A simultaneous consideration of the three parameters (mean, b_j & S^2d_j) revealed that all the genotypes, except BAU 135, BAU 95-1, BAU 286-5 and BAU 138 had shown stability over environment for number of primary branches. Out of these six *viz;* LCK 8657, RLC 165, BAU 189-2, BAU 147, T 397 and BAU 160 had shown high stability for wider range of environmental conditions. Similarly, for number of secondary branches per plant 14 genotypes had shown stability over environment. Out of which two, namely BAU 135 and T 397 had shown high stability and adaptability with high mean, unit bj and zero S^2b_j

For number of capsules per plant thirteen genotypes had shown their stability over wide range of environment as their b_j were close to unity and S^2d_j were non-significant. But out of these stable genotypes BAU 135, T 397, BAU 195-4, BAU 160, BAU 95-1, RLC 165 and 189-2 were found highly stable and adaptable as their deviation from regression were zero.

The genotypes, BAU 286-5, BAU 159-4, RLC 8, BAU 195-4, BAU 65-2 and RLC 33 were found to be highly stable to unfavourable environmental conditions for seed yield as these had b_j close to unity and non-significant S^2d_j. The most stable and adaptable genotypes were BAU 286-5, BAU 159-4 and BAU8 because their mean for seed yield were also high. While other six genotypes viz; Sweta, LCK 8657, BAU 160, BAU 189-2, Shubhra and BAU 135 had produced high yield of seed but their deviation from regression were significant and thus unstable and suitable only for favourable environment.

On the basis of stability results of different characters the genotypes, namely BAU 65-2, RLC 165 and BAU 195-4 were found to be stable for most of the characters with higher seed yield. The genotypes BAU 286-5 although stable only for a few characters produced the highest and stable seed yield. Thus these genotypes can be suggested for commercial cultivation in wide range of environmental conditions and can be used in further breeding programme.

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Combining ability estimates in groundnut (*Arachis hypogaea* L.)

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Abstract : Accurate identification of promising parents is crucial for groundnut (*Arachis hypogaea* L.) cultivar development. Six cultivars, namely, ICGS 44, Ginar 1, ALR 2, JL 24, GG 2 and CO 2 were intermated in all possible combinations in a full diallel mating design. The 30 reciprocal F_1 hybrids and six parents were utilized for the study. Five traits, namely, number of mature pods, kernel weight, pod yield, shelling outturn and oil content were recorded for the estimation of general combining ability (*gca*) and specific combining ability (*sca*) effects. The greater SCA variance than GCA variance for the number of mature pods, pod yield, shelling outturn and oil content, whereas, the reverse is true for kernel weight. The crosses ALR 2 x JL 24 and ICGS 44 x JL 24 had greater *sca* effects for pod yield. Hence the gene action involved in this cross may be of additive x additive type. These two crosses could be used for further selection to obtain high yielding progenies. Seven of the fifteen crosses had significant reciprocal effect for the traits, pod yield and oil content. Hence, the influence of maternal effect on the economic traits is evident in the present material. (***Key words** : Groundnut, gca, sca, Combining ability, Maternal effect*).

The ability to accurately identify promising parents is crucial for the success of groundnut breeding programme. The diallel mating design has been used to pursue this objective. Baker (1978) reported that diallel cross data from self-pollinated species can provide useful information on combining abilities for parental selection rather than estimation on genetic variance components.

Early generation progeny from diallel mating design have been used to estimate combining abilities for yield and yield components of groundnut genotypes. Wynne *et al.* (1970) and Swe and Branch (1986) used F_1 progeny data to estimate combining ability for yield. The present study was undertaken to determine general and specific combining ability of six varieties for five traits namely, number of mature pods, kernel weight, pod yield, shelling outturn and oil content in a full diallel mating design.

Materials and Methods

The material for the present investigation consisted of six spanish bunch groundnut genotypes, namely, ICGS 44, Girnar 1, ALR 2, JL 24, GG 2 and Co 2. They were crossed in all possible combinations. The 30 F_1 hybrids and six parents were planted in Randomised Block Design replicated three times at the Regional Research Station, Vridhachalam. Each cross consisted of 12 row plots with row length of 5 m. The rows and plants within the row were spaced at 30 cm and 15 cm apart respectively.

At full maturity, the harvest was carried out on individual plant basis. Twenty plants were chosen randomly from each replication in each entry for recording observation. Number of mature pods in each plant was counted at the time of harvest. After proper drying of the produce, the mature pods of individual plants were weighed and expressed in gram. A known quantity of mature pods was hand shelled and from the recovery of kernels, the shelling outturn was calculated and expressed in percentage. From this number of kernels per plant, their weight and the 20 kernel weight was obtained and expressed in gram. Oil content of the kernels was estimated by Nuclear Magnetic Resonance Spectrometer (NMR) installed at ICRISAT, Hyderabad. The general combining ability (*gca*) of the parents and specific combining ability (*sca*) of the crosses were computed by adopting method I and model I of Griffing (1956).

Results and Discussion

The mean squares for *gca, sca* and reciprocal effects were significant for all the five traits studied. All the characters except kernel weight recorded greater magnitude of *sca* variance than *gca* variance. It indicated the preponderance of non additive gene action for these characters. Whereas, *gca* contributed the highest variance for kernel weight and hance controlled by additive genetic variance. The contribution of reciprocal effect was higher for the traits shelling outturn and pod yield (Table 1). The *gca* : *sca* variance ratio ranged from 0.14:1 for pod yield to 2.13:1 for kernel weight.

