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Inheritance of Earliness and other Characters in Upland Cotton

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Abstract: Certain features of gross morphology of the cotton plant furnish clues to earliness of crop production. Node of first fruiting branch (NFB), number of monopodial branch per plant (NMB), days taken to first flower, days taken to open first boll were used a morphological measures of earliness in the studies reported here. The estimation of component of variation for these characters suggested that the additive component was significant in all the traits and were greater than dominant components of variation except for seed cotton yield per plant, where the dominant components were higher in magnitude than additive. The ratio of $H_2/4H_1$ indicated asymmetry of positive and negative genes in parents for seed cotton yield and percent first pick, whereas symmetrical distribution of positive and negative genes in the parents was observed for node of first fruiting branch, number of monopodial branches per plant, days taken to first flower and days taken to open first boll. All of these traits were significantly correlated but because of its higher heritability and lower variability, node of first fruiting branch is considered the most reliable and the most practical one of these. NFB and NMB were significantly correlated phenotypically with percent first pick (earliness). From the estimates of heritability value (broad and narrow) sense it was concluded that cross Reshmi × NIAB-78, NIAB-78 × MNH-93 and S-14 × NIAB-78 are valuable crosses for improvement of early maturing traits (node of first fruiting branch, days taken to first flower, days taken to open first boll and percent first pick) with seed cotton yield.

Key words: Cotton, gross morphology, crop

Introduction

Cotton plant is indeterminant in habit and sets its bolls (fruit) over a period of 80 days, until over or more factors may affect and development become limiting. Thus the environment has an opportunity to act on the development and maturation over a relatively long period of time. Critical, reliable and practical methods for measuring or estimating earliness of maturity in cotton are essential " tools' for manipulating earliness of crop maturity in cotton breeding programme. Richmond and Radwan (1962) reported on the results of a comparative study of seven methods of measuring earliness of crop maturity in cotton that the combined weight of the first and second pickings expressed as a percentage of total seed cotton harvested was one of the most practical methods out of these seven methods. Ray and Richmond (1966) reported Node of first fruiting branch (NFB), Number of vegetative branches (NVB), Percentage of bolls on vegetative branches (PBV) features of gross morphology of cotton plant furnished clues to earliness of crop production. NFB was considered most reliable and practical one for measuring earliness due to high heritiblity.

Hearn (1969) studied growth and performance of cotton in desert environment and stated that early maturity in cotton was determined by the faster squaring or flowering mode, more squaring or flowering sites on fruiting branches, more fruiting branches on vegetative branches.

Gipson and Ray (1970) studied temperature variety interrelationship in cotton and concluded that early maturity in cotton is measured by the days required from flower to boll opening. Weijun (1998) studied correlation between earliness and agronomic characters of upland cotton and showed that earliness is very significantly and positively correlated with the height of first sympodial node and earliness is negatively correlated with plant height. It was concluded that height of first sympodial node could be used to select for earliness in cotton. Jain (1980) observed additive gene action for first fruiting node number and seed cotton yield in Desi cotton (***G. arboreum*** L.). Heritability and genetic advance were low for these characters. Godoy and Palomo (1999) studied inheritance of earliness in upland cotton (***G. hirsutum*** L.) and reported significant additive genetic variance for days to first square, days to first flower, days to first boll open and node to first fruiting branch. Heritability estimates were medium for these traits. Correlation analysis showed that the lower the node to the first fruiting branch, shorter was the plant and earlier was the onset of squaring, flowering and boll opening. Babar ***et al.*** (2002) stated that the main stem node number of first sympodial branch and days taken to first flower are reliable and efficient methods for predicting the earliness of any variety in cotton. Khan ***et al.*** (2002) reported partial dominance type of gene for seed cotton yield in upland cotton.

Materials and Methods

Ten varieties of upland cotton, representing a wide range of earliness of crop maturity, were grown in 1998 in a performance experiment at Cotton Research Station Multan. The purpose of this test was to survey varieties for suitable parental material for a genetic study of earliness. Out of these, six selected varieties viz; Reshmi, MNH-439, S-14, NIAB-78, DPL-54 and MNH-93 were crossed in all possible combinations. F_1 of each cross was raised and reciprocally crossed to both parents to obtain BC_1 and BC_2. The data was recorded from the centrally ten guarded plants. Experimental plot was 4.6 meter long, single row with 30 cm plant to plant distance, while row to row distance was kept 75 cm. F_1 plants were harvested and were used for raising F_2 crop. Parents, F_2 and back cross populations were in triplicate progeny row trial in randomized complete block design (RCBD) during the year 2000-01 Data was recorded on 50, 20 and 10 plants of F_2, Back crosses and F_1 respectively in each replication. The data for node of first fruiting branch, number of monopodial branches per plant, number of days taken to open first flower, number of days taken to open first boll, percent first pick and seed cotton yield was recorded for estimating the earliness.

