of the plant when breeding programme targets yield improvement. As expected, a positive correlation was observed between various root, shoot associated traits and the total biomass but root to shoot ratio showed a negative relationship with biomass (Table 4). Apart from root and shoot dry weight, a strong positive correlation was observed between the leaf area and the biomass (Fig.1) suggesting that the photosynthetic surface area contributes significantly to the biomass production. However, an inverse relationship was observed between root to shoot ratio and the biomass suggesting that plant allocate carbon reserve to root at the cost of shoot growth (Fig. 2).

Table 4: Correlation co-efficients of different root and shoot traits with total biomass in the recombinant inbred lines of finger millet

Traits	r values
Root volume Vs BM	0.274
Root length Vs BM	0.177
Root dry weight Vs BM	0.542
R/S Vs BM	-0.228
Tiller number Vs BM	0.314
Shoot dry weight Vs BM	0.960
Leaf Area Vs BM	0.443
Leaf weight Vs BM	0.512

Physiological traits recorded in the mapping population are influenced not only by the environmental factors but also the plant's genetic constitution. Hence, the interrelationship among these traits that contribute to the total biomass of the plant has been ascertained through correlation analysis

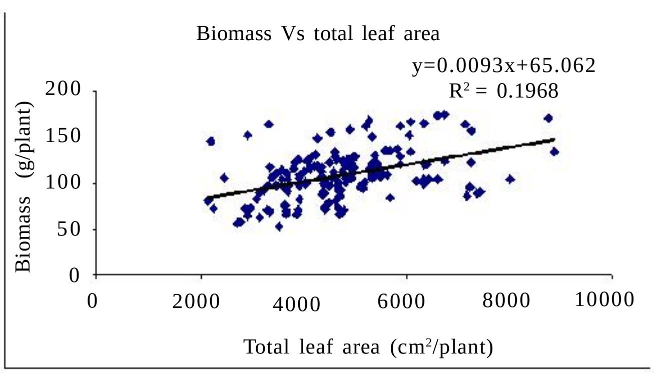

Fig. 1 : Relationship between leaf area (dm^2 $plant^{-1}$) and Biomass (g $plant^{-1}$) among RILs of finger millet

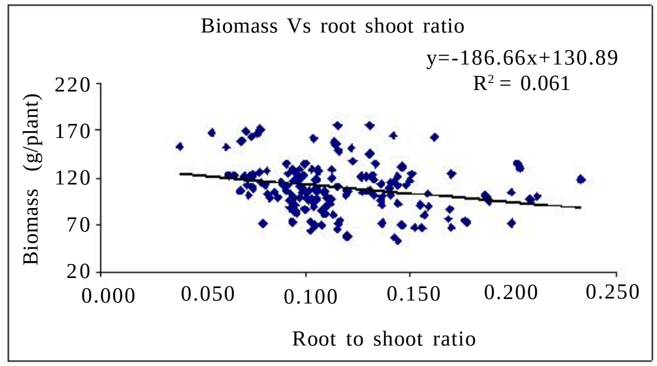

Fig. 2 : Relationship between biomass (g $plant^{-1}$) and root to shoot ratio among RILs of finger millet

Many root and shoot traits were positively correlated with biomass (Table 4) indicating their contribution to the total biomass. But inverse relationship observed between biomass and root to shoot ratio (Fig. 2) suggests that plant allocates carbon reserve to root at the cost of shoot growth. In a nutshell, it can be inferred that for further investigation in this mapping population it would be better if the selection is made for biomass and root traits.

It is very much clear from this study that for assessing total biomass production, the knowledge on different traits which are contributing for the total biomass is important and their relationship with biomass is also crucial. Further selecting for good biomass types with better partitioning efficiency will be helpful in crop improvement programmes.

REFERENCES

Araus, J. L., Slafer, G. A., Reynolds, M. P. and Royo, C. (2002). Plant breeding and drought in C_3 cereals: What should We Breed For? *Ann. Bot.*, **89** : 925 – 940.

National Research Council (1996). *Lost crops of Africa*; Volume I Grains. National Academy Press, Washington, D.C., U.S.A.

Passioura, J. B. (1982). The role of root system characteristics in the drought resistance for crop plants. In: Drought resistance in cereals crops with emphasis on rice, *IRRI*, Los Bonos, Philippines, 71-82.

Richards, R.A., Rebetzke, G.J., Condon, A.G. and Van Herwaarden, A.F. (2002). Breeding opportunities for increasing the efficiency of water use and crop yield in temperate cereals. *Crop Sci.*, **42**:111-121.