ASSESSMENT OF EARLINESS IN *Gossypium hirsutum* L.

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Fifty one lines/varieties of *G. hirsutum* showed highly significant genotypic differences for node for 1st fruiting branch, days taken to 1st boll opening, earliness index and seed cotton yield. The results exhibited that early and late maturing varieties may be distinguished on the basis of data on these four characters but it is obvious from the results that no single criterion seems to be adequate for measuring earliness of these varieties. On the basis of metroglyph analysis of the available material four varieties/lines i.e. FH-901, CIM-448, NIAB-999 and LRA-5166 with highest index score were rated as early maturing and three i.e. CP-15/2, Pilose-3 and MNH-93 with lowest index score i.e., late maturing, were chosen out of fifty one for hybridization.
Keywords: Metroglyph analysis, *Gossypium hirsutum* L, earliness and seed cotton yield

INTRODUCTION

Upland cotton, *Gossypium hirsutum* L., is the world's leading fibre producing species, and grown in more than 80 countries with an annual production of 20 million tones (Dutt *et al*., 2004). The cotton crop in Pakistan accounts for 60 % of the total foreign exchange earnings through the export of value added cotton products like garments (Iqbal *et al*., 2005) and contributes 8.6 % of the value addition in agricultural sector and about 1.8 % to GDP (Anonymous, 2007).

Pakistan is predominantly an agricultural country, and due to varying environmental conditions, from north to south, an array of crops is grown in winter, autumn, spring and summer seasons. Spring wheat, *Triticum aestivum* is the staple food of people in Pakistan, and thus the crop is grown on an extensive area, following different rotation systems, to meet the demand of food supply to increasing population. It has been observed that wheat-cotton-wheat rotation system is not much efficient resulting poor wheat yields in these areas. In late maturing cotton varieties, during the favourable market years like 2007, the farmers continue to pick seed cotton till at the end of December, or even early January. Thus the fields under late maturing cotton varieties in the core areas are not vacated and planting of wheat is delayed, and majority of the farmers do not like planting wheat as they expect poor yields from these fields.

In this regard, early maturing cotton varieties have many other advantages; these varieties complete most of the life cycle during weather conditions most favourable to the crop, and thus mature before the damage due to unfavourable weather. In addition, it has been studied that by planting early maturing varieties losses due to diseases and insect pest complex are also reduced (Singh, 2004). Chu *et al. (*1992) suggested that damage from pink bollworm (*Pectinophora gossypiella*) can be avoided by the cultivation of early maturing cotton cultivars, and in another study damage by pink bollworm was lessened in moderately early and very early cotton than the long season cotton (Wilson *et al*., 1981). Thus keeping in view the suggestions of Chu *et al.* (1992) and Singh (2004), other possibility of saving the cotton crop is through breeding early maturing varieties. The cultivation of such cultivars will not only minimize the use of pesticides, but the expenses incurring on other inputs like irrigation water and fertilizer will also be reduced.

Previous information on earliness of cotton plant is few, but what does exists reveal that earliness in cotton is a complex trait which is assessed by measuring many plant characters. Ray and Richmond (1966) reported that node of first fruiting branch, number of vegetative branches, percent of bolls on vegetative branches were important attributes, whilst Gody (1994) emphasized on measuring plant height, date of first flower and date of first open boll for assessing cotton material. Baloch and Baloch (2004) used data on first sympodial node number on maim stem, sympodial branch length, inter node length, and percent first pick to measure earliness. Babar *et al.* (2002) had suggested that main stem node number of first sympodial branch and days taken to open first flower are reliable and efficient parameters for predicting earliness of any variety. Thus keeping in view the importance of early maturing cotton varieties in local agriculture system, the present study was initiated at Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

The use of statistical method which could help cotton breeder for assessing the cotton germplasm for earliness is important. In previous studies, metroglyph analysis developed by Anderson (1957) had been used to study variation in *Triticum aestivum* (Begum *et al.* 1995), *Oryza sativa* (Cheema *et al*., 2004; Rashid *et al.,* 2007) and *Gossypium hirsutum* (Punitha and

Raveendron, 2000). This biometrical method classifies the germplasm into distinct groups on the basis of their morphological and genetic diversity. Therefore, the pattern of variation in earliness related characters measured in 51 lines/varieties of *Gossypium hirsutum* L. has been investigated by analysing the data following metroglyph analysis technique.