Components of genetic variation were computed through the method given by Hayman (1954a and b, 1958), Jinks (1954 and 1956) Heritability estimates in broad sense and narrow sense was calculated by using the formula given by Mahmud and Kramer (1951) and Warner (1952), respectively. Phenotypic correlations in F_2 population were calculated by the computer program (Excel, 1998).

Results and Discussion

Genetic analysis

The analysis of variance showed significant differences among genotypes for all traits under study (Table 1). The estimates of component of genetic variance (D, H_1, H_2 and F) along with their standard error are presented in Table 2. The both additive (D) and dominance (H_1 and H_2) components were significant for all traits under study. It was further observed that magnitude of additive (D) genetic component was larger than dominant component (H_1) for node of first fruiting branch, number of monopodial branch per plant, days taken to first flower, days taken to open first boll and percent first pick. The H_1 value is not equal to H_2, for number of monopodial branch per plant, days taken to first flower, percent first pick and seed cotton yield, indicating unequal gene frequencies at all loci. It was also confirmed from $H_2/4H_1$ ratios, as value is less than 0.25. While the H_1 and H_2 are equal for node of first fruiting branch and days taken to open first boll indicating equal gene frequencies at all heterozygous loci which was also confirmed from $H_2/4H_1$ ratios, as value is very close to 0.25. The positive value of F for node of first fruiting branch, number of monopodial branch per plant, days taken to open first boll and

Table 1: Mean squares for various plant characters of cotton in F_1 generation of 6x6 diallel cross

S.O.V	D.F	Node of first friting branch	No. of monopodial branches Per plant	Days taken to first flower	Days taken to open first boll	% first pick	Seed cotton yield per Plant
Block	2	0.25	0.09	10.78	14.34	0.28	1.68
Genotypes	35	13.52**	1.62**	140.97**	67.50**	1.08**	2138.08**
Error	70	0.44	0.08	11.63	12.37	0.02	2.15

*: $P \leq 0.05$; ** : $P \leq 0.01$

Table 2: Estimates of the components of genetic variance

Component of variation	Node of first fruiting branch	No. of monopodial branches per plant	Days taken to first flower	Days taken to open first boll	Percent first pick	Seed cotton yield
D	6.52±1.02**	1.17±0.014*	25.99±2.53**	37.74±5.65**	2.18±0.026**	1041.44±127.37**
H_1	5.95±2.60**	0.15±0.034*	14.98±6.44**	-2.44±14.33	1.85±0.067**	1101.48±323.33**
H_2	5.74±2.32**	0.13±0.031*	13.58±25.7**	2.34±12.8	0.29±0.061**	721.48±288.80**
F	1.06±2.5	0.26±0.033*	-22.60±6.19	-0.17±14.34	3.09±0.065**	202.80±311.10
E	0.14±0.38	0.03±0.005	3.87±0.96**	4.12±11.92	0.01±0.011	0.720±48.18
$(H1/D)^{½}$	0.955	0.13	0.759	0.25	0.92	1.03
$H_2/4H_1$	0.241	0.22	0.23	0.24	0.04	0.16
$(4DH_1)^{½}+F / (4DH_1)^{½}-F$	1.54	1.89	0.27	0.98	7.65	1.13

*: $P \leq 0.05$; ** : $P \leq 0.01$

Table 3: Genotypic and phenotypic correlation among various plant characters

Characters		Node of first fruiting branch	Monopodial branches per plant	Days taken to first flower	Days taken to open first boll	Total yield per plant	Percent first pick
Node of first	r_g		0.43**	0.81**	0.49**	0.34**	-0.68**
fruiting branch	r_p		0.51**	0.72**	0.44**	-0.26	-0.39**
Monopodial	r_g			0.63**	0.34*	0.49**	-0.39*
branches per Plant	r_p			0.60**	0.76	0.52**	-0.22
Days taken	r_g				0.75*	-0.04	-0.67**
to first flower	r_p				0.75**	-0.20	0.55**
Days taken to	r_g					0.10	-0.72**
open first boll	r_p					0.08	-0.48**
Total yield	r_g						0.31
per plant	r_p						0.27

