Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 565-568

Ramesh M
Department of Biotechnology, Institute of Agri-Biotechnology, University of Agricultural Sciences, Dharwad, Karnataka, India

IS Katageri
Department of Biotechnology, Institute of Agri-Biotechnology, University of Agricultural Sciences, Dharwad, Karnataka, India

Suresh Handi
Department of Genetics and plant breeding, University of Agricultural Sciences, Dharwad, Karnataka, India

Nagaraju CH
Department of Genetics and plant breeding, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
IS Katageri
Department of Biotechnology, Institute of Agri-Biotechnology, University of Agricultural Sciences, Dharwad, Karnataka, India

Assessment of genetic variability for root traits in recombinant inbred lines of tetraploid cotton (*Gossypium* Spp.)

Ramesh M, IS Katageri, Suresh Handi and Nagaraju CH

Abstract
Dharwad Hirsutum Barbadense Recombinant Inbred Lines (DHBR lines) derived from cross between *G.hirsutum* var.DS-28 and *G. barbadense* var.SBYF-425 were under evaluation for seed cotton yield (kg/ha), yield contributing and fiber quality traits under assured rain fed condition at Agriculture Research Station, Dharwad during 2012-13 in the process of QTL mapping. But this testing year became adverse as it received 33.35% (549 mm) less rainfall as against 823.78 mm of last twenty one years. Therefore, we recorded observations on root traits related to moisture stress tolerance. Presence of significant difference between DHBR lines for root traits indicates the presence of variability for these traits under moisture stress conditions. Moderate to high heritability observed for root traits. As genotypes with longer primary roots are expected to be moisture stress tolerant, six genotypes *viz.*, DHBR- 170 (31.0 cm), 87 (28.50 cm), 96 (28.50 cm), 44, 111 (28.0 cm) and 145 (28.0 cm) recorded significantly higher primary root lengths than superior check; MCU-5 and SBYF-425 (21.95 cm). Only one genotype DHBR-116 recorded significantly higher secondary root length (25.50 cm) than superior check, DS-28 (19.96 cm).

Keywords: Cotton, Recombinant Inbred Lines, Roots, Variability, Moisture Stress

Introduction

Water stress acts as a serious factor in agricultural production by preventing a crop from reaching the genetically determined and theoretical maximum yield. The monsoon should be considered to be the backbone of Indian agriculture. Despite the expansion in alternative forms of irrigation, agricultural dependency on monsoon is indispensable even today. Although increasing resilience of agricultural growth to monsoon deficiency is seen recently, its significance still continues with the fact that 55-60 percent of the net sown area in India is rain fed. Cotton (*Gossypium hirsutum* L.) is an important agricultural commodity. It is grown in a wide range of ecosystems under varying temperatures and water regimes. A number of morphological, physiological and phenological traits have been reported to improve the performance of cotton challenged by water stress. The adverse effects of water stress on the cotton plant have been reported by various researchers. Ball *et al.* [6] reported that root growth of 55 days old seedlings of cotton reduced after withholding water, but Pace *et al.* [13] observed that stressed plants had greater tap root length than control in cotton. This suggested that increase in tap root at the expense of root thickening may be a common response of cotton plant and permits to survive under stress by accessing water from deeper in the soil profile. Dewi [7] studied in the two cotton cultivars under water stress, TAM 94L-25 showed averaged tap root fresh and dry weight, higher lateral root fresh weight and shoot fresh weight and DPL 50 exhibited greater weight of lateral roots and shoot fresh weight. Quisenberry *et al.* [14] found significant genetic variation in shoot and root growth in cotton. From these studies, it seems that root morphology and root growth appeared to be an important plant character for the adaptation of cotton to conditions, where water availability is a major constraint to growth.

For successful breeding of cotton cultivars tolerant to drought through conventional approach, availability of diverse genetic material is essential to breeders. Firstly, there must be significant variability in genotypic responses to water stress and secondly, this variation must be genetically controlled. Thus, an understanding of the knowledge of these two components of the breeding material under consideration is necessary [12].

Although the evaluation plan of the DHBR lines (Dharwad Hirsutum Barbadense Recombinant Inbred Lines) was for seed cotton yield, yield contributing traits and fiber traits under assured rain fed conditions, because of prevalence very low rainfall situation during this testing season (2012-13), tempted us to record the observations for the traits related to moisture stress tolerance.

Therefore, in this research paper we discussed on presence of genetic variability for various traits related to moisture stress tolerance.