MATERIALS AND METHODS

The plant material consisting of 51 diverse cotton varieties/lines was planted in the field during May, 2004 in three replications following randomized complete block design. Seeds of each lines were planted in a 3.3 m long single row having 12 plants spaced 30 cm within the row which was 75 cm apart from the other row.

Measurement of earliness

In order to measure earliness in different varieties/lines data on eight guarded plants from each row were collected on the following characters related to earliness. Average node number for first fruiting branch was determined by counting number of nodes above the cotyledonary node (zero node) along the main stem, till the one that gave rise to the first fruiting branch on the plants. Data were averaged for each variety/line in each replication. Number of days taken from sowing to opening of first boll was recorded on each variety. This was done on individual plant basis, and means in each replication was calculated for statistical analysis. Earliness index was determined by weighing seed cotton of first pick (after 130 days) and expressing it as a percentage of total seed cotton harvested from all picks. This measurement was recorded in three replications of each entry. As cotton is indeterminate plant, therefore, total seed cotton harvest of a plant was completed by making three picks, which were mixed and weighed with an electronic balance to obtain total produce of plant. The average yield of each variety/line in each replication was calculated.

Statistical analysis

The data on four earliness related traits of 51 varieties/lines were analysed following analysis of variance technique (Steel *et al*., 1997). Co-efficient of variation (CV %) for the four traits were calculated to assess the variability among the four characters. The data were further subjected to metroglyph analysis (Anderson, 1957). This technique is a semi graphic method for assessing pattern of morphological variation in a large number of genotypes. Means over replication (mean of three replications) were worked out for the four traits measured. Each variety/line was represented by a small circle called 'glyph'. Two characters showing high CV % were chosen for plotting glyph on the graph, one character plotted along x-axis and other along y-axis. Mean of each variety/line for these two characters plotted along x-axis and y-axis were used to position the glyph of that variety/line on the graph. In this way each entry occupied a definite position on the graph. The variation of two remaining characters of each variety/line was displayed through their mean values on the respective glyph by different lengths of rays i.e., no ray for minimum, half ray for medium and full ray for maximum mean value depending on the index value of a variety/line. For the construction of index score, the variation for each character was divided into three groups, *viz.*, low, medium and high. The varieties/lines with low, medium and high mean values were given index score 1, 2 and 3 respectively. The performance of a variety/line was indicated by its total index score, which was the sum of index values for four earliness related characters.

RESULTS AND DISCUSSION

Assessment of variation in earliness

Fifty one lines/varieties of *Gossypium hirsutum* L. were assessed for variation in earliness measuring node for first fruiting branch, days taken to 1st boll opening, earliness index and seed cotton yield. The mean values of the four parameters recorded in each of 51 entries are given in Table 4. The results of analysis of variance showed highly significant genotypic differences ($P \leq 0.01$) for the four parameters (Table 1).

Table-1. Mean squares from simple analysis of variance of four plant traits related to earliness in 51 lines/varieties of *G. hirsutum*

Source of variation	Degree of freedom	Node for first fruiting branch	Days taken to 1st boll opening	Earliness index	Seed cotton yield
Replication	2	0.011	2.51	5.45	10.72
Lines/varieties	50	4.44**	34.77**	197.11**	1264.08**
Error	100	0.12	0.98	12.84	3.085

**Highly significant ($P \leq 0.01$)

Node for first fruiting branch

Node for first fruiting branch ranged from 6.05 to 11.04 with a mean value of 8.42 (Table 2). In variety FH-901, node number at which first fruiting branch appeared was 6.05 showing it early maturing variety, and similarly S-12, CIM-473 and VH-142 with 6.02, 6.02 and 6.58 respectively, found to be early maturing. In contrast MNH-93 developed first fruiting branch at node 11.04 followed by Coker-30, Allepo-4 and Pilose-3 with 10.83, 10.50 and 10.25 node respectively, appeared to be late maturing. Co-efficient of variation for the character was 4.02.

