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USE OF INDIRECT SELECTION METHOD IN BREEDING FOR DROUGHT TOLERANCE IN PEANUT (*ARACHIS HYPOGAEA* L.)

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Abstract

An investigation was carried out in 192 progenies derieved from seven hybrids involving eight parents in Peanut (*Arachis hypogaea* L.). The objectives of this investigation were to make the potential use of indirect (Trait based) selection in breeding for drought tolerance conventional breeding programmes by assessment of drought related morpho-physiological traits at one hand *viz.* water use efficiency (WUE) measured in terms of SPAD reading and harvest index (HI) and quantitative traits on the other. The important outcome of this investigation is that the two selection methods one is indirect (Trait based) selection which was exercised under drought and irrigated conditions and second empirical selection under irrigation condition did not show significant superiority of indirect (Trait based) selection over the empirical for yield under either limited – moisture or normal – moisture condition. However, there was a strong trend for increased kernal yield in trait-based genotypes among the top genotypes, although the yield gains were statistically non - significant when compared with the highest yielding parent ICGS – 76. Even so there were significant yield gains among the top genotypes compared to the other seven parents. Thus the results suggested that the inclusion of some of the constituent traits of the selection index, or their easily measurable surrogate traits would be useful in peanut breeding programs. These data should enable tools to be developed for indirect selection of genotypes suited to drought prone environments. Assessing over all performance of the progenies twenty-two progenies were found to be superior for one trait or the other for resistance/tolerance to drought selection through trait based selection method. However, empirical selection method could not yield a profenly sustaining in drought conditions.

Key Words: Peanut, *Arachis hypogaea* L., Selection Method, Secondary Traits, Drought Tolerance

Introduction

Peanut (*Arachis hypogaea* L.) is grown as an important oil-seed as well as food legume and cash crop mainly in rain-fed conditions between 40°N and 40°S latitudes. Over two thirds of the global peanut production occurs in seasonally rain-fed regions where drought is a potential constraint for crop production (Smartt 1994). There are two options for the management of crops in water limiting environments namely agronomic management and genetic management. With the genetic management option drought tolerant varieties, once developed, would be a low economic input technology that would be readily acceptable to resource-poor rain-fed small land holding farmers. Genetic enhancement to maximize crop production per unit input of water has been a major research thrust of crop improvement programs throughout the world.

In field crops, in general, where breeding for drought tolerance has been a focus for many years, empirical breeding methods have been the most successful. An alternative approach is traits based selection in which lines are selected on the bases of specific traits determined to be beneficial under water deficit conditions (Bidinger and Witcombe, 1989). For the 'indirect trait' approach to be successful, the trait must have high genetic correlation with yield, high heritability, and selection methods must be applicable on a large scale (Richards *et al.,* 2001).

In order to make similar achievements in Peanut, it is first necessary to show that there is a sufficient genetic variation for drought tolerance and that there are the genetic resources to improve current breeding material. With these aims, we studied the agronomical traits and

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drought performance of a wide range of groundnut germplasm representing diverse genetic backgrounds. Significant genotypic variation for drought tolerance as well as yields stability, harvest index and on traits based to water use efficiency via SPAD under drought and irrigated condition has been reported in peanut (Nigam *et al.,* 2004; Basu *et al.* 2004). Morpho-physiological traits of the progenies are described in this study and efforts were made to identify drought tolerance progenies through traits based empirical selection methods in Peanut.

Materials and methods

Udaipur (India) is situated at 579.5 m altitude, on 24.35ºN latitude and 73.30ºE longitudes, where an average annual rainfall is 637 mm. Most of the rainfall is received during the monsoon season, which extends from July to October. The experimental materials consisted of eight parents and 192 progenies (table 1) derived from seven hybrids (table-1) of peanut (*Arachis hypogaea* L.) which were selected on the basis of their traits related to water use efficiency. Indirect selection scheme, based on traits related to water use efficiency, harvest index and Soil-Plant Analyses Development (SPAD) Chlorophyll meter reading was formulated. It was termed as trait based selection (M_1). This selection was exercised under drought (E_1) and irrigated condition (E_2) at four respective centers (table 1). There were originally three crosses *viz*., ICGS-76´CSMG-84-1, ICGS-44´ CSMG-84-1, ICGV-86031´TAG-24 were common at all the four centres and one each was location specific *i.e.* ICGS-76´ICGS-44 at ICRISAT, K-134´TAG-24 at Tirupati, JL-220´TAG-24 at Jalgaon and GG-2´ICGV-86031 at Junagadh and Udaipur in India.

Selection Protocols

Trait (indirect) based selection uniformaly

The trait-based selections were made using a selection index (SI) approach described by Nigam and Chandra (2003). The form of SI was consistent over all crosses and locations. The schedule of outlay of development of genetic material, their exposure to stress / non-stress environments and selection approaches is given below.

• The F_1 plants from the initial crosses (c50 plants/ cross) were grown out under non-stressed conditions as spaced plants to maximise seed multiplication.

• The F_2 seed from these crosses was grown out as spaced plants to maximise seed multiplication for the F_3 populations (assumed to be c1000 seeds/ cross, based on c25 seeds/plant). This population was then divided equally between 'trait' and 'empirical' selection approaches (c500 F_2 plants/ cross).

• $F_{2:3}$ progeny bulks (derived from the spaced F_2 plants, c50 seeds/row @ 20 cm spacing) were planted out and grown under water-non-limiting conditions.

• All $F_{2:3}$ progeny bulks were assessed for pod yield, TDM, TE (via SLA and SPAD), HI and T (using the reverse engineering approach of Wright *et al*. (1996), by sampling 0.5 m^2 quadrates at maturity. SPAD (and in some cases SLA) were measured 2–3 times during the crop growth cycle. As soon as possible after this data had been collected and analysed, a selection index (SI) value was calculated for each progeny, and the top 10% of progeny bulks (or the top 50 if n<500) carried forward to the $F_{2:4}$ generation. Some 400 progenies (including both trait based and empirical selections), incorporating representative members from each cross, were carried forward at each centre.

• The carried forward $F_{2:4}$ progeny bulks were then planted out under both stressed and non-stressed conditions, and the same measurements made as for the F_3 generation. The ability to select progenies under both stressed and non-stressed conditions enabled an assessment of the relative merit of selection environment during the final evaluation studies. This further cycle of selection was implemented in the F_4 generation, and the top 10% of the progenies were advanced.

• The selected $F_{2:4}$ families were used to generate five $F_{2:5}$ families at each breeding site for each selection method. In India, these $F_{2:5}$ families from both selection methods were advanced to $F_{2:6}$ and their seed increased. The replicated field trials, conducted in 2000-01, consisted of 192 $F_{2:6}$ families, three each from no- moisture-stress and managed moisture- stress for trait selection method, and six from the empirical selection method for each cross/breeding site combination.