Material and methods

Experimental populations: 200 F_9 generation, Dharwad Hirsutum Barbadense Recombinant Inbred (DHBR) Lines derived from a cross between *G.hirsutum* var. DS-28 and *G.barbadense* var. SBYF-425 were sown along with parents and check *viz* Sahana, MCU-5 at Agriculture Research Station, Dharwad farm, UAS, Dharwad (India) during the year 2012-13 in an augmented design by planting in spacing of 90 cm between rows and 20 cm between plants. NPK fertilizer at the rate of 75:75:75 kg/ha was given as basal dose at the time of sowing and 75 kg/ha of nitrogen was applied as a top dressing after 30 days of sowing. Both sucking pests and boll worm were effectively controlled by six different insecticidal sprays (for sucking pests – Polo 0.5ml/L, Regent 1ml/L and Ulla 0.3g/L; for boll worms control- Curacron 2ml/L, Avant 0.5ml/L and Tracer 0.1ml/L). Weeds were controlled by inter cultivation and hand weeding. During 2012-13, annual rainfall (549 mm) was drastically decreased by 33.35 % of the last twenty one years of average (823.78 mm) at Agriculture Research Station, Dharwad farm, UAS, Dharwad (India).

Observation recorded: During cropping season, there was a 75-80 days gap of receiving rainfall after sowing. Under such condition, plants were almost showing severe drought symptoms. On 80th days there was occurrence of heavy rainfall (36.8 mm**)** in a day. So, five plants were randomly pulled from the each genotype by taking precautions for minimum damage to roots. Roots were cleaned to remove soil. Using sharp scalpel, roots were separated and fresh weight was recorded. Primary root length (PRL) was measured from the end of epicotyl portion to root tip and expressed in centimeters. Length of secondary roots (SRL) was measured from surface of the main root (from where secondary root starts) to tip of the secondary root and expressed in centimeter. The mean of primary root length and secondary root length were used to determine the total root length (TRL). Number of secondary roots (SR) present on main tap root was counted from epicotyl portion to tip of the main root. The roots were kept in hot air oven at 60-80 ^{0}C for 72 hours before recording dry weight. Seed cotton yield (SCY) from each recombinant inbred lines was harvested and calculated to derive kilogram per hectare (kg/ha). Data was subjected to analysis of variance using Windostat version 9.2 software.

Results and discussion

There was significant difference among 200 DHBR lines for all root traits under study indicating differential responses of these lines to the water stress as F test was significant. Mean, range and variability parameters including heritability (h^2) and genetic advance as per cent mean are presented in Table.1. The wider range was recorded for all traits viz, primary root length (range of 10.50 to 31.00 cm with mean of 20.39), secondary root length (range of 3.50 to 25.50 cm with mean of 13.04), total root length (range of 9.00 to 25.00 cm with mean of 16.71), number of secondary roots (range of 6.50 to 34.00 with mean of 16.76) and seed cotton yield (range of 63.49 kg/ha to 1052.90 kg/ha with mean of 450.38 kg/ha). Highest PCV and GCV was recorded for primary root length (16.03 % and 10.74 %) followed secondary root length (31.54 % and 26.15 %), number of secondary roots per plant (30.45 % and 28.10 %) and total root length (17.40 % and 14.49 %) respectively. Presence of moderate to higher heritability is desirable in genetic improvement of these root traits in enhancing moisture stress tolerance. Presence of moderate to high heritability was observed. Khalid *et al.* [9] reported of high genetic variability and heritability for root length traits in cotton germplasm. Ana *et al*. [4] reported in *Cucumus melo* L. for root traits showed moderate to high heritability. Highest heritability was observed for number of secondary roots per plant (0.85) followed total root length (0.69) and primary root length (0.44). Presence of moderate to high heritability indicates that these traits can be improved through pedigree selection. High genetic advance as per cent mean for these traits viz, secondary roots per plant (53.43 %) followed by secondary root length (44.67 %) and total root length (24.85 %) supports this and thus indicated that traits were less affected by the environment. High genetic advance predicts that a character is governed by additive genes and that genetic variance is fixable and selection would improve character. Abbas *et al*., [1]. Nour [10] grew sorghum plants in pots filled with washed sand for 3 weeks, after which wet root weight, root lengths, volume, and root shoot ratios were measured. The relatively more drought-resistant cultivars had the greatest values for all the four variables. Khalid *et al.* [9] have studied shoot and root traits under normal and water stress conditions, and they concluded that the existence of variability in cotton germplasm suggests that genetic improvement can be achieved through selection and breeding provided that the variability is affected by genetic components. Root mass under drought conditions is important in breeding for drought resistance (Hurd and Spratt, [8]. Quisenberg *et al*. [14] have reported significant variability in tap root length and a number of lateral roots among 35-day-old exotic cotton germplasm grown in a greenhouse. McMicheal and Quisenberg [11] evaluated growing conditions for exotic cotton genotypes as well as modern cultivars for 60-70 days and found significant differences in root growth and branching.