Table-2. Range, mean and CV% of 51 lines/varieties of *G. hirsutum*

Character	Range	Mean	C.V. %
Node for first fruiting branch	6.05-11.04	8.42	4.02
Days taken to 1st boll opening	91.17-106.83	96.72	1.02
Earliness index	31.55-70.95	52.68	6.80
Seed cotton yield	36.51-126.8	78.07	2.25

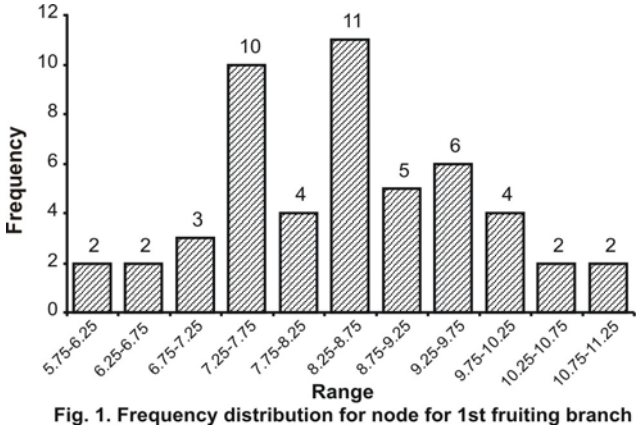

Fig. 1. Frequency distribution for node for 1st fruiting branch

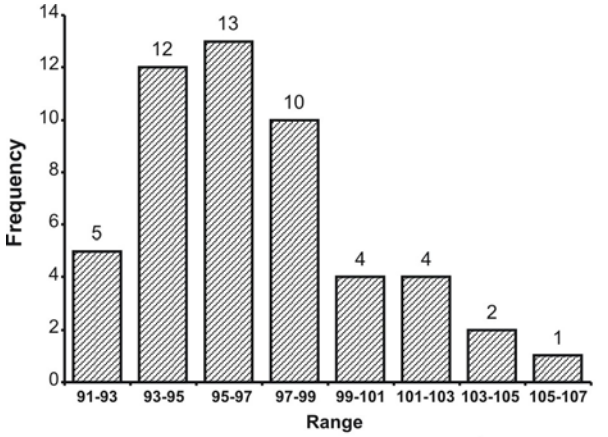

Fig. 2. Frequency distribution for days to 1st boll opening

The variety comparison in Fig. 1 showed that maximum eleven lines/varieties i.e. MNH-129, VH-37, DPL-26, Rashmi, CIM-1100, MNH-3570, FH-634, DPL-2775, CRIS-121, CRIS-220 and CRIS-164 produced their first sympodia node at node number 8.25 to 8.75 from zero nodes, whilst ten lines/varieties, CIM-446, CIM-482, NIAB-999, NIAB-86, VH-59, CIM-448, FH-682, MNH-156, NIAB-98 and FH-925 were grouped between 7.25 to 7.75.

Days taken to 1st boll opening

Days taken to 1st boll opening ranged 91.17 to 106.83 days with a mean of 96.72 and C.V % 1.02 (Table 2). The varieties, FH-901, NIAB-999, VH-142, MR-73 and NIAB-98 took relatively minimum number of days i.e. 91.17 to 92.83 for opening of 1st boll (Table 1). By contrast, varieties MNH-124, Pilose-3, MNH-156, Coker-30, MNH-147, SLS-1 and MNH-93 took 101.0 to 106.8 days for first boll opening.

Frequency distribution of the data (Fig 2) formed eight groups, for example, 13 varieties, CIM-506, FH-634, CIM-1100, Acala-SJ, CIM-482, AUH-50, Lasani-6, S-12, VH-37, FH-682, FH-925, Rashmi and Hg-Hn-45 opened first boll 95 to 97 days after seed sowing, 12 varieties namely CIM-448, NIAB-111, NIAB-Karishma, DPL-26, Coker-31, LRA-5166, CRIS-220, BH-136, Allepo-4, BH-89, H-499.3 and CRIS-121 took 93-95 days. Only five varieties i.e. FH-901, NIAB-999, VH-124, MR-73 and NIAB-98 opened first boll before 93 days, whilst only MNH-93 took more than 105 days to open first boll.

