1613 Path of Productivity – A method to handle genetic material using F_1s in Cotton (*Gossypium arboreum* L.)

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Abstract

Hybridization and selection in the segregating generations will ultimately give lines of our choice. However, choosing the right kind of material is a prerequisite to success. A method that would aid in such an exercise is outlined herein. The present study involved forty-two hybrids produced in a diallel using seven *Gossypium arboreum* L. parents. A simple method which considers the *per se* deviations of the selected crosses from the overall group mean for each trait is discussed. The selected crosses that show different paths of productivity would mean that they are carrying different alleles for the said trait. Combining such differential crosses further would lead to segregating generations where selecting lines with a congregation of desirable alleles becomes the goal. The three top yielding crosses *viz.*, G. cot 19 X LD 764, LD 764 X DLSA 305 and CINA 310 X G. cot 19 showed different paths to productivity and were involved in further hybridization and selection. In $F_{5,}$ three productive segregants showed superior performance over check varieties.

Keywords: Path of productivity, genotypic correlation, hybridization

Introduction

Breeders of desi cotton, *Gossypium aboreum*, attempt to capture heterosis in pure lines following hybridization of diverse parents, often referred to as pyramiding genes. The choice of best parental material may be determined via a diallel where the combining ability of the potential parents is revealed. The purpose of this research was to elucidate a simple, but different procedure where the top three F_1s in terms of seedcotton yield were considered for an uncomplicated method of analysis .This method does not need a diallel to be conducted as combining ability is not the criterion for selecting the parents to be involved in a systematic crossing scheme. Only, in this study, three top yielding F_1s (as parents) were picked from a diallel study for further crossing simply based on their *per se* performance. The diallel experiment has no connection with the new method outlined except to supply data about the top performers. This method can be employed after the evaluation of any group of hybrids for their productivity. The method proposed is superior to other methods as it considers the differences in the contribution of traits towards yield in the various hybrids. The basic premise of the proposed method is that the different paths to productivity across a group of hybrids can be seen as deviations from the mean of the group of hybrids included in the study. This deviation is simply measured in percentage values and if for the traits there are differences within the hybrids chosen, then combining such hybrids further should result in the breeder is combining diverse genotypes and creating the necessary variability upon which improvement rests. Superior segregates can later be isolated from these crosses. Obviously, picking the top hybrids and utilizing their diversity, if any, would lead to better results.

Material and methods

The primary objective of our breeding program is to develop *arboreum* cultivars suited to the late-sown-low-rainfall areas of the northern regions of Karnataka state where no *arboreums* are presently grown. Raichur comes under the Northeastern dry zone of Karnataka. It is located between 16^{o} $15^{'}$ N latitude and 77^{o} $21^{'}$ E longitude with an altitude of 389.37 m above mean sea level. The cotton sowings at Raichur, Karnataka are late when compared with the other parts of the state as the monsoon rains arrive only by late July and canal water is available only by September every year. This situation prevents cultivation of *arboreums* as they show better response to early sowings (June) and adequate soil moisture. Coupled with the low moisture regime (<800 mm annual rainfall), the high temperature (43^{0} C - 44^{0} C) prevailing during the later part of the crop season makes arboreum cultivation highly non-remunerative.

After extensive screening of *arboreum* germplasm, seven promising lines (Table 1) were identified and crossed in a diallel fashion in 2001-02.The salient features and sources of the lines reveal the diversity of the starting material in terms of morphology as well as geographical origin. The resulting forty-two experimental hybrids were evaluated under protective irrigation in a completely randomized block design with two replications in during the rainy season of 2002-03 (sowings conducted in June 2002). At the end of the season, the top 3 F_1s for productivity were identified and analyzed for their paths of productivity. There were differences in the productivity levels, as well as 11 other quantitative traits, of these hybrids. For the purpose of this presentation, the three most productive hybrids were chosen and subjected to a novel yet simple method of analysis where the contribution of different component characters to productivity were determined.

The path of productivity analysis was computed as the percent deviation of *per se* performance from the group mean using the following formula (Deepak, 2002; Kanavi *et. al.*, 2004).