Empirical (direct) selection programm

In order to maintain consistency between empirical (M_2) and trait-based selection protocols, the empirical selection procedure practiced pod-yield selection at the same time as the trait-based measurements/selections (*i.e.* in $F_{2:3}$ and $F_{2:4}$ generations). In essence, the procedure was similar to the plan for trait-based selections, except that selections were made in an appropriate target environment as chosen by the relevant breeding program (for example, under rain-fed or irrigated conditions at the main experimental site, like normal practice for the local breeding program). By the end of the selection cycles, the empirical selection approach carried out at the four centres in India, supplied a subset of $F_{2:5}$ progenies for inclusion in the multilocation testing during 2000-01. As for the trait-based approach, selection for yield was strictly within maturity classes to avoid confounding effects of crop phenology, drought escape and yield-determining traits.

The experiment was laid out in a resolvable incomplete block (Alpha) design (Patterson, and Williams, 1976) with three replications. Each replication had 50 blocks, 48 for selections and two for parents, each with four plots. Each plot consisted of four four-meter rows. The inter-row and intra-row spacing were 30 and 10 cm, respectively. The basal dose of fertilizers consisted of 44 kg urea (20kg N) and 375 kg single super phosphate (60 kg P_2O_4) per hectare. Before sowing, the seeds were treated with 1% ethrel solution to break any seed dormancy. For protection from fungi and insects, seeds were treated with Bavistin (3 g/kg of seed) and chlorpyriphos 20 EC (1.5 litres/100 kg of seed). At 35–40 days after sowing, chlorpyriphos 20 E.C. was again applied to the soil to control termites. Other agronomic practices were followed as per local crop recommendations. The observations for all the traits *i.e.* harvest index, pod yield per plant, shelling percentage, kernel yield per plant, 100-kernel weight, oil content percentage, protein content, soil plant analysis development (SPAD) chlorophyll meter reading (SPAD-502, Minolta) were recorded on one meter row length, having competitive plants for each treatment in each replication. All the data were nasalised through statistical software Gen state var. 6.0.

Results

Harvest index

Value of mean square for harvest index (HI) due to genotypes was significant. Harvest index of the parents (54.95%) was significantly higher than their progenies (51.58%) (table 4). Among the parents it was maximum in TAG-24 (62.33%). GG-2 (58.72%) was also having harvest index at par with TAG-24 (table 3). Among the centres maximum harvest index was in the progenies selected at Jalgoan (52.92%) followed by progenies selected at junagardh (table 8). Between method difference was significant in progenies from ICRISAT, Jalgoan and Tirupati. Progenies selected through trait based selection showed higher harvest index at ICRISAT and Tirupati. Whereas, progeny selected through empirical selection was superior from Jalgoan (Table 9).

In trait based selection harvest index of progenies selected in irrigated condition at Jalgoan was significantly higher than progenies selected under drought condition (table-5) whereas for rest of the centres no effect of environment could be observed. Among the crosses in drought condition ICGS-44´CSMG-84-1 of ICRISAT, GG-2´ICGV-86031 of Junagadh and ICGS-76´ICGS-44 of Tirupati was having maximum harvest index (table - 6).

In empirical selection difference was significant between crosses from all the four centres. Cross ICGV-86031´TAG-24 had significantly higher harvest index than rest of the crosses of ICRISAT and Tirupati (table-7) whereas, ICGS-44´CSMG-84-1 showed maximum harvest index among Jalgaon and Junagadh crosses. Within cross difference was significant in the cross from all the centres. But some of the progenies could show significantly higher harvest index than the parent TAG-24.

Pod yield per plant

Analysis of variance revealed significant difference among genotypes. Among the parents maximum pod yield was observed in CSMG-84-1 (21.89 g). Mean performance of TAG-24 and ICGV-86031 was also at par with CSMG-84-1 (table-3). Maximum pod yield per plant was observed in progenies selected at Jalgoan (15.82 g) followed by Junagadh (15.49 g), ICRISAT (14.88 g) and Tirupati (13.84 g). Progenies selected through empirical selection at Jalgoan had significantly higher pod yield per plant (16.34 g) than trait-based selection (15.30) g whereas at rest of the centres progenies of both the methods were at par (table-4).

In trait based selection under drought condition cross ICGS-76´ICGS-44 of ICRISAT, GG-2´ICGV-86031 of Junagadh and ICGS-76´CSMG-84-1 of Tirupati and in irrigated condition ICGV 86031´TAG-24 of Jalgoan, GG-2´ICGV-86031 of Junagadh, ICGS-76´CSMG-84-1 of Tirupati had maximum pod yield per plant at respective centres (table-6). Progeny JUG_11 showed significantly higher yield (26.01 g) than the best parent, CSMG-84-1 (21.89 g).

In empirical selection difference between cross was significant of all the four centres. Progenies selected at ICRISAT and Tirupati from cross ICGV-86031 ´ TAG-24 had maximum pod yield per plant than other crosses of respective centres (table-7). Similarly progenies of cross ICGS-44´CSMG-84-1 selected at Jalgoan and from cross GG-2´ICGV-86031 at Junagadh also had higher pod yield per plant (table-7). Among the progenies maximum pod yield per plant was observed in 'ICR 39' (28.33 g). Progeny 'JUG 35' (25.25 g) was also at par to 'ICR 39' and their pod yield was higher than the best parent 'CSMG-84-1'.

Shelling percentage

Difference between genotypes was significant for shelling percentage whereas, difference between mean

Table 1: 192 progenies drived from crosses which prepared at four different breeding locations.

Crosses Symbols	Female Parent	Male Parent	Parentage	Breeding Centre	No. crosses	Methods	Environment	Progenies
XA	ICGS 76	CSMG 84-1	(ICGS 76 × CSMG 84-1)	Common all Centre	4	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XB	ICGS 44	CSNG 84-1	(ICGS 44 × CSNG 84-1)	Common all Centre	4	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XC	ICGV 86031	TAG 24	(ICGV 86031 × TAG 24)	Common all Centre	4	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XD	GG-02	ICGV 86031	(GG-02 × ICGV 86031)	Junagadh	1*	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XE	JL-220	TAG 24	(JL-220 × TAG 24)	Jalgaon	1*	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XF	K-134	TAG 24	(K-134 × TAG 24)	Tirupati	1*	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
XG	ICGS 44	ICGS 76	(ICGS 44 × ICGS 76)	ICRISAT	1*	Trait Based	Drought	03
							Irrigated	03
						Empirical	Irrigated	06
12 progenies drive from each crosses of the four centres =								192
Total genotypes including 08 parents =								200

* Local specific cross

Table 2: Analysis of variance of Alpha design for various traits in Peanut.

Trait / Source		Harvesting index	Pod yield/ plant	Shelling percen-tage	Kernal yield/ plant	100-Kernal weight	Oil content	Protein content	SPAD reading
Replication (2)		1.2	9.865	2.472	8.569	237.395**	0.045	0.231	617.250**
Genotypes (Adjusted) (199)		48.956**	27.342**	33.782**	14.151**	89.213**	10.067**	8.904**	3.612**
Genotypes (Unadjusted) (199)		67.174**	36.347**	45.792**	18.951**	128.814**	14.360**	11.993**	14.214**
Block/Replication (Adjusted) (147)		5.822	7.602	4.046	3.687	10.728	0.188	0.12	7.098
Block/ Replication (Unadjusted) (147)		30.485**	19.793**	20.304**	10.186**	64.338**	5.998**	4.302**	21.450**
Error (151)		5.354	6.066	3.457	2.901	9.143	0.178	0.123	7.517
C. V.	Alpha	10.35	40.15	4.89	28.18	16.59	0.37	0.53	17.69
	RBD	4.55	17.05	2.71	17.35	5.66	0.88	1.5	6.39

( ) Figures in parenthesis are degrees of freedom.