Earliness index

Earliness index of 51 varieties ranged from 31.55 to 70.95, with a mean value of 52.68, and coefficient of variability 6.80 (Table 2). Earliness index of MNH-93 was the lowest (31.55%) followed by CP-15/2, NIAB-98 and Pilose-3 which had 33.60%, 40.13% and 40.35% earliness index respectively, indicating that these were late maturing varieties. Cultivar NIAB-999 with highest earliness index i.e. 70.95% was early maturing.

Frequency distribution showed that 14 lines/varieties namely CRIS-121, CRIS-164, DPL-26, MNH-156, DNH-29, CRIS-379, MNH-129, H-499.3, VH-142, AUH-

50, CIM-473, MNH-147, CRIS-220 and Coker-30 had 52.5 to 57.5% earliness index (Fig.3). Twelve lines/varieties namely CIM-482, S-12, SL-7, CIM-446, NIAB-Karishma, BH-89, MR-73, FH-925, FH-682, VH-37, FH-900 and SLH-41 had earliness index from 47.50 to 52.5%. Three varieties i.e. DPL-2775, CIM-506 and NIAB-999 had more than 67.5% earliness index, and in contrast CP-15/2 and MNH-93 showed less than 37.5% earliness index.

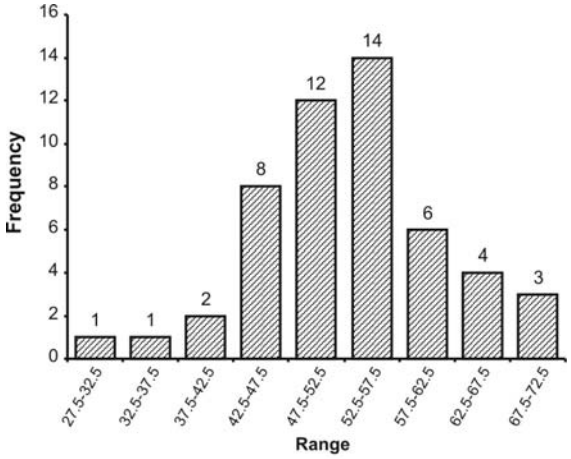

Fig. 3: Frequency distribution for earliness index

65 to 75 g seed cotton yield (Fig. 4), whilst seed cotton yield of eight varieties, MNH-147, DPL-26, CIM-482, DPL-2775, Coker-30, CIM-473, NIAB-111 and H-499.3 ranged from 55-65g. Five varieties i.e. CIM-448, NIAB-Karishma, CRIS-121, CIM-1100 and MNH-93 produced maximum seed cotton yield (> 115 g).

Selection of the parents

For selecting the suitable parents from the germplasm

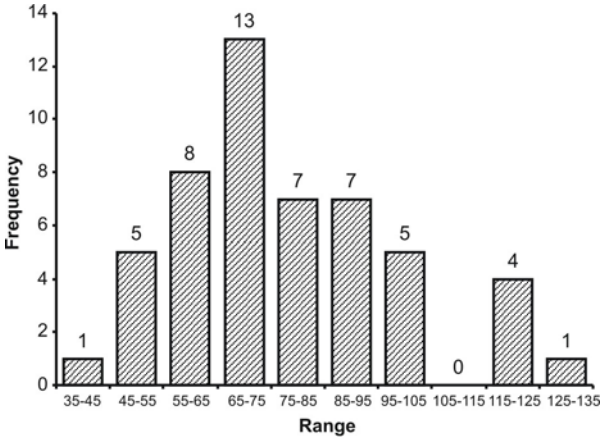

Fig. 4. Frequency distribution for seed cotton yield

Seed cotton yield

Data revealed significant variation in seed cotton yield of 51 lines/varieties, and it ranged 36.51 to 126.8 g with C.V% 2.25 (Table 2). MNH-93 produced maximum seed cotton yield i.e. 126.8 g followed by CIM-1100, CRIS-121, NIAB-Karishma and CIM-448, which produced 123.84, 117.69, 115.93 and 115.41g respectively, while CP-15/2 and MNH-156 weighed 36.51 and 45.48 g respectively.