*: $P \leq 0.05$; **: $P \leq 0.01$, r_p= Phenotypic correlation, r_g= Genotypic correlation

seed cotton yield, indicated that there were more dominant genes than recessive genes in the parents, which was also supported by the estimate of ratio $[(4DH_1)^{½} + F] / [(4DH_1)^{½} - F]$ having positive value and greater than one. The value of F and ratio of $[(4DH_1)^{½} + F] / [(4DH_1)^{½} - F]$ for days taken to first flower and days taken to open first boll suggested that recessive genes were in equal proportion with dominant genes in the parents. The degree of dominance exhibited by the ratio $(H_1/D)^{½}$ demonstrated that greater part of genetic variation was additive in nature for node of first fruiting branch, number of monopodial branch per plant, days taken to open first boll and days taken to open first boll while for seed cotton yield major portion of genetic variation was dominant in nature. Heritability estimates for six characters are summarized in Table 4. In all crosses and for all traits heritabilities in narrow sense were smaller than the corresponding broad sense ones. Narrow sense heritabilities are less likely to be biased upward by dominance and epistatic effects. Values obtained for the node of first fruiting branch, days taken to first flower, days taken to open first boll and percent first pick were most consistent between the broad and narrow sense estimates. As the heritability in broad sense and narrow sense generally was high to moderate for node of first fruiting branch, days taken to first flower, monopodial branches per plant, days taken to open first boll and percent first pick, while moderate for seed cotton yield. It was further observed that the cross combinations Reshmi × NIAB-78, Reshmi × MNH-93, possessed high to moderate heritability and genetic advance for the traits of earliness and high seed cotton yield, thus could lead to development new promising genotypes by use of efficient selection techniques. These results are almost in confirmation with earlier findings of Ray and Richmond (1966), Jain (1980), Godoy and Palomo (1999), Khan ***et al.*** (2002).

Correlation

Significant association were found among all the morphological measurement under study except days taken to first flower with seed cotton yield, days taken to open first boll with seed cotton yield and percent first pick with seed cotton yield (Table 3). It is also evident that

Table 4: Heritability estimated for earliness traits of upland cotton

	Node of first fruiting branch			No. of monopodial branches per plant			Days taken to first flower			Days taken to open first boll			% first pick			Seed cotton yield per plant		
Cross	$H_{b.s}$	$H_{n.s}$	G.A	$H_{b.s}$	$H_{n.s}$	G.A	$H_{b.s}$	$H_{n.s}$	G.A	$H_{b.s}$	$H_{n.s}$	G.A	$H_{b.s}$	$H_{n.s}$	G.A	$H_{b.s}$	$H_{n.s}$	G.A
AxB	62.2	58.1	2.36	78.8	50.2	1.03	72.6	46.0	8.8	65.6	58.5	10.0	89.5	43.7	0.48	59.2	47.3	8.50
AxC	66.0	52.1	2.29	83.5	67.9	2.40	81.0	73.1	13.5	68.2	56.0	11.3	80.0	57.0	0.44	61.2	52.8	12.29
AxD	69.3	66.3	2.35	75.9	61.1	1.81	76.1	42.3	12.8	68.1	60.1	11.6	94.4	60.9	0.83	76.1	50.0	15.20
AxE	48.1	32.3	1.67	67.5	55.8	1.25	73.6	56.0	9.2	65.2	50.7	6.0	75.0	42.5	0.26	41.2	31.4	5.95
AxF	66.3	51.3	2.56	75.8	46.3	1.54	82.7	61.7	14.6	82.3	54.1	11.4	80.1	54.2	0.37	52.6	32.3	7.92
BxC	61.8	45.2	2.18	66.0	47.4	1.28	73.5	44.3	10.1	66.4	52.7	13.4	82.5	54.1	0.50	36.4	28.6	5.77
BxD	71.9	60.1	2.74	63.5	44.5	0.95	80.7	65.6	10.2	73.8	52.1	13.1	83.3	46.6	0.44	52.4	43.0	7.45
BxE	41.1	29.2	1.18	54.4	34.5	0.80	78.4	49.5	10.6	75.5	51.6	9.4	66.6	50.0	0.20	65.4	24.1	10.50
BxF	44.6	38.4	1.52	57.9	54.6	1.27	65.6	53.9	8.0	64.3	46.1	7.8	85.0	46.0	0.47	66.9	54.4	12.19
CxD	59.1	48.1	1.89	25.7	15.7	0.27	74.3	57.5	9.2	51.4	46.6	7.4	60.0	44.2	0.27	60.2	42.7	9.17
CxE	52.6	36.9	1.46	38.0	17.8	0.6	74.6	56.9	10.5	62.9	41.9	10.2	75.0	58.7	0.37	54.8	35.1	8.99
CxF	54.2	42.0	1.71	66.4	46.4	1.23	73.7	61.3	11.6	66.1	56.3	10.5	60.1	35.7	0.28	52.1	46.4	7.73
DxE	75.0	47.3	2.66	62.0	58.8	1.46	87.6	62.9	13.9	61.9	56.0	11.9	94.1	55.4	0.81	65.0	45.3	9.34
DxF	53.8	45.4	1.55	57.3	53.0	1.15	82.8	67.2	12.7	64.1	48.3	9.6	60.0	40.0	0.23	68.3	39.2	9.64
ExF	53.8	39.0	1.73	44.8	34.4	0.84	66.9	49.5	8.3	63.9	47.7	9.4	65.0	50.0	0.22	78.9	58.1	15.56