Performance of selected recombinant inbred lines for root traits was presented in Table 2. Six genotypes *viz.,* DHBR-170 (31.0 cm), DHBR-87 (28.50 cm), DHBR-96 (28.50 cm), DHBR-44 (28.0 cm), DHBR-111 (28.0 cm) and DHBR-145 (28.0 cm) recorded significantly higher primary root lengths than superior checks, MCU-5 and SBYF-425 (21.95 cm). Only one genotype DHBR-116 recorded significantly higher secondary root length (25.50 cm) than superior check, DS-28 (19.96 cm). Only one genotype DHBR-145 recorded significantly higher total root length (25.0 cm) and primary root length (28.00 cm) than superior check (DS-28) with on par value in secondary root length. The trend of increase in primary root length in cotton on exposer to moisture was observed by Pace *et al.* [13]. Increase in root mass under drought conditions is important in breeding for drought resistance in cotton was reported by Hurd and Spratt [8].

The range of primary root length, secondary root length, total root length and number of secondary roots was considerably higher than range existed for these traits among check and parents included in this study, which indicates the occurrence of transgressive segregants for these traits on both positive and negative direction. For all these four traits, lines with significantly higher value than parents and checks were identified. However, many of them are not superior in seed cotton yield than commercial check, Sahana (668.8 kg/ha) during severe moisture stress condition. However, genotypes like DHBR-170 (31 cm, primary root length), 44 (28 cm, primary root length), 156 (22.5 cm, secondary root length), 161 (22.5 cm, secondary root length) and 171 (34, number of secondary roots) are not only promising in terms of root parameters but also promising for seed cotton yield having on par yielding ability with commercial check, Sahana (668.8 kg/ha). Quisenberg *et al*. [14] have reported significant variability in tap root length and a number of lateral roots among 35 days old exotic cotton germplasm grown in a greenhouse. McMicheal and Quisenberg [11] also found significant differences in root growth and branching in cotton. *Pace et al*. [13], Ali *et al*. [2] and Basal *et al*. [6] have measured root and shoot characteristics in cotton that correlate with drought tolerance. Allah *et al*. [3] reported the variability in the total root length which is strongly related to drought tolerance in rice under upland conditions. These results clearly indicate that through interspecific hybridization, the possibility of deriving different types of recombinant inbred line with only one desirable trait or lines with more than one desirable traits.

Table 1: Mean, range, genetic variability for root traits in the recombinant inbred lines

Traits	PRL(cm)	SRL(cm)	TRL(cm)	SR	SCY(kg/ha)
P1(DS-28)	21.95	19.96	20.48	23.00	468.50
P2(SBYF-425)	20.27	18.43	20.19	13.33	52.60
Mean	20.39	13.04	16.71	16.76	450.38
Minimum	10.50	3.50	9.00	6.50	63.49
Maximum	31.00	25.50	25.00	34.00	1052.90
h^2	0.44	0.68	0.69	0.85	0.16
GA	3.02	5.82	4.15	8.95	62.30
GAM	14.83	44.67	24.85	53.43	13.83
GCV (%)	10.74	26.15	14.49	28.10	6.62
PCV (%)	16.03	31.54	17.40	30.45	41.17

Table 2: Performance of selected superior recombinant inbred lines for root traits