Frequency distribution of seed cotton yield data exhibited that 13 varieties i.e. CRIS-310, Rashmi, FH-682, FH-925, S-12, MNH-3570, SLH-41, AUH-50, CIM-506, CRIS-79, DNH-29, CIM-446 and Allep-4 produced

examined for earliness, Anderson's metroglyph technique (1954) was used. In this technique the index score which revealed the potential of the lines was allotted to each character measured in 51 lines/varieties (Table. 3 and 4), and same information is represented as rays on the glyph (Fig. 5). For node for first fruiting branch and days taken to 1st boll opening, higher score was given to the entry which showed a low magnitude of these characters as their desirability was in lower magnitude, and in contrast for earliness index and seed cotton yield higher score was given to the entry which obtained higher magnitude of

Table-3. Range of means and index scores for four plants traits related to earliness in 51 lines/varieties of *G. hirsutum*

Plant traits	Score I		Score 2		Score 3	
	Value > than	Sign	Range	Sign	Value < than	Sign
Node for first fruiting branch	9.417	●	9.25-7.867	●	7.640	●
Days taken to Ist boll opening	101.5	●	101.6-96.41	●	96.33	●
	Score I		Score 2		Score 3	
	Value < than	Sign	Range	Sign	Value > than	Sign
Earliness index	44.25	●	44.43-57.88	●	58.04	●
Seed cotton yield	66.21	●	66.93-95.56	●	97.97	●

Table-4. Means and scores (in parenthesis) of four traits measured for assessing earliness in 51 lines/varieties of *G. hirsutum*