% deviation = [(individual genotypic mean – group mean) / group mean] * 100

Group mean is the mean expression of a trait over all the 42 hybrids included in the study.

In addition to the calculation of hybrid performance and deviations from the overall mean, genotypic correlations were determined for 12 traits among the 42 hybrids per Al-Jibouri *et al.* (1958). These correlations serve only to provide additional guidance in the selection of parents.

The top 3 F_1s were intercrossed to produce three different populations, i.e.,

Population 1 [(G. cot 19 X LD 764) x (LD 764 X DLSA 305)],

Population 2 [(G. cot 19 X LD 764) x (CINA 310 X G. cot 19)], and Population 3 [(LD 764 X DLSA 305) x (CINA 310 X G. cot 19)].

These double cross populations were evaluated during the regular rainy season of 2003-04 (sowings were done in August 2003), with each population composed of more than 500 plants. Thirty individual plants in each population were advanced to the F_2 generation based upon their superior productivity. These ninety progenies were sown in two row plots each the following year. Based on individual plant productivity ten plants were selected in

Population 1, eight plants were selected in Population 2 and eight plants from Population 3. Each plant produced seed enough for three rows, which was sown in August 2005 (rainy season of 2005-06). This constituted the F_3 generation. The 26 F_3 families were critically evaluated in under standard production practices, which included only one protective irrigation. At the end of the season, 10 families across the three populations (5, 3 and 2 families from Population 1, 2 and 3, respectively) were selected based on their high productivity. The seed in each family were bulked, thus providing enough seed for a replicated trial. In the second week of August 2006, these ten entries along with two recommended check cultivars (AK 235 and DLSA 17) were sown in a completely randomized block design with 3 replications. Each entry was sown in three row plots, each plot measuring 12.96 m^2. The spacing adopted in each plot was 90 cm between rows and 20 cm between plants. Weeds were controlled by hand and two inter-cultivations with a bullock drawn harrow. Recommended levels of fertilizers were applied at the rate of 80:40:40 kg ha^{-1} of N, P, and K. Observations were recorded on five randomly chosen plants in each entry. Data on twelve important morphological as well as yield traits were subjected to analysis in SPAR, a statistical package for agricultural research developed by the Indian Agricultural Statistical Research Institute, New Delhi, India.. Results for the three best performing populations are presented below.

Results and discussion

The performance and per cent deviation from the overall mean of the three most productive single cross hybrids are presented in Tables 2 and 3, respectively. The data indicated a 39 to 50% improvement in the seed cotton yield of these three hybrids compared with the mean of all hybrids. These yield increases were due primarily to the number of bolls $plant^{-1}$ across all three hybrids, yet LD 764 x DLSA 305 exhibited heavier seeds and bolls, and a greater number of monopodia. G.cot 19 x LD 764 combines more yet small bolls than CINA 310 x G.cot 19. Although 10 double cross families were advanced to replicated trials, data are presented in Table 4 for only the three best performing families, referred to as Selection 1, Selection 2, and Selection 3. All the three selections *viz.,* Selection 1 and Selection 2 (both derived from Population 1) and Selection 3 (derived from Population 3) were superior to check cultivars AK 235 and DLSA 17 in seedcotton yield and fibre length. The three Selections presented in Table 4 ranged from 35 to 77 % higher yielding (p=0.05) than the check cultivars. Selection 1 exhibited superior fiber length and strength to the best quality check cultivar, AK 235, while all three selections out performed DLSA 17 for these two fiber quality traits. Selection 1 will move to additional testing before it is considered for release in the late-sown-low-rainfall situation for which it has been bred.

Similar results when comparing the different paths to productivity were reported by Deepak (2002) and Kanavi *et al* (2004)..

Notwithstanding the fact that it is the combination of parental genes in every hybrid that is responsible for the increased expression of a trait, hybridization of the hybrids followed by selection in the segregating generations will give better lines as evidenced by the present study. Selection 1 needs to be stabilized further and extensively yield tested before release. The three selections can also be used to produce superior hybrids again.

Though the promising selections were isolated from effectively three double crosses, the method of choosing the F_1s is a novel approach that which considers the differential distribution of alleles for various traits across the hybrids. Unlike in prediction of a double cross hybrid performance using single cross hybrid data, here we use the information generated on allelic distribution for various traits thereby making this 'path-of-productivity' analysis a better option.