*** Significant at 1 and 5 per cent level of significance, respectively

performances of parents and their progenies was non-significant. Among the parents, maximum shelling percentage was observed in 'TAG-24' (74.33%) (Table 3). Shelling percentage of progenies selected through trait based selection (71.40%) was significantly higher than progenies selected through empirical selection (70.35%) at Junagadh (table 9). Whereas in crosses of Tirupati results were reverse. Shelling percentage of progeny

Table 3: Mean values of parents for various characters in Peanut

Parents and their selection based traits		Harvest index (%)	Pod yield/ plant (g)	Shelling (%)	Kernal yield/ plant (g)	100- kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
ICGS-44	**High HI**	51.80^{c}	$15.27^{b,c}$	$71.33^{a,b}$	$10.47^{c,d}$	$57.00^{a,b}$	44.95^{f}	26.85^{a}	39.90^{b}
ICGS-76	**High T and HI**	49.35^{c}	15.96^{b}	63.33^{d}	$9.81^{b,c}$	$57.00^{a,b}$	50.39^{b}	21.39^{d}	44.87^{a}
CSMG-84-1	**High TE,T and Low HI**	56.96^{b}	21.89^{a}	$71.33^{a,b}$	15.12^{a}	56.00^{b}	48.94^{c}	23.94^{c}	39.63^{b}
ICGV-86031	**High TE & WUE**	54.68^{b}	20.35^{a}	68.00^{c}	$13.44^{a,b}$	55.67^{b}	51.84^{a}	20.84^{e}	44.40^{a}
TAG-24	**High TE & HI**	62.23^{a}	20.69^{a}	74.33^{a}	14.85^{a}	55.67^{b}	$45.39^{e,f}$	24.05^{c}	$41.10^{a,b}$
JL-220	**locally adapted line**	57.72^{b}	16.54^{b}	72.67^{a}	11.57^{b}	61.67^{a}	50.28^{b}	21.28^{d}	37.17^{b}
GG-2	**locally adapted line**	$58.72^{a,b}$	17.54^{b}	$68.67^{b,c}$	11.70^{b}	$51.33^{b,c}$	47.92^{d}	21.56^{d}	39.07^{b}
K-134	**locally adapted line**	48.13^{c}	11.91^{c}	72.67^{a}	8.27^{d}	46.33^{c}	45.80^{e}	25.78^{b}	37.17^{b}
Mean		54.95	17.52	70.29	11.90	55.08	48.19	23.21	40.41
Sed		1.36	1.49	1.11	1.03	1.80	0.25	0.20	1.57
CD 5%		3.78	4.13	3.08	2.87	5.01	0.68	0.56	4.36

Means having different alphabets differ significantly

Table 4: Mean values of trait based and empirical selection for centres for various characters in Peanut

Methods	Harvest index (%)	Pod yield/ plant (g)	Shelling (%)	Kernal yield/ plant (g)	100-kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
C_1 M_1	51.72^{a}	14.84	70.37	10.03	57.38^{a}	48.40	23.34^{a}	43.54^{a}
M_2	50.70^{b}	14.93	70.43	10.17	53.25^{b}	48.35	23.12^{b}	42.46^{b}
C_2 M_1	52.31^{b}	15.30^{b}	71.18	10.63	56.06^{b}	48.93^{a}	22.74^{b}	42.46
M_2	53.53^{a}	16.34^{a}	70.76	11.10	57.24^{a}	47.86^{b}	23.11^{a}	42.46
C_3 M_1	52.00	15.82	71.40^{a}	10.86^{a}	51.43	48.42^{a}	23.00^{b}	42.51
M_2	52.11	15.17	70.35^{b}	10.26^{b}	52.07	47.69^{b}	23.80^{a}	42.21
C_4 M_1	50.66^{a}	13.49	69.83^{b}	9.14	56.89	48.36^{a}	23.59	42.62
M_2	49.64^{b}	14.19	71.72^{a}	9.64	56.38	48.09^{b}	23.68	42.30
Mean	51.58	15.01	70.76	10.23	55.09	48.26	23.30	42.57
Sed	0.28	0.30	0.23	0.21	0.37	0.05	0.04	0.32
CD 5%	0.77	0.84	0.63	0.59	1.02	0.14	0.11	0.89

Means having different alphabets differ significantly

C_1 = ICRISAT, C_2 = Jalgaon, C_3 = Junagadh, C_4 = Tirupati and M_1 = trait based, M_2 = Empirical

Table 5: Mean values of drought and irrigated environments of four centres in trait based selection for various characters in Peanut.

Environ -ments	Harvest index (%)	Pod yield/ plant (g)	Shelling (%)	Kernal yield/ plant (g)	100-kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
C_1 E_1	51.32	14.25	69.39^{b}	9.46^{b}	56.31^{b}	48.64^{a}	23.46^{a}	43.99
E_2	52.12	15.43	71.36^{a}	10.59^{a}	58.44^{a}	48.16^{b}	23.22^{b}	43.08
C_2 E_1	51.51^{b}	14.54^{b}	72.39^{a}	10.15^{b}	57.28^{a}	49.98^{a}	22.01^{b}	42.23
E_2	53.11^{a}	16.07^{a}	69.97^{b}	11.11^{a}	54.83^{b}	47.87^{b}	23.47^{a}	42.68
C_3 E_1	51.99	16.14	71.06	10.96	52.17^{a}	48.45	22.97	41.66^{b}
E_2	52.01	15.49	71.75	10.77	50.69^{b}	48.39	23.03	43.35^{a}
C_4 E_1	50.32	12.73^{b}	70.00	8.55^{b}	57.78^{a}	48.26	23.65	42.98
E_2	51.01	14.24^{a}	69.67	9.73^{a}	56.00^{b}	48.46	23.53	42.27
Mean	51.67	14.86	70.70	10.17	55.44	48.53	23.17	42.78
Sed	0.39	0.43	0.32	0.30	0.52	0.07	0.06	0.45
CD 5%	1.09	1.19	0.89	0.83	1.45	0.20	0.16	1.26

Means having different alphabets differ significantly

C_1 = ICRISAT, C_2 = Jalgaon, C_3 = Junagadh, C_4 = Tirupati and E_1 = Drought condition, E_2 = Irrigated condition

Table 6: Mean values for each hybrid in two environments of four centres through trait based selection for various characters in Peanut.

