Genetic Variability and Character Association in Roselle (*Hibiscus sabdariffa* L.) Genotypes for Fibre Yield and its Attributes

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Article History

Article ID: IJEP176
Received in 28th March, 2017
Received in revised form 20th April, 2017
Accepted in final form 30th April, 2017

Abstract

Genetic variability, correlation and path analysis were studied in a set of sixty diverse genotypes of roselle (*Hibiscus sabdariffa* L.) during *Kharif*, 2013 at Agricultural Research Station, Ragolu (ANGRAU), Srikakulam District, Andhra Pradesh for eleven important traits. Phenotypic as well as genotypic coefficients of variability were high for the important productivity characters like fibre yield plant^{-1}, dry stick weight plant^{-1}, green fresh weight plant^{-1} and green dry weight plant^{-1} (for PCV) and medium for other characters like plant height and bark thickness. High heritability coupled with high expected genetic advance was observed for fibre yield plant^{-1}, dry stick weight plant^{-1}, green fresh weight plant^{-1} and green dry weight plant^{-1}. Fibre yield per plant was found to be significantly and positively correlated with plant height, base diameter, bark thickness, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1}. Plant height, base diameter, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1} also exhibited significant positive inter correlation among themselves. Partitioning of correlation coefficients of various components upon fibre yield plant^{-1} into direct and indirect contributions revealed that green fresh weight plant^{-1} has maximum direct effect upon fibre yield plant^{-1} followed by plant height, bark thickness and dry stick weight plant^{-1}.

Keywords: Character association, genetic variability, path analysis, roselle

1. Introduction

Roselle (*Hibiscus sabdariffa* L.) is an annual or biennial plant belonging to the large family Malvaceae and is cultivated in Tropical and Sub-Tropical regions for bast fibre, paper pulp or edible calyces, leaves and seed (Osman et al., 2011). In India, roselle is one of the most important bast fibre crop which occupies second place in area and production after jute and is used mainly for manufacturing of sacs, twines, carpets etc. Bast fibre yield in roselle is a complex and highly variable character and is a result of cumulative effects of its component characteristics and therefore, direct selection for it may not be effective. These component characters are independent in their action but are interlinked complex genetic system, selection practiced for one individual character might subsequently bring about a change in the other.

Collection of germplasm and assessment of genetic variability is a basic step in any crop improvement programme. Yield being a complex character, is influenced by a number of yield contributing characters controlled by polygenes and influenced by environment. So, the variability in the collections for these characters is the sum total of heredity effects of concerned genes and influence of the environment. Hence, it becomes necessary to partition the observed variability into heritable and non-heritable components measured as genotypic and phenotypic coefficients of variation (GCV and PCV), heritability expressed as per cent mean.

Correlation and path coefficient analysis of traits will also help in component characters in a breeding programme whose selection would result in the improvement of complex traits that are positively correlated. Keeping this in view, the present investigation was undertaken to assess the genetic variability, heritability and genetic advance, character association and path coefficient analysis of the fibre yielding traits of roselle.

2. Materials and Methods

Sixty roselle (*Hibiscus sabdariffa* L.) genotypes (consisting of eleven exotic lines; four released varieties; 28 local accessions from Andhra Pradesh and 17 local accessions from West Bengal) were evaluated at Agricultural Research Station, Ragolu (ANGRAU), Srikakulam District, Andhra Pradesh during *Kharif*, 2013. The experimental trial was laid out in randomized complete block design with two replications under rainfed conditions. The recommended package of practices was followed to raise a good crop. Data on the basis of five randomly selected competitive plants were recorded on plant height (cm), base diameter (mm), mid diameter (mm), top diameter (mm), internodal length (cm), petiole length (cm), bark thichness (mm), green fresh weight plant^{-1}, green dry weight plant^{-1}, dry stick weight plant^{-1} (g) and fibre yield plant^{-1} (g). Genotypic and Phenotypic coefficients of variation were calculated using the formula suggested by Burton and De Vane (1953). Heritability and genetic advance were estimated according to the formulae given by Allard (1960). Correlation coefficients were calculated as suggested by Johnson et al. (1955). The phenotypic correlations were used to find out the direct and indirect effects of the component characters on fibre yield per plant, according to Dewey and Lu (1959).