Sr. No.	Genotypes	Node for 1st fruiting branch	Days taken to 1st boll opening	Earliness index	Seed cotton yield	Total score
1	FH-634	8.50 (2)	95.08 (3)	44.25 (1)	84.80 (2)	8
2	FH-682	7.50 (3)	96.46 (2)	51.58 (2)	66.21 (1)	9
3	FH-900	7.00 (3)	97.02 (2)	52.02 (2)	47.63 (1)	8
4	FH-901	6.05 (3)	91.17 (3)	63.48 (3)	97.94 (3)	12
5	FH-925	7.64 (3)	96.87 (2)	51.42 (2)	66.93 (2)	9
6	MNH-93	11.04 (1)	106.83 (1)	31.55 (1)	126.80(3)	6
7	MNH-129	8.25 (2)	101.00 (2)	54.54 (2)	83.11 (2)	8
8	MNH-156	7.50 (3)	101.58 (1)	53.51 (2)	45.48 (1)	7
9	MNH-147	9.42 (1)	103.11 (1)	56.49 (2)	55.29 (1)	6
10	MNH-3570	8.48 (2)	100.08(2)	46.60 (2)	69.83 (2)	8
11	CIM-506	8.92 (2)	95.03 (3)	68.27 (3)	71.91 (2)	10
12	CIM-448	7.46 (3)	93.08 (3)	63.59 (3)	115.41 (3)	12
13	CIM-446	7.250 (3)	99.610 (2)	48.665 (2)	74.218 (2)	9
14	CIM-473	6.42 (3)	98.69 (2)	55.92 (2)	63.27 (1)	8
15	CIM-482	7.25 (3)	95.85 (3)	47.51(2)	61.01 (1)	9
16	CIM-1100	8.47 (2)	95.50 (3)	45.43 (2)	123.84(3)	10
17	NIAB-999	7.42 (3)	91.43 (3)	70.95 (3)	94.10 (2)	11
18	NIAB-86	7.42 (3)	96.67 (2)	58.35 (3)	79.85 (2)	10
19	NIAB-Karishma	8.03 (2)	93.17 (3)	48.96 (2)	115.93(3)	10
20	NIAB-98	7.62 (3)	92.83 (3)	40.13 (1)	95.53 (2)	9
21	NIAB-111	6.75 (3)	93.17 (3)	57.88 (2)	63.62 (1)	9
22	BH-36	6.83 (3)	94.02 (3)	42.93 (1)	50.55 (1)	8
23	BH-89	8.17 (2)	94.09 (3)	49.63 (2)	86.36 (2)	9
24	VH-37	8.26 (2)	96.42 (2)	51.79 (2)	84.69 (2)	8
25	VH-59	7.42 (3)	98.32 (2)	45.57 (2)	103.02(3)	10
26	VH-142	6.58 (3)	92.08 (3)	54.95 (2)	86.63 (2)	10
27	CRIS-121	8.53 (2)	94.75 (3)	52.90 (2)	117.69(3)	10
28	CRIS-164	8.67 (2)	98.00 (2)	53.35 (2)	95.56 (2)	8
29	CRIS-220	8.58 (2)	93.87 (3)	56.91 (2)	99.89 (3)	10
30	CRIS-310	9.42 (1)	100.21 (2)	59.87 (3)	65.60 (1)	7
31	CRIS-379	8.92 (2)	98.07 (2)	54.23 (2)	72.71 (2)	8
32	S-12	6.20 (3)	96.42 (2)	47.99 (2)	68.69 (2)	9
33	SLS-1	9.50 (1)	103.17 (1)	47.41 (2)	91.79 (2)	6
34	SLH-41	9.75 (1)	98.67 (2)	52.39 (2)	70.09 (2)	6
35	SL-7	9.67 (1)	97.18 (2)	48.28 (2)	53.63 (1)	6
36	Rashmi	8.42 (2)	96.92 (2)	46.72 (2)	65.68 (1)	7
37	Lasani-9	10.00 (1)	96.33 (3)	58.47 (3)	77.95 (2)	9
38	AUH-50	7.92 (2)	95.87 (3)	54.99 (2)	70.43 (2)	9
39	DNH-29	9.75 (1)	97.90 (2)	53.52 (2)	74.15 (2)	7
40	Pilose-3	10.25 (1)	101.47 (2)	40.35(1)	86.52 (2)	6
41	Allepo-4	10.50 (1)	94.08 (3)	58.01 (3)	74.48 (2)	9
42	Acala sj	10.17 (1)	95.70 (3)	63.27 (3)	82.82 (2)	9
43	CP-15/2	9.57 (1)	99.93 (2)	33.59 (1)	36.51 (1)	5
44	DPL-26	8.33 (2)	93.17 (3)	53.38 (2)	58.14 (1)	8
45	DPL-2775	8.50 (2)	98.08 (2)	68.02 (3)	61.95 (1)	8
46	Coker-30	10.83 (1)	102.73 (1)	57.33 (2)	62.86 (1)	5
47	Coker-31	9.17 (2)	93.57(3)	42.89 (1)	83.81 (2)	8
48	Hg-Hn-45	9.08 (2)	97.00 (2)	58.37 (3)	53.38 (1)	7
49	LRA-5166	7.87 (2)	93.83 (3)	64.00 (3)	92.72 (2)	10
50	MR-73	9.17 (2)	92.26 (3)	50.00 (2)	86.99 (2)	9
51	H-499.3	9.25 (2)	94.12 (3)	54.72 (2)	63.71 (1)	8

these characters (Table 3). The total score varied from 5 to 12. Twelve varieties/lines, CIM-506, CIM-1100, NIAB-86, NIAB-Karishma, VH-59, VH-142, CRIS-121, CRIS-220, LRA-5166, NIAB-999, FH-901 and CIM-448 had total score more than 9, while seven varieties i.e.Coker-30, CP-15/2, Sl-7, SLH-41, SLS-1, MNH-147 and MNH-93 had less than 7. Varieties, FH-901, CIM-448 and NIAB-999 topped in the scoring list, and had total score ≥ 11, whilst CIM-506, CIM-1100, NIAB-86, NIAB-Karishma, VH-59, CRIS-220, and LRA-5166 had the total score 10. The varieties/lines like CP-15/2, Coker-30, MNH-147, MNH-93, PILOSE-3, SL-7, SLH-41 and SLS-1 had lowest score i.e. ≤ 6.

The relative positions of the lines/varieties are presented on the graph (Fig. 5). It is shown that four varieties/lines i.e. FH-901, CIM-448, NIAB-999 and LRA-5166 appeared to have higher score, and thus may be considered as early maturing, whilst three varieties i.e. CP-15/2, Pilose-3 and MNH-93 with lowest score may be called late maturing. Thus on the basis of the results of metroglyph analysis, seven varieties were selected as parents for hybridization.