Hybrids	Harvest index(%)	Pod yield/ plant (g)	Shelling (%)	Kernal yield/ plant (g)	100- kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
$C_1 E_1 H_1$	46.95^{c}	11.79^{b}	68.67	7.77^{b}	56.67^{a,b}	48.52^{b}	22.96^{c}	44.99
H_2	54.98^{a}	15.36^{a}	69.11	10.22^{a}	53.89^{b}	48.34^{b}	24.51^{a}	42.76
H_3	52.70^{b}	14.39^{a}	68.89	9.51^{a}	56.67^{a,b}	48.72^{a,b}	23.47^{b}	44.79
H_4	50.64^{b}	15.43^{a}	70.89	10.36^{a}	58.00^{a}	48.98^{a}	22.90^{c}	43.44
$E_2 H_1$	49.64^{b}	13.65	75.22^{a}	9.93	60.78^{b}	47.02^{c}	23.61^{b}	43.29
H_2	52.21^{a}	15.72	68.33^{c}	10.32	54.22^{c}	49.96^{a}	22.77^{c}	42.33
H_3	54.20^{a}	16.59	70.78^{b}	11.31	54.89^{c}	46.35^{d}	24.20^{a}	43.41
H_4	52.41^{a}	15.75	71.11^{b}	10.80	63.89^{a}	49.32^{b}	22.31^{d}	43.30
$C_2 E_1 H_1$	51.03	14.93	72.67^{a,b}	10.44	56.44^{b}	50.50^{a}	22.14^{b}	44.99^{a}
H_2	52.12	15.47	72.33^{b}	10.74	58.89^{b}	50.27^{a,b}	20.96^{c}	40.34^{b}
H_3	50.10	12.88	70.11^{c}	8.76	51.44^{c}	49.08^{c}	23.11^{a}	43.07^{a}
H_4	52.77	14.87	74.44^{a}	10.65	62.33^{a}	50.07^{b}	21.83^{b}	40.51^{b}
$E_2 H_1$	49.37^{b}	14.66^{b}	68.22^{c}	10.03^{b}	50.89^{b,c}	48.18^{a}	22.68^{c}	44.67^{a}
H_2	54.46^{a}	14.69^{b}	73.78^{a}	10.77^{a,b}	55.22^{b}	47.45^{b}	24.46^{a}	41.62^{b}
H_3	53.49^{a}	18.21^{a}	67.67^{c}	12.33^{a}	51.44^{c}	47.70^{b}	23.29^{b}	43.67^{a,b}
H_4	55.10^{a}	16.71^{a,b}	70.22^{b}	11.31^{a}	61.78^{a}	48.16^{a}	23.46^{b}	40.78^{b}
$C_3 E_1 H_1$	50.96^{b}	14.82^{b}	73.56^{a}	10.45^{b}	54.11^{a}	48.22^{b}	23.32^{a,b}	44.34^{a}
H_2	50.39^{b}	16.09^{b}	65.33^{c}	10.00^{b}	53.78^{a}	50.18^{a}	22.04^{c}	39.59^{b}
H_3	51.01^{b}	13.94^{b}	71.67^{b}	9.60^{b}	53.22^{a}	47.21^{c}	23.43^{a}	41.92^{a,b}
H_4	55.59^{a}	19.70^{a}	73.67^{a}	13.77^{a}	47.56^{b}	48.17^{b}	23.07^{b}	40.78^{b}
$E_2 H_1$	52.86^{a}	14.94^{a}	73.00^{a,b}	10.41	58.22^{a}	49.03^{a}	23.26^{a}	45.44^{a}
H_2	48.81^{b}	13.68^{b}	74.44^{a}	10.14	50.89^{b}	48.22^{b,c}	22.86^{b}	42.06^{b}
H_3	53.06^{a}	16.23^{a}	68.00^{c}	10.67	49.33^{b}	48.35^{b}	23.48^{a}	42.32^{b}
H_4	53.29^{a}	17.12^{a}	71.56^{b}	11.86	44.33^{c}	47.95^{c}	22.52^{c}	43.59^{a}
$C_4 E_1 H_1$	53.56^{a}	14.24^{a}	69.22^{b}	9.45^{a}	53.78^{c}	48.59^{a}	23.09^{b}	43.10
H_2	49.17^{b}	13.69^{a}	71.89^{a}	9.46^{a}	56.44^{b,c}	48.55^{a}	24.56^{a}	42.61
H_3	50.31^{b}	10.96^{b}	69.56^{b}	7.30^{b}	58.22^{b}	47.49^{b}	24.54^{a}	42.43
H_4	48.24^{b}	12.01^{a}	69.33^{b}	7.98^{a}	62.67^{a}	48.40^{a}	22.42^{c}	43.77
$E_2 H_1$	52.62^{b}	15.08^{b}	73.00^{a}	10.62^{b}	56.33^{a}	48.34^{c}	23.17^{b}	43.37^{a,b}
H_2	55.61^{a}	17.72^{a}	70.44^{b}	12.52^{a}	58.56^{a}	49.71^{a}	22.90^{c,d}	43.50^{a}
H_3	46.72^{d}	11.31^{b,c}	67.89^{c}	7.49^{c}	51.11^{b}	47.06^{c}	24.58^{a}	39.94^{b}
H_4	49.08^{c}	12.87^{b}	67.33^{c}	8.27^{c}	58.00^{a}	48.73^{b}	23.48^{b}	42.26^{a,b}
Sed	0.78	0.86	0.64	0.60	1.04	0.14	0.12	0.90
CD 5%	2.18	2.39	1.78	1.66	2.89	0.39	0.32	2.51

Means having different alphabets differ significantly

selected under irrigated condition at ICRISAT and under drought condition at Jalgoan was significantly higher than their counter condition at both the locations (Table-6). In drought conditions JL-220´TAG-24 of Jalgoan, GG-2´ICGV-86031 of Junagadh, and ICGS-44´CSMG-84-1 of Tirupati had maximum shelling percentage among the crosses of respective centres (table-7). Among all the parents maximum shelling percentage was observed in the best parent 'TAG-24' (74.33 %).

In empirical selection differences between crosses were significant of all the four centres. Progeny of cross ICGS-76´CSMG-84-1 selected at ICRISAT and Junagadh showed higher shelling percentage (Table-7) whereas, ICGS-76´ICGS-44 of ICRISAT and K-134´TAG-24 of Tirupati were having higher shelling percentage than rest of the crosses of same centres. The progenies were significant difference in all the cross of four centres.

Kernal yield per plant

Among the parents maximum kernal yield was observed in 'ICMS-84-1' (table-3). Mean performances of 'TAG-24' and 'ICGV-86031' was also at par with CSMG84-1. Among the centres maximum kernal yield

Table 7: Mean values for four crosses selected through empirical selection centres for various characters in Peanut.