3. **Results and Discussion**

The analysis of variance revealed significant difference among the genotypes for all the eleven characters studied. The characters green dry weight plant^{-1}, dry stick weight plant^{-1} and fibre yield plant^{-1} showed high genotypic and phenotypic coefficient of variance (Table 1) suggesting that these characters are under the influence of genetic control. The character green fresh weight plant^{-1} showed high PCV and moderate GCV showing the influence of environment. Moderate values of genotypic and phenotypic coefficient of variation were found for the characters plant height and bark thickness. These findings are in agreement with Bhattacharya et al. (2007); Echekwu and Showemino (2004); Nagaraja et al. (2009); Ghodke and Wadikar (2011); Elsadig et al. (2013). The characters base diameter, mid diameter, top diameter, petiole length and internodal length showed low genotypic and medium phenotypic coefficient of variation revealing the influence of environment. Further, the estimates of PCV were generally higher than their corresponding GCV for all the characters studied suggesting thereby the important role of environment in the expression of these traits. Hence, phenotypic selection may not hold good for genetic improvement in these traits.

Practically, heritability estimates are of greater value to the breeder, since, they indicate the degree of dependence of genotypic value on phenotypic value. The characters plant height, green fresh weight plant^{-1}, green dry weight plant^{-1}, dry stick weight plant^{-1} and fibre yield plant^{-1} showed highest estimates of heritability. Moderate estimates of heritability were recorded by the characters base diameter, internodal length, petiole length and bark thickness. Similar results were also reported by Bhattacharya et al. (2007); Echekwu and Showemino (2004); Ghodke and Wadikar (2011). The estimates of heritability, however, indicate only the effectiveness with which the selection of genotypes can be made based on their phenotypic performance, but fail to indicate the amount of progress expected from selection. For an effective selection, the knowledge alone on the estimates of heritability is not sufficient and genetic advance (%) of mean if studied alongwith heritability is more useful. High heritability coupled with high genetic advance of mean was observed for the traits plant height, green fresh weight plant^{-1}, green dry weight plant^{-1}, dry stick weight plant^{-1} and fibre yield plant^{-1}. The above findings are in accordance with the results reported by Bhattacharya et al. (2007); Ghodke and Wadikar (2011). This indicated substantial improvement for these characters could be achieved through direct selection and these traits could govern by additive type of genes. Moderate heritability coupled with moderate genetic advance of mean was observed for petiole length and bark thickness.

Table 1: Genetic variability parameters for fibre yield and yield contributing characters in roselle

Characters	Mean	Range	GCV (%)	PCV (%)	Heritability	Genetic advance as percent mean (GAM)
Plant height (cm)	307.85	196–370	11.91	13.15	81.98	22.22
Base diameter (mm)	20.61	14.75–24.51	6.40	11.65	30.21	7.25
Mid diameter (mm)	15.76	11.93–18.81	1.08	12.11	0.79	0.20
Top diameter (mm)	11.50	9.59–13.22	5.65	12.57	20.23	-5.24
Petiole length (cm)	12.00	9.00–14.69	9.86	12.74	59.94	15.93
Internodal length (cm)	6.44	5.15–7.85	6.67	10.78	38.33	8.51
Bark thickness (mm)	2.38	1.57–6.51	10.81	15.93	46.13	15.14
Green fresh weight plant^{-1} (g)	665.71	295.0–942.5	18.75	21.16	78.50	34.22
Green dry weight plant^{-1} (g)	310.58	107.5–507.5	23.95	27.63	75.13	42.77
Dry stick weight plant^{-1} (g)	59.09	25.0–92.5	26.83	27.97	92.05	53.03
Dry fibre yield plant^{-1} (g)	26.18	10.37–37.65	25.38	27.15	87.40	48.88