This simple methodology is also well supported by the biometrical analysis for the genotypic correlations among the twelve traits evaluated (Table 5). Significant correlations were noted for monopodia per plant (0.382), number of bolls per plant (0.980) , lint index (0.586) and seed index (0.522) with seedcotton yield. These traits have also shown a positive deviation of the chosen productive hybrids, from the group mean in the simple path of productivity model put forth and discussed earlier. The trait, seeds boll^{-1} showed a negative yet significant correlation (-0.476) with seedcotton yield (Table 4). Here also, a negative deviation was noticed in the simple model discussed earlier. This corroboration further proves the efficacy of the methodology of path of productivity analyses in the present study. The method is simple and needs no complicated analysis. The methodology, though needing further corroboration from other studies, still promises to be a simple tool for identifying the proper material to be used in hybridization followed by selection. The success achieved in deriving superior segregants in the present study using 'path of productivity' speaks of the efficacy of the method.

References

1. AL-JIBOURI, H.A., MILLER, P.A. AND ROBINSON,H.F., 1958, Genotypic and environmental variances in upland cotton cross of interspecific origin. *Agronomy Journal*, **50**: 633-636

2. DEEPAK, C.A., 2002, Genetic studies on potentiality of herbaceum cotton genotypes in diverse situations. *M.Sc.(Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka (India).

3. KANAVI, M.S.P., PATIL, S.S., SALIMATH, P.M., SOMASHEKHAR AND PATIL,B.C., 2004, Comparison of robust and compact hirsutum cotton types: a search for ideal plant type International Symposium on *"Strategies for Sustainable Cotton Production – A Global Vision",* 1. Crop Improvement, 125- 129, 23-25, Nov. 2004, University of Agricultural Sciences, Dharwad, Karnataka (India).

Table 1 : Salient features and source of the *Gossypium arboreum* parents used in the diallel analysis

Sl. No.	Parents	Salient features	Source
1.	AK 235	Thick and erect stem, lodging resistant, tolerant to sucking pests, high oil content.	Developed at Cotton Section, Punjab Rao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra.
2.	DLSA 24	Tall, thin stem, tolerant to sucking pests, longer fibre length.	Developed at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka.
3.	AKA 9431	Thin stem, compact, tolerant to sucking pests, good fibre length and ginning out turn.	Developed at Cotton Section, Punjab Rao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra.
4.	G. cot 19	Thin stem, lodging resistant, tolerant to sucking pests, good fibre length.	Developed at Main Cotton Research Station Athwa Farm, Gujurat Agricultural University, Surat, Gujarat.
5.	CINA 310	Thin and erect stem, lodging resistant, big bolls, more number of bolls, high yielding, tolerant to sucking pests, good ginning out turn.	Developed at Central Institute for Cotton Reaearch, Nagpur, Maharashtra.
6.	DLSA 305	Tall, thin and erect stem, big bolls, non-lodging, tolerant to sucking pests,	Developed at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka.
7.	LD 764	Semi-dwarf, thin and erect stem, lodging resistant, big bolls, more number of bolls, high yielding, tolerant to sucking pests, high lint index.	Developed at Agricultural Research Station, Lam farm, Andhra Pradesh Agricultural University, Guntur, Andhra Pradesh.

Table 2: *Per se* performance of the top 3 hybrids for productivity and other yield contributing traits in cotton (*Gossypium arboreum* L.)

Hybrid	Seed cotton yield (kg ha^{-1})	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	No of bolls per plant	Boll weight (g)	Number of seeds per boll	Ginning out turn (%)	Lint index	Seed index	Fibre length (mm)	Oil content (%)
G. cot 19 X LD 764	1623	178.32	1.50	30.00	62.50	1.48	18.00	34.29	2.65	5.08	23.00	12.84
LD 764 X DLSA 305	1555	191.50	2.28	32.50	57.50	2.76	20.50	29.48	2.63	6.28	24.44	12.64
CINA 310 X G. cot 19	1505	194.28	1.65	26.65	45.50	2.09	18.50	32.66	2.74	5.64	24.00	12.04
Mean (Top 3 hybrids)	1561	188.03	1.81	29.72	55.17	2.11	19.00	32.14	2.67	5.67	23.81	12.51
Group Mean (42 hybrids)	1082	212.94	1.72	29.71	30.51	2.09	23.10	33.13	2.66	5.37	23.71	12.87
CD(5 %)	211	49.26	0.28	5.84	6.23	0.43	3.99	6.06	0.46	0.58	1.47	2.09