Hybrids	Harvest index (%)	Pod yield/ plant (g)	Shelling (%)	Kernal yield/ plant (g)	100-kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
$C_1 H_1$	50.25^{c}	15.61^{a}	72.00^{a}	10.78^{a}	56.06^{a}	48.69^{a}	22.96^{b}	42.89
H_2	46.36^{b}	11.78^{b}	69.56^{b}	7.87^{b}	52.22^{b}	47.56^{b}	23.52^{a}	43.05
H_3	54.26^{a}	16.64^{a}	71.22^{a}	11.49^{a}	53.61^{b}	48.70^{a}	23.35^{a}	42.67
H_4	51.94^{b}	15.70^{a}	68.94^{b}	10.53^{a}	51.11^{c}	48.43^{a}	22.67^{c}	41.22
$C_2 H_1$	51.29^{c}	13.93^{c}	72.00^{b}	9.62^{b}	62.50^{a}	48.62^{a}	23.13^{b}	44.99^{a}
H_2	55.02^{a}	18.26^{a}	69.50^{c}	12.23^{a}	52.72^{b}	48.29^{b}	23.39^{a}	41.98^{b}
H_3	54.85^{a}	17.10^{a,b}	67.56^{d}	11.27^{a}	51.94^{b}	47.14^{c}	23.30^{c}	43.99^{a}
H_4	52.96^{b}	16.06^{b}	74.00^{a}	11.27^{a}	61.78^{a}	47.41^{c}	22.60^{c}	38.88^{c}
$C_3 H_1$	51.83^{b}	14.01^{b}	72.44^{a}	9.78^{b}	55.72^{a}	47.66^{b}	23.49^{c}	42.42
H_2	53.61^{a}	16.20^{a}	69.67^{b}	10.81^{a,b}	51.83^{b}	47.83^{b}	23.73^{b}	41.62
H_3	51.26^{b}	13.94^{b}	67.22^{c}	9.03^{b,c}	54.06^{a}	46.85^{c}	24.43^{a}	42.38
H_4	51.72^{b}	16.51^{a}	72.06^{a}	11.42^{a}	46.67^{c}	48.42^{a}	23.55^{b,c}	42.43
$C_4 H_1$	46.13^{c}	11.95^{c}	71.39^{b}	8.16^{c}	50.78^{c}	47.72^{b}	24.31^{a}	42.31
H_2	48.95^{b}	13.22^{b,c}	70.44^{b}	8.93^{b,c}	58.94^{a}	47.79^{b}	24.35^{a}	43.26
H_3	54.53^{a}	17.20^{a}	72.50^{a,b}	11.92^{a}	60.56^{a}	48.31^{a}	23.16^{b}	41.47
H_4	48.95^{b}	14.38^{b}	72.56^{a}	9.54^{b}	55.22^{b}	48.53^{a}	22.91^{c}	42.17
Sed	0.55	0.61	0.45	0.42	0.74	0.10	0.08	0.640
CD 5%	1.54	1.69	1.26	1.17	2.04	0.28	0.23	1.78

Means having different alphabets differ significantly **(1.)** C_1 = ICRISAT, C_2 = Jalgaon, C_3 = Junagadh, C_4 = Tirupati **(2.)** H_1 = ICGS-76 ´CSMG-84-1, H_2 = ICGS-44 ´CSMG-84-1, H_3 = ICGV-86031 ´TAG-24, $C_1 H_4$ = ICGS-76 ´ICGS-44, $C_2 H_4$ = JL-220 ´TAG-24, $C_3 H_4$ = GG-2 ´ ICGV 86031, $C_4 H_4$ = K-134 ´TAG-24, P= Progeny

observed in progenies selected at Jalgoan followed by Junagadh, ICRISAT and Tirupati. Difference between progenies of Jalgoan and Junagadh was not significant. Kernal yield per plant in progenies selected through trait-based selection was significantly higher than the progenies of empirical selection exercised at Junagadh (table-5). For rest of the centres no such difference was observed. However effect of environment was significant for these three centres whereas progenies selected under irrigated conditions had higher kernal yield per plant than progeny selected under drought condition. Between cross difference was significant at all the four centres in both the environments except in irrigated environment of ICRISAT and Junagadh and drought condition of Jalgoan. Progeny 'JUG 11' (18.98 g) was only having significantly higher kernal yield than the best parent CSMG 84-1 (15.12 g). In empirical selection difference between crosses was significant at all the four centres. Progenies of ICGV 86031´TAG 24 selected at ICRISAT and Tirupati, of ICGS 44´CSMG 84-1 selected of Jalgoan and of GG 2´ICGV 86031 selected at Junagadh had maximum kernal yield per plant than other crosses of these centres (table-7). Within cross difference was significant in all the crosses of all the four centres. Among all the progenies only 'ICR 39' (20.56g) showed higher kernal yield per plant than the best parent CSMG 84-1.

100-kernal weight

The differences between parents and progenies means were non-significant. Among the parents highest 100-kernal weight was observed in JL 220 (61.67 g). The 100-kernal weight of ICGS 44 (57.00 g), ICGS 76 (57.00 g) and ICGS 76 (57.00 g) (table-3) were at par with JL 220. Among the centres highest 100-kernal weight was observed in progenies selected at Jalgoan (56.65 g) followed by Tirupati (56.63 g), ICRISAT (55.31 g) and Junagadh (51.75 g). Between cross difference was significant in both the environments at all the four centres. At ICRISAT under both the environments ICGS 76 ´ ICGS 44, at Jalgoan and Junagadh under both the environments ICGS 76´CSMG 84-1, at Tirupati under drought condition K 134´TAG 24 had maximum 100-kernal weight. Progeny difference was also significant in all the crosses at all the four centres and selected in both the environments except in ICGS 76´CSMG 84-1 selected under drought condition at Junagadh and under irrigated condition of Tirupati, in progenies of ICGS 44´CSMG 84-1 selected under irrigated at Junagadh and in progenies of ICGV 86031´TAG 24 selected under irrigated at Tirupati. Among all the progenies highest 100 kernal weight was observed in TIR 19' (70.33 g). It was followed by 'TIR 01' (64.00 g), 'TIR 09' (63.00 g), 'TIR 13' (64.67 g), 'JAL 03' (62.00 g), 'JAL 04' (67.67 g)

Table 8: Detail of genetic materials investigate for drought tolerance in Peanut Parent.

S.No.	Gen_ID	Hybrid symbol(Parentage)	Environment	Selected Traits	value	Methods
1	JUG- 09	XC(ICGV 86031 X TAG 24)	DRO	Sheeling Parcentage (%)	75.00	Trait based
2	TIR- 09	XA(ICGS 76 X CSMG 84-1)	DRO	100 Keranal weight (g)	63.00	Trait based
3	JAL- 02	XA(ICGS 76 X CSMG 84-1)	DRO	Sheeling Parcentage (%)	75.00	Trait based
4	JUG -01	XA(ICGS 76 X CSMG 84-1)	DRO	Sheeling Parcentage (%)	75.00	Trait based
5	JAL- 12	XE (JL-220 X TAG 24)	DRO	100 Keranal weight (g)	64.00	Trait based
6	JAL- 04	XB(ICGS 44 X CSNG 84-1)	DRO	100 Keranal weight (g)	67.67	Trait based
7	JUG- 11	XD (GG02 X ICGV 86031)	DRO	Sheeling Parcentage (%) Pod yield (g) Kerenal yield (g)	76.00 26.01 18.98	Trait based
8	ICR- 01	XA(ICGS 76 X CSMG 84-1)	DRO	100 Keranal weight (g)	63.00	Trait based
9	JUG- 02	XA(ICGS 76 X CSMG 84-1)	DRO	SPAD Reading	46.43	Trait based
10	JAL- 07	XC(ICGV 86031 X TAG 24)	DRO	Sheeling Parcentage (%) SPAD Reading	74.67 45.23	Trait based
11	JAL -03	XA(ICGS 76 X CSMG 84-1)	DRO	100 Keranal weight (g)	62.00	Trait based
12	TIR- 01	XB(ICGS 44 X CSNG 84-1)	DRO	100 Keranal weight (g)	64.00	Trait based
13	ICR -09	XC(ICGV 86031 X TAG 24)	DRO	SPAD Reading	46.63	Trait based
14	ICR -11	XG (ICGS 44 X ICGS 76)	DRO	Sheeling Parcentage (%)	74.67	Trait based
15	JAL- 11	XE (JL-220 X TAG 24)	DRO	100 Keranal weight (g)	64.33	Trait based
16	ICR- 08	XC(ICGV 86031 X TAG 24)	DRO	100 Keranal weight (g)	62.33	Trait based
17	JUG- 10	XD (GG02 X ICGV 86031)	DRO	Sheeling Parcentage (%)	75.00	Trait based
18	TIR- 13	XC(ICGV 86031 X TAG 24)	DRO	100 Keranal weight (g)	64.67	Trait based
19	TIR -19	XF (K134 X TAG 24)	DRO	Sheeling Parcentage (%) 100 Keranal weight (g)	75.33 70.33	Trait based
20	ICR- 60	XC(ICGV 86031 X TAG 24)	DRO	Protien Parcentage (%)	27.81	Trait based
21	JAL- 10	XE (JL-220 X TAG 24)	DRO	Sheeling Parcentage (%)	76.00	Trait based
22	ICR -03	XA(ICGS 76 X CSMG 84-1)	DRO	SPAD Reading	47.80	Trait based