A= Reshmi, B= MNH-439, C= S-14, D= NIAB-78, E=DPL-54, F= MNH-93, $H_{b.s}$= Heritability broad sense, $H_{n.s}$= Heritability Narrow sense, G.A = Genetic Advance

correlation of node of first fruiting branch, number of monopodial branch per plant, days taken to first flower, days taken to open first boll with percent first pick was negative and significant which indicated that as the value of these morphological traits decrease the percent first pick will increase and vise versa. So it is suggested that genotypes with lower node of first fruiting branch, less number of monopodial branch per plant, and less number of days required taking first flower and to open first boll, will be earlier in maturity. Ray and Richmond (1966), Weijun (1998), Godoy and Palomo (1999), Babar ***et al.*** (2002) working on upland cotton also found similar relationships.

The traits relating to maturity are node of first fruiting branch, number of monopodial branches per plant, days taken to first flower, days taken to open first boll and percent first pick (product quantity measure). Percent first pick was negatively and significantly correlated with node of first fruiting branch, number of monopodial branches per plant, days taken to first flower, days taken to open first boll (Table 3). These results indicated that the genotypes involved in this study, when entered earlier in reproductive phase, the first fruiting branch was developed at a lower node on the main stem which cause the development of its fruiting parts relatively earlier by impeding the growth and development of monopodial branches being vegetative in nature. Since the reproductive phase started earlier, the first flower and first boll took less number of days to open and resultantly the proportion of seed cotton yield in first pick became higher in early maturing genotypes. This study therefore, leads to the conclusion that probably, the earliness of crop maturation is affected more by the position of first fruiting branch than by other morphological traits. Significant genotypic correlations were found among all these morphological traits, but node of first fruiting branch appears to be the most appropriate one for earliness investigations, as this method is so elementary and simple in nature that to use it one needs only to be able to recognize first fruiting branch and to count main stem nodes. The node number of first fruiting branch measure is adaptable to any problem or program that requires the quantification of genetic earliness. It will also give reliable estimates of earliness, when it is impossible or impractical to collect data on the time and rate of fruiting or boll maturation. Other measures such as the days taken to open first boll proved to have an important place in estimating earliness of the crop maturity but not practicable in large populations of segregating generations and for common grower.

References

Gipson, J.R. and L.L. Ray, 1970. Temperature variety interrelationships in cotton. J. Agri. Sci., Cambridge, 73: 65-97.

Babar, S.B., A.R. Soomro, R. Anjum, A.M. Memon and A.W. Soomro, 2002. Two preliminary reliable indicator of earliness in cotton- II. Asian. J. Pl. Sci., 1: 121-122.

Godoy, A.S. and G.A. Palomo, 1999. Genetic analysis of earliness in upland cotton (*G. **hirsutum*** L.). II. Yield and lint percentage. Euphytica, 105: 161-166.

Hayman, B.I., 1954a. The theory and analysis of diallel crosses. Genetics, 39: 789-809.

Hayman, B.I., 1954b. The analysis of variance of diallel table. Biometrics, 10: 235-244.

Hayman. B.I., 1958. The theroy and analysis of diallel crosses. Genetics, 43: 63-85.

Hearn, A.B., 1969. Growth and performance of cotton in a desert environment. J. Agric. Sci., Cambridge, 73: 65-97.

Jain, D.K., 1980. Genetics of yield components and fiber characters in desi cotton (*G. **arboreum*** L.). M.Sc.Thesis Abst. 6 304-305. Haryana Agric. Univ. Hissar, India.

Jinks, J.L., 1954. The analysis of continuous variation in a diallel cross of ***Nicotiana rustica***. Genetics, 39: 767-788.

Jinks, J.L., 1956. The F_2 back cross generation from a set of diallel crosses. Heridity, 10: 1-30.

Khan, M.A., A.S. Larik and Z.A. Soomro, 2002. Study of gene action for yield and yield components in ***G. hirsutum*** L. Asian. J. Pl. Sci., 1: 130-131.

Mahmud, I. and H.H. Kramer, 1951, Segregation for yield, height and maturity following a soybean cross. Agron. J., 43: 605-609.

Ray, L.L. and T.R. Richmond, 1966. Morphological measures of earliness of crop maturity in cotton. Crop Sci., 6: 527-531.

Richmond, T.R. and R.H. Radwan, 1962. A comparative study of seven methods of measuring earliness of crop maturity in cotton. Crop Sci., 2: 397-400.

Warner, J.N., 1952, A method for estimating heritability. Agron. J., 44: 427-430.

Weijun, S., 1998. Research on the correlation between earliness and agronomic characters of upland in Xinjiang. China Cotton, 25: 17-18.