Genotypes with higher primary root length						Genotypes with higher secondary root length					
DHBR lines	**PRL (cm)**	**SRL (cm)**	**TRL (cm)**	**SR**	**SCY (kg/ha)**	**DHBR lines**	**SRL (cm)**	**PRL (cm)**	**TRL (cm)**	**SR**	**SCY (kg/ha)**
DHBR -170	31.00	12.50	21.75	17.50	894.2	DHBR -116	25.50	21.00	23.25	13.00	412.7
DHBR -87	28.50	15.50	22.00	19.00	497.4	DHBR -156	22.50	20.00	21.25	26.00	740.7
DHBR -96	28.50	9.50	19.00	12.00	473.5	DHBR -161	22.50	12.50	17.50	22.50	1037.0
DHBR -44	28.00	15.00	21.50	11.50	904.8	DHBR -175	22.25	23.50	22.87	15.50	317.5
DHBR -111	28.00	21.25	24.62	13.50	489.4	DHBR -85	22.00	19.00	20.50	8.00	798.9
DS-28	21.95	19.96	20.48	23.00	468.50	DS-28	19.96	21.95	20.48	23.00	468.50
SBYF-425	20.27	18.43	20.19	13.33	52.60	SBYF-425	18.43	20.27	20.19	13.33	52.60
Sahana	20.27	12.38	16.32	18.75	668.8	Sahana	12.38	20.27	16.32	18.75	668.8
CD @ 5%	5.36	3.75	5.65	4.57	405.29	CD @ 5%	3.75	5.36	5.65	4.57	405.29
Genotypes with higher total root length						**Genotypes with higher secondary root number**					
DHBR lines	**TRL (cm)**	**PRL (cm)**	**SRL (cm)**	**SR**	**SCY (kg/ha)**	**DHBR lines**	**SR**	**PRL (cm)**	**SRL (cm)**	**TRL (cm)**	**SCY (kg/ha)**
DHBR -145	25.00	28.00	22.00	10.00	375.7	DHBR -171	34.00	19.50	9.00	14.25	891.5
DHBR -111	24.62	28.00	21.25	13.50	489.4	DHBR -138	31.50	20.50	13.83	17.16	145.5
DHBR -160	24.00	26.50	21.50	16.00	492.1	DHBR -174	31.50	18.50	13.00	15.70	465.6
DHBR -110	23.25	24.50	22.00	19.50	497.4	DHBR -188	31.00	22.50	13.33	17.91	396.8
DHBR -116	23.25	21.00	25.50	13.00	412.7	DHBR -187	30.50	17.00	6.66	11.83	306.9
DS-28	20.48	21.95	19.96	23.00	468.50	DS-28	23.00	21.95	19.96	20.48	468.50
SBYF-425	20.19	20.27	18.43	13.33	52.60	SBYF-425	13.33	20.27	18.43	20.19	52.60
Sahana	16.32	20.27	12.38	18.75	668.8	Sahana	18.75	20.27	12.38	16.32	668.8
CD @ 5%	5.65	5.36	3.75	4.57	405.29	CD @ 5%	4.57	5.36	3.75	5.65	405.29

References

1. Abbas G, Arif MJ, Saeed S, Karar H. Increasing menace of a new mealybug Phenacoccus gossypiphilous to the economic crops of southern Asia; p.30. Abstract in XI Int. Symp. On Scale Insect Studies (ISSIS), Oeiras, Portugal, 2007, 24-27.
2. Ali MA, Jabran K, Awan SI, Abbas A *et al*. Morpho-physiological diversity and its implications for improving drought tolerance in grain sorghum at different growth stages. Australian journal of Crop Science. 2011; 5:311-320.
3. Allah AA, Shimaa A, Badawy BA, Zayed, El. Gohary AA. The role of root system traits in the drought tolerance of rice (*Oryza sativa* L.). World Academy of Science, Eng. and Technol. 2010; 4:28-29.
4. Ana Fita, belen Pico. Genetics of root system architecture using near-isogenic lines of Melon. Journal of American. Society of Horticulture Science. 2008; 133(3):448-458.
5. Ball RA, Derrick MO, Mauromoustakos A. Growth dynamics of cotton plant during water-deficit stress. Agronomy Journal. 1994; 86:788-795.
6. Basal H, Bebeli P, Smith CW, Thaxton P. Root growth parameters of converted races of upland cotton (*Gossypium hirsutum* L.) and two BC2F2 populations. *Crop Science.* 2003; 43:1983-1988.
7. Dewi Elvira Sari. Root morphology of drought resistance in cotton (*Gossypium hirsutum* L.). Texas A&M University in partial fulfillment of the requirements for the degree of Master of Science, 2009.
8. Hurd EA, Spratt ED. Root pattern in crop related to water and nutrition Uptake. Physiological aspects of dry land farming (Gupta US, ed). Oxford and IBH Publ. Co., New

Dehli, 1975.
9. Khalid I, Faqir MA, Iftikhar AK, Ehsan U. Variability for Drought Tolerance in Cotton (G*ossypium hirsutum*) and its Genetic Basis. International Journal of Agriculture & Biology. 2011. ISSN Print: 1560–8530; ISSN Online: 1814–9596 09–396/DHB//13–1–61–66.
10. Nour AM. Some aspects of drought resistance in grain sorghum. Ph.D. thesis, Oklahoma State University, Stillwater, OK, USA, 1975.
11. McMichael BL, Quisenberry JE. Genetic variations for root shoot relationship among cotton germplasm. Environment of Experimental Botany. 1991; 31:461-470.
12. Mitra J. Genetics and genetic improvement of drought resistance in crop plants. Current Science. 2001; 80:758-763.
13. Pace PF, Cralle HT, El-Halawany SHM, Cothren JT, Senseman SA. Drought-induced changes in shoot and root growth of young cotton plants. Journal of Cotton Science. 1999; 3:183-187.
14. Quisenberry JE, Jordan WR, Roark BA, Fryrear DW. Exotic cottons as genetic sources for drought resistance. Crop Science. 1981; 21:889-895.