Table 9: Mean values of four breeding centres for various traits in peanut.

Centres	Harvest index (%)	Pod yield/ plant (g)	Shelling per-centage (%)	Kernal yield/ plant (g)	100-kernel weight (g)	Oil content (%)	Protein content (%)	SPAD reading
ICRISAT	51.21[c]	14.88[b]	70.40	10.10[b]	55.31[b]	48.37[a]	23.23[c]	43.00
Jalgaon	52.92[a]	15.82[a]	70.97	10.86[a]	56.65[a]	48.40[a]	22.92[d]	42.46
Junagadh	52.05[b]	15.49[a]	70.88	10.56[a]	51.75[c]	48.05[c]	23.40[b]	42.36
Tirupati	50.15[b]	13.84[c]	70.78	9.39[c]	56.63[a]	48.22[b]	23.64[a]	42.46
Mean	51.58	15.01	70.76	10.23	55.09	48.26	23.30	42.57
Sed	0.20	0.21	0.16	0.15	0.26	0.04	0.03	0.23
CD 5%	0.55	0.60		0.41	0.72	0.10	0.08	

'JAL 11' (64.33 g), 'JAL 12' (64.00 g) 'ICR 01' (63.00g), and 'ICR 8' (62.33g) (table 8). 100-kernal weight of these progenies was significantly higher than best parent 'JL 220' (61.67 g).

In empirical selection between cross difference was significant at all the four centres. Cross ICGS-76 ´ CSMG-84-1 had maximum 100-kernal weight at ICRISAT, Jalgoan and Junagadh, whereas, ICGV-86031 ´ TAG-24 had at Tirupati. Within cross difference was significant in all the crosses of all the four centres except cross ICGS-44´CSMG-84-1 of Junagadh.

Oil content

Among parents maximum oil content was observed in ICGV-86031 (51.84%). Among the centres oil content was maximum in progenies selected at ICRISAT (48.37%) followed by Jalgoan (48.40%), Tirupati

Table 10: Analysis of variance of RBD for different characters in groundnut.

Source	D.F.	Mean Square							
		Harvest index	Pod yield/ plant	Shelling %	Kernal yield/ plant	100-kernel weight	Oil content (%)	Protein content (%)	SPAD reading
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Replication	2	1.20	9.86	2.47	8.56	237.40**	0.05	0.23	617.25**
2. Genotype (Unad)	199	67.18**	36.35**	45.79**	18.95**	128.81**	14.36**	11.99**	14.21**
Bet parent & progeny	1	261.15**	145.17**	4.99	64.65**	0.00	0.12	0.18	107.23**
Parents	7	71.51**	33.05**	36.90**	17.65**	61.21**	20.27**	15.64**	25.70**
Progeny	191	66.01**	35.90**	46.33**	18.76**	131.97**	14.22**	11.92**	13.31**
Between centres	3	201.11**	109.62**	8.94	59.49**	768.15**	3.59**	12.94**	12.09
ICRISAT	47	85.59**	41.49**	34.50**	22.01**	135.82**	14.95**	12.84**	8.47
Between method	1	37.19**	0.35	0.11	0.71	612.56**	0.10	1.73**	
Trait based	23	63.05**	22.48**	35.05**	12.34**	103.63**	11.10**	10.74**	
Bet. Environ.	1	11.44**	25.09**	70.01**	22.82**	82.35**	4.05**	1.02**	
Drought cond.	11	63.80**	19.82**	22.84**	10.29**	80.51**	8.37**	7.25**	
Between hybrid	3	104.67**	26.09**	9.30**	12.67**	26.92**	0.67**	5.04**	
Hybrid 1	2	34.75**	8.85**	27.00**	2.08**	127.00**	5.43**	8.07**	
Hybrid 2	2	29.41**	4.68**	4.11**	1.40**	87.11**	19.30**	1.83**	
Hybrid 3	2	38.38**	24.19**	48.11**	8.34**	124.33**	0.80**	2.07**	
Hybrid 4	2	91.34**	32.18**	32.44**	25.77**	64.00**	19.48**	20.34**	
Irrigated cond.	11	66.99**	24.90**	44.09**	13.44**	128.69**	14.46**	15.12**	
Between hybrid	3	31.76**	14.09**	73.44**	3.23**	196.67**	27.43**	6.43**	
Hybrid 1	2	16.41**	25.71**	14.78**	17.83**	130.11**	1.78**	22.04**	
Hybrid 2	2	51.04**	43.39**	86.33**	23.63**	43.11**	4.78**	10.46**	
Hybrid 3	2	4.18	16.83	4.11	5.97	38.78*	26.47**	29.44**	
Hybrid 4	2	249.19**	29.89*	27.11**	21.64**	200.78**	5.37**	11.59**	
Empirical	23	110.24**	62.29**	35.43**	32.61**	147.28**	19.45**	15.42**	
Between hybrid	3	199.48**	83.37**	36.38**	45.28**	81.80**	5.22**	2.66**	
Within hybrid 1	5	66.61**	33.28**	10.40**	13.59**	180.99**	27.87**	17.55**	
Within hybrid 2	5	80.95**	16.54**	37.42**	5.87	131.96**	30.49**	19.79**	
Within hybrid 3	5	90.41**	122.49**	58.22**	71.17**	58.19**	16.37**	15.20**	
Within hybrid 4	5	149.43**	64.19**	35.12**	32.20**	257.29**	11.59**	16.78**	
Jalgaon	47	59.38**	33.67**	53.26**	17.09**	123.72**	14.87**	12.85**	17.89**
Between method	1	54.10**	38.75*	6.25	7.91	50.17*	40.53**	4.84**	0.00
Trait based	23	63.72**	36.74**	51.59**	19.40**	116.63**	14.73**	12.14**	13.71**
Bet. Environ.	1	46.12**	42.18*	105.12**	16.68**	107.56**	80.05**	38.53**	3.74
Drought cond.	11	25.61**	24.77**	32.05**	13.73**	111.38**	8.41**	7.43**	18.76**
Between hybrid	3	12.57	11.65	28.48**	7.82	188.63**	3.54**	7.11**	44.46**
Hybrid 1	2	13.53	14.54	16.33*	9.50	81.44**	7.54**	12.60**	4.13
Hybrid 2	2	26.14**	66.13**	4.00	29.16**	173.44**	2.41**	4.47**	2.54
Hybrid 3	2	57.80**	21.01*	107.44**	18.09**	44.44*	17.49**	4.83**	26.66*
Hybrid 4	2	24.55*	17.10	5.78	7.05	30.33*	13.52**	8.30**	3.15
Irrigated cond.	11	103.43**	48.22**	66.27**	25.32**	122.70**	15.10**	14.46**	9.57
Between hybrid	3	59.89**	26.74**	68.77	8.44*	226.26**	1.18**	4.92**	
Hybrid 1	2	141.54**	66.94**	117.44**	43.77**	75.11**	18.24**	27.92**	
Hybrid 2	2	162.65**	65.60**	18.78**	36.02**	31.44*	3.72**	3.08**	
Hybrid 3	2	110.24**	68.11**	40.33**	29.59**	106.78**	28.16**	24.80**	
Hybrid 4	2	64.61**	24.45*	84.78**	17.24**	122.11**	31.17**	16.34**	
Empirical	23	55.26**	30.37**	56.97**	15.18**	134.01**	13.91**	13.90**	22.85**