The present investigations were carried out in order to examine the existence of potential in *Gossypium hirsutum* L. for developing earliness through conventional breeding approach. As a first step to achieve the objective, availability of selection criteria which could help evaluate the cotton germplasm for assessing variability in earliness related characters is important. In previous studies similar to one conducted here, node for first fruiting branch (Gody, 1994; Babar *et al.,* 2002; Baloch and Baloch, 2004), days to first boll opening (Gody, 1994; Godoy and Palomo, 1999), and earliness index (Iqbal *et al.,* 2003; Rauf *et al.,* 2005) were used as effective selection criterion for the assessment of earliness in cotton, and therefore these parameters along with seed cotton yield were also used for making comparison among 51 lines/varieties of cotton studied here. The existence of variation found in node for first fruiting branch, days to 1st boll opening, earliness index and seed cotton yield measured in the germplasm investigated here has been substantiated by the data reported by Anjum *et al.,* (2001), Panhwar *et al.,* (2002), Babar *et al.* (2002), Ali *et al.* (2003) and Iqbal *et al.* (2005). Although estimates of broad sense heritability of these characters calculated using mean squares from analysis of variance were high, these are encouraging and suggest that the plant material may be exploited for development of earliness in *Gossypium hirsutum* L. through selection and breeding.

On the basis of the data on the four characters, early and late maturing varieties may be distinguished, for example, considering node for first fruiting branch, varieties FH-901, S-12, CIM-473 and VH-142 may be called early maturing, whilst Pilose-3, Allepo-4, Coker-30, and MNH-93 which appeared to develop first fruiting branch at higher node may be rated as late maturing varieties. Considering days taken to first boll opening, varieties FH-901, VH-142, NIAB-999, MR-73 and NIAB-98, which took minimum number of days were found to be early maturing, and in contrast varieties MNH-129, Pilose-3, MNH-156, Coker-30, MNH-147, SLS-1 and MNH-93 took relatively maximum number of days to open first boll, and thus may be categorised as late maturing varieties in the germplasm. The greater earliness index of NIAB-999, DPL-2775, LRA-5166, CIM-448 and FH-901 suggested them as early maturing varieties, and in contrast MNH-93, CP-15/2, NIAB-98 and Pilose-3 with low percentage of seed cotton yield at first pick appeared to be late maturing.

Thus from these results, it is quite obvious that no single criterion seems to be adequate for measuring earliness of varieties. Selection of one parent as early maturing, on the basis of one character, is not justified suggesting that use of critical, reliable and practical methods for measuring earliness in cotton are essential to cotton breeders for making selection of potential parents for the development of an effective breeding programme aimed to improve the character. Godoy and Palomo (1999) and Iqbal *et al.* (2003) had suggested that effective alternation of maturity can best be achieved by selecting more than one component of earliness.

The metroglyph analysis is relatively a simple technique and used in the present work for grouping accessions on the basis of morphological characters, as suggested by Bhadara and Akhter (1991). This technique uses index score allotted to each character measured in each line/variety, and the available germplasm is classified into different groups on the basis of total index score. In the present case, total index score of 51 line/varieties based upon the four characters varied from 5 to 12. It was found that three varieties namely FH-901, CIM-448, and NIAB-999, having total score ≥ 11 topped the list, and in contrast CP-15/2, Coker-30, MNH-147, MNH93, Pilose-3, SL-7, SLH-41 and SLS-1 with lowest score (≤ 6) were late maturing. The use of metroglyph analysis technique in the present research work found sufficient support of previous work on sorghum (Mehdi and Asghar, 1999) rice (Cheema *et al.,* 2004), sugarcane (Mujahid *et al.,* 2001), and brassica (Khan *et al.,* 2005). Singh and Narayanan (1993) have suggested that genotypes to be used as parents in the hybridization programme should be chosen from different groups representing whole of the genetic variability existed in the plant