The phenotypic correlation coefficients for different pairs of characters are given in Table 2. Significant positive association of fibre yield plant^{-1} was observed with plant height, base diameter, bark thickness, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1} which are in agreement with Kameswara Rao (2002); Mostofa et al. (2002). Pullibai et al. (2005); Rani et al. (2006); Bhajantri et al. (2007). This suggests selecting for these characters would improve

Table 2: Phenotypic correlation coefficients between fibre yield and its component characters in roselle

Characters	PH	BD	MD	TD	PL	IL	BT	GFWP	GDWP	DSWP	DFYP
PH	1.000	0.513^{**}	0.182^{NS}	0.082^{NS}	-0.267^{**}	0.314^{**}	0.077^{NS}	0.594^{**}	0.584^{**}	0.786^{**}	0.856^{**}
BD		1.000	0.238^{**}	0.167^{NS}	0.249^{**}	-0.066^{NS}	0.549^{**}	0.851^{**}	0.584^{**}	0.698^{**}	0.677^{**}
MD			1.000	0.697^{**}	0.093^{NS}	-0.018^{NS}	0.098^{NS}	0.192^{*}	0.718^{**}	0.168^{NS}	0.187^{NS}
TD				1.000	0.017^{NS}	-0.058^{NS}	0.146^{NS}	0.095^{NS}	0.137^{NS}	0.094^{NS}	0.070^{NS}
PL					1.000	-0.055^{NS}	0.321^{**}	0.218^{*}	0.017^{NS}	-0.064^{NS}	-0.112^{NS}
IL						1.000	0.171^{NS}	-0.011^{NS}	0.128^{NS}	0.117^{NS}	0.199^{*}
BT							1.000	0.449^{**}	0.095^{NS}	0.257^{**}	0.301^{**}
GFWP								1.000	0.835^{**}	0.822^{**}	0.769^{**}
GDWP									1.000	0.805^{**}	0.728^{**}
DSWP										1.000	0.882^{**}
DFYP											1.000

PH: Plant height (cm); BD: Base diameter (mm); MD: Mid diameter (mm); TD: Top diameter (mm); PL: Petiole length (cm); IL: Internodal length (cm); BT: Bark thickness (mm); GFWP: Green fresh weight plant^{-1} (g); GDWP: Green dry weight plant^{-1} (g); DSWP: Dry stick weight plant^{-1} (g); DFYP: Dry fibre yield plant^{-1} (g); *: Significant at level ($p<0.05$); **: Significant at level ($p<0.01$); ^{NS}: Non-significant

the fibre yield in roselle.

Plant height exhibited significant positive association with base diameter, inter-nodal length, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1}, whereas base diameter exhibited positive significant association with plant height, mid diameter, petiole length, bark thickness, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1}. Mid diameter exhibited positive significant association with base diameter, top diameter and green dry weight plant^{-1}. Green fresh weight plant^{-1} exhibited significant positive association with plant height, base diameter, bark thickness, green dry weight plant^{-1} and dry stick weight plant^{-1}. Green dry weight plant^{-1} exhibited significant positive association with plant height, base diameter, mid diameter, green fresh weight plant^{-1} and dry stick weight plant^{-1}. Dry stick weight plant^{-1} exhibited significant positive correlation with plant height, base diameter, bark thickness, green fresh weight plant^{-1}, green dry weight plant^{-1} and dry stick weight plant^{-1} which was also reported by Rani et al. (2006). By this it is evident that selection for these characters would increase the fibre yield of roselle. Petiole length has non-significant negative correlation with fibre yield plant^{-1} which was also reported by Kameswara Rao (2002).