Continue table 10..........

Continued table 10.......

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Between hybrid	3	55.76**	60.82**	143.35**	21.27**	580.27**	8.85**	2.26**	130.82**
Within hybrid 1	5	48.36**	20.49**	57.87**	12.10**	85.17**	11.19**	9.46**	7.84
Within hybrid 2	5	56.92**	18.60*	88.90**	9.04*	64.72**	15.20**	21.20**	5.07
Within hybrid 3	5	34.92**	25.95**	16.76**	14.89**	72.72**	14.66**	12.90**	5.53
Within hybrid 4	5	80.57**	38.15**	12.53**	21.03**	45.69**	17.60**	19.02**	8.19
Junagadh	47	42.45**	34.37**	59.33**	16.60**	101.50**	11.48**	9.71**	15.19**
Betweenn method	1	0.43	15.25	40.11**	13.16*	14.69	18.89**	23.18**	3.06
Trait based	23	39.00**	29.79**	62.98**	16.19**	113.90**	12.54**	9.87**	19.20**
Between Env.	1	0.01	7.50	8.68	0.63	39.01*	0.06	0.07	51.68**
Drought cond.	11	55.98**	45.14**	61.51**	25.09**	80.15**	16.04**	9.07**	25.03**
Between hybrid	3	52.60**	57.82**	138.56**	32.73**	86.26**	14.04**	3.66**	37.03**
Hybrid 1	2	38.18**	8.38	8.78	2.73	21.44	5.61**	17.14**	12.82
Hybrid 2	2	47.83**	31.30**	44.33**	8.17	33.78*	4.06**	7.30**	22.81*
Hybrid 3	2	12.76	5.16	46.33**	4.39	48.11**	8.11**	0.95**	24.15*
Hybrid 4	2	130.21**	116.67**	31.00**	73.58**	208.11**	49.41**	19.01**	22.34*
Irrigated cond.	11	25.56**	16.47**	69.40**	8.71**	154.45**	10.18**	11.56**	10.42
Between hybrid	3	41.10**	20.42*	68.77**	5.19	297.06**	1.90**	1.62**	
Hybrid 1	2	35.34**	31.13**	21.00**	10.39*	38.11*	14.28**	29.86**	
Hybrid 2	2	2.40	2.68	14.78*	1.16	23.11	11.31**	13.63**	
Hybrid 3	2	2.09	16.94	84.00**	13.83**	270.33**	12.91**	14.12**	
Hybrid 4	2	39.08**	9.22	158.78**	14.73*	72.33**	14.63**	3.54**	
Empirical	23	47.72**	39.77**	56.51**	17.17**	92.87**	10.09**	8.96**	11.70*
Between hybrid	3	19.29*	34.19**	105.27**	20.46**	279.20**	7.61**	3.33**	2.81
Within hybrid 1	5	54.64**	44.40**	46.36**	19.29**	56.72**	15.46**	10.61**	35.31**
Within hybrid 2	5	76.16**	66.83**	67.20**	22.59**	13.57	18.36**	18.28**	3.08
Within hybrid 3	5	58.83**	46.19**	63.82**	21.44**	145.66**	3.03**	4.58**	7.72
Within hybrid 4	5	18.32**	5.02	19.39**	3.35	43.73**	5.00**	5.74**	6.04
Tirupati	47	67.99**	29.36**	40.63**	16.74**	126.22**	16.25**	12.23**	11.75**
Between method	1	37.65**	17.73	128.44**	8.97	9.51	2.62**	0.30	3.71
Trait based	23	52.41**	22.46**	47.94**	12.51**	112.11**	14.33**	11.26**	14.06**
Between Env.	1	8.52	41.46*	2.00	24.91**	56.89*	0.74*	0.25	9.10
Drought cond.	11	43.39**	7.84	34.61**	4.41	140.26**	13.36**	9.35**	6.58
Between hybrid	3	48.55**		14.44**		125.63**	2.44**	10.33**	
Hybrid 1	2	30.63**		27.11**		215.44**	15.51**	16.96**	
Hybrid 2	2	43.63**		8.78		131.44**	2.11**	3.25**	
Hybrid 3	2	86.94**		24.78**		101.78**	20.26**	3.08**	
Hybrid 4	2	4.65		108.00**		134.33**	31.96**	12.61	
Irrigated cond.	11	65.42**	35.35**	65.45**	19.48**	88.97**	16.53**	14.18**	21.99**
Between hybrid	3	137.66**	69.84**	60.96**	47.12**	103.63**	10.89**	4.89**	24.37*
Hybrid 1	2	32.75**	17.32	9.33	11.35*	8.33	16.23**	26.00**	27.61**
Hybrid 2	2	31.74**	31.03**	83.44**	1.46	96.78**	27.36**	14.58**	5.74
Hybrid 3	2	51.52**	18.23	154.78**	17.15**	28.44	7.01**	8.33**	34.45**
Hybrid 4	2	37.32**	23.06*	21.00**	6.52	200.33**	23.95**	21.77**	16.60
Empirical	23	84.89**	36.77**	29.50**	21.30**	145.40**	18.76**	13.71**	9.79
Between hybrid	3	223.19**	90.22**	18.26**	47.46**	340.42**	2.85**	10.30**	
Within hybrid 1	5	195.91**	40.43**	12.72**	17.06**	96.22**	18.64**	11.36**	
Within hybrid 2	5	21.24**	12.58	45.82**	5.23	184.59**	8.24**	4.59**	
Within hybrid 3	5	16.60*	26.66**	15.57**	17.77**	131.02**	41.87**	27.92**	
Within hybrid 4	5	22.83**	35.32**	50.62**	29.45*	52.76**	15.85**	13.04**	
3. Error	398	5.54	6.63	3.67	3.19	9.73	0.18	0.12	7.36

(48.22%) and Junagadh (48.05%). Oil content in progenies of trait based selection was significantly higher than empirical selection exercised at Jalgoan, Junagadh and Tirupati (table-4).