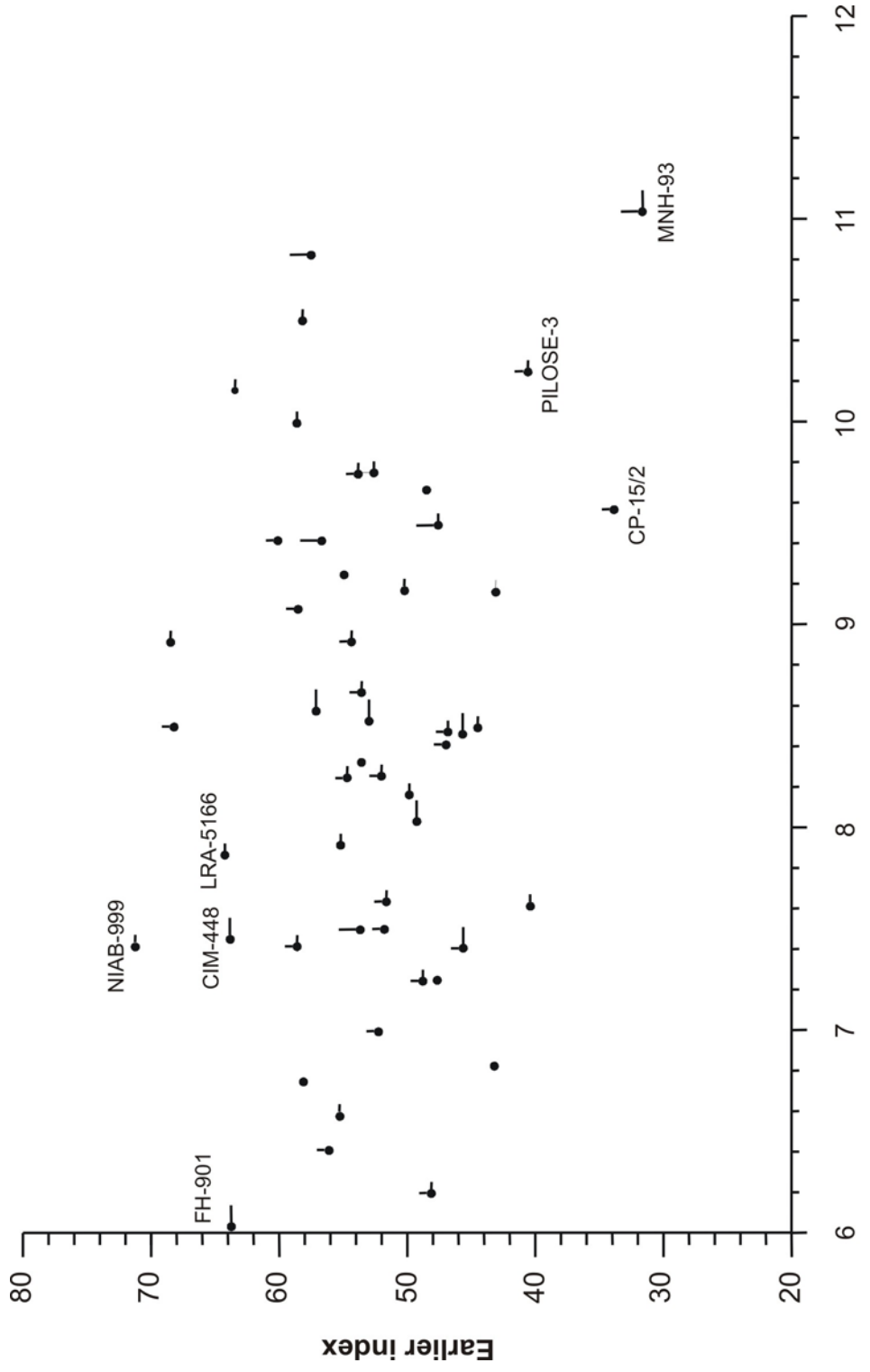

Figure 5. Metroglyph scatter diagram showing variation in 51 genotypes of cotton

material. Thus considering the position of the lines/varieties in Figure 5 and total score index, four lines/varieties namely FH-901, CIM-448, NIAB-999 and LRA-5166 having higher score (≥ 10) were selected as early maturing parents, and three lines/varieties i.e., CP-15/2, Pilose-3 and MNH-93 with lowest total score (≤ 6) were selected as late maturing parents for hybridization.

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