Table 3: Per cent deviation from group mean of the three productive hybrids for different yield contributing traits in cotton (*Gossypium arboreum* L.)

Hybrid	Seed cotton yield	Plant height	Number of monopodia per plant	Number of sympodia per plant	No of bolls per plant	Boll weight	Number of seeds per boll	Ginning out turn	Lint index	Seed index	Fibre length	Oil content
G. cot 19 X LD 764	50.1	-16.3	-13.0	1.0	104.8	-29.1	-22.1	3.5	-0.5	-5.4	-3.0	-0.2
LD 764 X DLSA 305	43.8	-10.1	32.2	9.4	88.5	32.3	-11.2	-11.0	-1.3	17.0	3.1	-1.8
CINA 310 X G. cot 19	39.1	-8.8	-4.3	-10.3	49.1	0.2	-19.9	-1.4	2.8	5.1	1.2	-6.4
Mean	44.3	-11.7	5.0	0.0	80.8	1.1	-17.7	-3.0	0.3	5.6	0.4	-2.8

Table 4: Performance and quality parameters of promising entries in advanced segregating generation (F_5) derived from the segregating generations of the inter-crosses among the top three hybrids

Sl.No	Entry name	Seed cotton yield (kg/ha)	Per cent Improvement Over AK 235	Per cent Improvement Over DLSA 17	Fibre length (mm)	Per cent Improvement Over AK 235	Per cent Improvement Over DLSA 17	Tenacity (g/tex)	Per cent Improvement Over AK 235	Per cent Improvement Over DLSA 17
1	Selection 1	1380	76.9	53.3	25.7	13.7	17.3	22.6	8.1	22.8
2	Selection 2	1352	73.3	50.2	23.7	4.8	8.2	20.6	-1.4	11.9
3	Selection 3	1212	55.3	34.6	24.2	7.0	10.5	19.8	-5.2	7.6
4	AK 235 (Check)	780			22.6			20.9		
5	DLSA 17 (Check)	900			21.9			18.4		
	CD (5 %)	219			1.3			1.2		
	CV	11.69			3.49			3.46		

Table 5 : Genotypic correlations among twelve different traits in cotton (*Gossypium arboreum* L.)

Characters	Plant height (cm)	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight (g)	Seed cotton yield (kg ha^{-1})	Number of seeds per boll	Ginning out turn (%)	Seed index	Lint index	Fibre length (mm)	Oil content (%)
Plant height (cm)	1	0.04	0.499**	-0.268	0.096	-0.164	0.032	0.008	0.114	0.028	0.412**	0.547**
Number of monopodia per plant		1	0.292*	0.357**	0.023	0.382**	0.012	-0.139	0.430**	0.288*	-0.257	-0.045
Number of sympodia per plant			1	0.234	0.19	0.048	-0.137	-0.176	0.578**	0.562**	-0.032	0.011
Number of bolls per plant				1	0.151	0.980**	-0.449**	0.14	0.523**	0.518**	-0.197	-0.318*
Boll weight (g)					1	0.249	-0.193	0.008	0.317*	0.347*	-0.062	0.11
Seed cotton yield (kg ha^{-1})						1	-0.476**	0.27	0.522**	0.586**	-0.093	-0.087
Number of seeds per boll							1	-0.247	-0.261	-0.365**	-0.132	0.300*
Ginning out turn (%)								1	0.1	0.686**	-0.029	0.143
Seed index									1	0.998**	0.028	-0.627**
Lint index										1	-0.066	-0.569**
Fibre length (mm)											1	0.124
Oil content (%)												1

*, ** Significant at 5% (p=0.05) and 1% (p=0.01), respectively