In traits based selection, effect of environment was significant at ICRISAT and Jalgoan where progenies selected under drought conditions had higher oil content. Between cross difference was significant at all the four centres in both the environments, but none of the crosses showed constant superiority over the centres and environments (table-6). Progenies difference was also significant in all the crosses in both the environments of all the four centres. Three of the progeny were superior to the best parent ICGV-86031 (51.84 %).

In empirical selection between cross difference was significant but none of the crosses had superiority across the centres (table-7) within cross difference was significant in all the crosses of all the four centres. Among all the progenies more was having significantely higher oil content than the best parent ICGV-86031.

Protein content

Difference among genotypes was significant but parents and their selected progenies were at par. Among the parents maximum protein content was observed in ICGS-44 (26.85%). Among the centres difference for protien content was significant. Maximum protein content was observed in progenies selected at Tirupati (23.64%) followed by Junagadh (23.40%), ICRISAT (23.23%) and Jalgoan (22.92%). Between method differences were significant at three centres (Table-4) where at two *viz.*, Jalgoan and Junagadh progenies selected through empirical selection had higher protein content (table-4) whereas at ICRISAT protein content was higher in progenies as derived through trait based selection.

In traits based selection, effect of environment was significant only at two centres where at ICRISAT protein content was higher in progenies selected under drought environment. Between cross difference was significant in both the environments of all the four centres where progenies from drought condition of Jalgoan and Junagadh had maximum protein content (table-6) where as progenies of ICGS-44´CSMG-84-1 selected under drought condition of ICRISAT and Tirupati had maximum protein content at their respective centres. Within cross difference was significant in all the crosses of both the environments of all the centres except progenies of K-134´TAG-24 selected under drought condition at Tirupati (Table-6). Among all the progenies maximum protein content was observed in ICR_06 (27.81%). Protein content of this progeny was significantly higher than the best parent ICGS-44 (26.85%).

In empirical selection between cross difference was significant at all the four centres. Where progenies of cross ICGS-44´CSMG-84-1 selected at ICRISAT, Jalgoan and Tirupati had maximum protein content (table-7) whereas, at Junagadh progenies of ICGV-86031´TAG-24 (table-7) had maximum protein content. Within cross difference was also significant in all the four centres. Progeny JUG_32 (27.74%) had significantly higher protein content than the best parent ICGS-44.

SPAD chlorophil meter reading

SPAD reading of genotypes differ significantly. SPAD reading of progenies was significantly higher than parents. Among the parents it was maximum in ICGS-76 (44.87%). Difference between SPAD readings of progenies selected at different centres was non-significant. Similarly effect of method was observed only at ICRISAT (table-3) where progenies of trait based selection had higher spad reading.

In traits based selection, effect of environment was significant only at Junagadh (table-5). Between crosses differences were significant of cross of Jalgoan and Junagadh. The SPAD reading of cross ICGS-76´CSMG-84-1 was higher. Within cross difference was significant in ICGV-86031´TAG-24 of Jalgoan and Junagadh under drought condition and of Tirupati under irrigated condition. Cross ICGS-76´CSMG-84-1 under irrigated condition of Tirupati, ICGS-44´CSMG-84-1 and GG-2´ICGV-86031 under drought condition of Junagadh also differed significantly (table-6). Twelve of the progenies had SPAD reading higher than the best parent ICGS-76.

In empirical selection differences between cross were significant only for Jalgoan. Where maximum SPAD reading was observed in ICGS -76´CSMG-84-1 followed by ICGV-86031´TAG-24, ICGS-44´CSMG-84-1 and location specific cross JL-220´TAG-24. Difference between cross ICGS-76´CSMG-84-1 and ICGV-86031´TAG-24 was non significant (table-7).

Discussion

Analysis of variance of alpha design (table 2) revealed that adjusted as well as unadjusted mean square due to genotypes was significant for all the traits. The magnitude of unadjusted mean square was higher than adjusted mean square. The unadjusted mean square due to block was significant for all the traits except number of primary branches per plant. Whereas, adjusted mean square was not significant for any character. In these conditions neither block effect nor adjustment of genotype mean was necessary. Therefore, further analysis was carried out in randomised block design with break up of different sources. The error variance of RBD was also less than the alpha design.

Average performance of progenies was either poor than the parents or at par to the parents for all the character except for SPAD reading. Average SPAD reading of progenies was significantly higher than parents. Though variability within parents was significant in all the traits *viz.*, harvest index, pod yield per plant, shelling percentage, kernel yield per plant, 100-kernel weight, oil content and protein content. Progenies selected at different centers also differed significantly for all the traits. Progeny selected at Jalgoan showed higher mean values for all yield related traits *viz.*, pod yield per plant, kernel yield per plant, 100-kernel weight, oil content, and harvest index. None of the methods studied shown superior consistently there results are in linear with easlier reports (Basu *et al.,* 2003; Yadav *et al.,* 2004) (table-4).

In trait based selection one of the components of selection index was SPAD reading and another component was harvest index. At Junagadh there was no difference and at Jalgoan even significantly low. Similarly, empirical selection was based on pod yield per plant but its superiority was observed only at Jalgoan. This low genetic gain was due to the higher environmental effect on the expression of the traits at the time of selection. The effect of environment under which selection was exercised *i.e.* drought and irrigated conditions was also not uniform (Yadav *et al.*, 2004; Ober *et al.*, 2005; Rachaputi, 2003). It varied for centers (table-5). Only progenies selected under irrigated condition at one or more centers were superior for harvest index, pod yield per plant, kernel yield per plant, SPAD reading and 100-kernel weight. However progenies selected under drought condition contained more oil. For rest of the traits progenies from one environment of one center were superior but progenies selected under same environment at other center could not perform well. Therefore, role of environment under which selection was exercised also could not be proved. Between crosses differences were significant in both the methodsfor progenies from all the centers for 100-kernel weight, oil content and protein content but superiority of cross varied from center to center and method to method (Nigam *et al.*, 2003). For rest of the traits the difference was significant at some centers and in some methods with differential superiority except SPAD reading which was superior in cross ICGS-76 × CSMG-84-1 at all the centers where difference was significant (table-6,7).

On the basis of average performance and restriction up to the group. We can't identify superior progenies. Therefore, the number of progenies having superiority over the best parent judged the test of superiority of above factors. For eight traits, 22 such superior progenies were observed only. Whereas for rest of the traits none of the progenies was significantly superior than the best parents (Yadav *et al.*, 2004).

Out of 192 progenies 22 were identified for different traits for drought conditions which local selected among through trait based selection method only and empirical selection method could be proved unable to yield any primising material for moisture stress conditions. Therefore, on the basis of this investigation it can be concluded that trait based method appeared to have an edge over empirical selection method for breeding varieties for drought conditions (Nigam *et al.*, 2003; Ober *et al.*, 2005).

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