Partitioning of phenotypic correlation coefficients of various component characters with fibre yield into direct and indirect contributions (Table 3) revealed that green fresh weight plant^{-1} (0.7086) has maximum direct effect on fibre yield followed by plant height (0.6329), bark thickness (0.3247) and dry stick weight plant^{-1} (0.1922) which are in conformity with Krishnaveni and Krishna Murthy (2000), Anuradha

Table 3: Direct and indirect contributions of component characters for fibre yield in roselle

Characters	PH	BD	MD	TD	PL	IL	BT	GFWP	GDWP	DSWP	PCCWFY
PH	0.6329^{*}	-0.2045	-0.0198	0.0022	0.0575	0.0423	-0.0107	0.4355	-0.1755	0.1601	0.856
BD	0.4395	-0.2946^{*}	-0.0208	-0.0073	-0.0314	0.0005	0.1833	0.7863	-0.2807	0.1952	0.677
MD	1.1583	-0.5669	-0.0108^{*}	-0.2179	-0.0716	0.1478	-0.0485	1.7881	-0.3807	0.307	0.187
TD	0.0184	0.0279	0.0305	-0.0772^{*}	-0.0007	0.0125	0.0091	0.1245	-0.0527	0.0088	0.070
PL	-0.2581	-0.0655	-0.0055	0.0004	-0.1411^{*}	-0.0248	0.1663	0.1475	-0.0451	-0.0258	-0.112
IL	0.3542	-0.0018	-0.0212	0.128	0.0463	0.0756^{*}	-0.0703	0.0557	-0.0901	0.0560	0.199
BT	-0.0209	-0.1663	0.0016	0.0022	-0.0722	-0.0164	0.3247^{*}	0.3377	-0.1043	0.0560	0.301
GFWP	0.3890	-0.3270	-0.0273	0.0136	-0.0234	0.0059	0.1548	0.7086^{*}	-0.2478	0.1652	0.769
GDWP	0.4404	-0.3278	-0.0163	0.0161	-0.0252	0.0270	0.1342	0.6962	-0.2523^{*}	0.1736	0.728
DSWP	0.5272	-0.2991	-0.0173	0.0035	0.0189	0.0220	0.0946	0.6088	-0.2278	0.1922^{*}	0.882

PCCWFY: Phenotypic correlation coefficient with fibre yield; *: Direct effects; Residual effect: 0.1029 and Suriyakumari (2002); Kameswara Rao (2002). The high correlation coefficient of green fresh weight plant^{-1} (0.769) with fibre yield was due to the direct effects of green fresh weight (0.7086) coupled with positive indirect effects with plant height (0.3890), bark thickness (0.1548) and dry stick weight (0.1652). The high correlation coefficient of dry stick weight plant^{-1} (0.882) with fibre yield was due to the direct effects of dry stick weight (0.1922) coupled with positive indirect effects with green fresh weight plant^{-1} (0.6088), plant height (0.5272) and bark thickness (0.0946). Likewise, the high correlation coefficient of plant height (0.856) with fibre yield was due to the direct effects of plant height (0.6329) coupled with positive indirect effects with green fresh weight (0.4355) and dry stick weight (0.1601), mid diameter (0.1945).

The value of residual effects was low (0.1029) suggesting that 90% of the total variations in roselle fibre yield was explained and the remaining 10% have not been studied in the present study. Finally, the path coefficient analysis revealed importance of green fresh weight plant^{-1}, plant height, bark thickness and dry stick weight plant^{-1} for their contribution either directly or indirectly to fibre yield and hence, during selection these traits should be given utmost attention for developing of high fibre yielding roselle varieties.

4. **Conclusion**

Selection is likely to be effective for traits with high heritability coupled with genetic advance i.e. green fresh weight plant^{-1}, green dry weight plant^{-1}, dry stick weight plant^{-1} and fibre yield plant^{-1} alongwith the traits with moderate heritability i.e. plant height and base diameter based on the studies of heritability and genetic advance. Based on character association and path analysis studies fibre yield plant^{-1} may be improved by selection of tall plants coupled with high, base diameter, bark thickness; more green fresh weight plant^{-1} green dry weight plant^{-1} and dry stick weight plant^{-1}.

5. **Acknowledgement**

The authors are highly thankful to BCKV and ANGRAU for providing necessary help and infrastructural facilities to undertake these studies.

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