The estimates of *gca* of the six parental lines are given in Table 2. ALR 2 was the only variety which exhibited positive general combining ability for number of mature pods, while JL 24 and ICGS 44 exhibited the same ability for kernel weight. Three parents, ALR 2, JL 24 and ICGS 44 showed good general combining ability for pod yield. While JL 24 and Co 2 were good general combiners for shelling outturn. Four parents, namely, Girnar 1, ALR 2, Co 2 and JL 24 were the desirable general combiners for oil content. The general combining ability effects of JL 24 also mentioned by Nadaf *et al.* (1988), Manoharan (1992) and Reddy *et al.* (1989). ALR 2 had positive *gca* effects for number of mature pods, pod yield and oil content, although earlier reports indicated a negative relationship between these two characters (Chiow and Wynne, 1983). Hence it may be possible to assemble the genes for yield and oil content in the segregating generations from the crosses involving the above parents.

The estimate of specific combining ability are presented in Table 3. Significant and positive *sca* effects were observed in ALR 2 x GG 2 and ICGS 44 x Girnar 1 for number of mature pods. For kernel weight three crosses, ICGS 44 x JL 24, Girnar 1 x GG 2 and Girnar 1 x ALR 2 were good specific combiners. Four hybrid combinations, ALR 2 x JL 24, ICGS 44 x JL 24, ICGS 44 x Girnar 1 and ICGS 44 x ALR 2, had significant *sca* effects for pod yield. Among which the crosses, ALR 2 x JL 24 and ICGS 44 x JL 24 were derived from parents which had significant *gca* effects for pod yields. The gene action involved in these

Table 1. Relative magnitude of mean squares for general, specific and reciprocal combining ability.

Components	Mean Squares				
	No. of pods	Kernel weight (g)	Pod yield (g)	Shelling out turn (%)	Oil content (%)
GCA	4.38	0.34	1.30	3.05	0.58
SCA	9.45	0.16	9.58	5.10	2.41
Reciprocal	2.71	0.28	8.44	11.48	2.80
GCA:SCA	0.46:1	2.13:1	0.14:1	0.60:1	0.24:1

Table 2. General combining ability effects of parents

Parents	No. of mature pods	Kernel weight (g)	Pod yield (g)	Shelling out turn (%)	Oil content (%)
ICGS 44	0.03	0.30**	0.96**	(-)2.24**	(-)1.41**
Girnar 1	(-)0.65	(-)0.50**	(-)0.77	(-)2.00**	1.03**
ALR 2	4.48**	(-)0.33**	2.23**	(-)0.71	0.43**
JL 24	(-)1.78**	1.10**	1.10**	3.11**	0.17*
GG2	0.54	(-)0.61**	(-)1.09**	0.57	(-)0.53**
Co 2	(-)2.61**	0.04	(-)2.42**	1.27**	0.31**
SE(gi)	0.52	0.08	0.41	0.56	0.07

*P<0.05, **P<0.01

crosses may be of additive x additive type. These combinations may throw desirable segregants as indicated by Ragaviah and Joshi (1986).

The estimates of reciprocal effects for the 15 cross combinations are shown in Table 4. Five combinations had positive reciprocal effects for mature pods. Similarly, three crosses, Girnar 1 x ICGS 44, ALR 2 x Girnar 1 and GG 2 x Girnar 1 showed reciprocal effects for kernel weight. Seven combinations displayed reciprocal effects for the traits pod yield and oil content. The same was observed in Girnar 1 x ICGS 44 and ALR 2 x Girnar 1 for shelling outturn. The cross Girnar 1 x ICGS 44 registered reciprocal differences for all the traits excepts for oil content. Similar reciprocal effects for number of mature pods and pod yield were observed by Sangha and Labana, (1982) and for shelling outturn by Reddy *et al.*, (1988) in groundnut. The importance of maternal effect of economic traits is evident in the present material as also observed by Wynne and Halward (1989) in this crop.

From the forgoing discussion, it may be concluded that the characters namely number of matured pods, pod yield, shelling outturn and oil content were predominantly controlled by non additive gene action and kernel weight by more of additive gene action. Among the parents studied, JL 24, ALR 2 and ICGS 44 showed good combining ability for pod yield and one or two other characters. The crosses ICGS 44 x JL 24 and ALR 2 x JL 24 could be used for further selection because of additive x additive gene action involved in these crosses for pod yield. The study revealed the presence of material effects for all the characters in some of the crosses.

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Table 3. Specific combining ability effects of hybrids

Cross	No. of mature pods	Kernel weight (g)	Pod yield (g)	Shelling out turn (%)	Oil content (%)
ICGS 44 x Girnar 1	4.29**	(-)0.26	2.92**	(-)2.49	0.71**
ICGS 44 x ALR 2	1.49	0.01	1.98*	(-)1.59	(-)2.94
ICGS 44 x JL 24	1.41	0.79**	3.64**	2.15	(-)0.28
ICGS 44 x GG 2	1.37	(-)0.52**	0.08	(-)3.48**	(-)0.26
ICGS 44 x Co 2	0.6	(-)0.29	(-)0.08	0.01	(-)0.1
Girnar 1 x ALR 2	(-)1.33	0.50*	(-)1.15	2.61*	(-)0.34*
Girnar 1 x JL 24	1.61	(-)0.14	0.20	(-)1.50	0.75**
Girnar 1 x GG 2	(-)1.1	0.76**	1.00	1.46	(-)2.05*
Girnar 1 x Co 2	(-)0.97	0.29	(-)2.28*	(-)4.43**	(-)0.76**
ALR 2 x JL 24	1.81	0.12	4.79**	(-)1.28	1.11**
ALR 2 x GG 2	4.85**	(-)0.46*	1.80	(-)2.65*	(-)0.57**
ALR 2 x Co 2	1.15	(-)0.03	(-)0.20	2.01	0.91**
JL 24 x GG 2	(-)2.67*	(-)0.14	(-)2.36*	(-)0.92	0.74**
JL 24 x Co 2	(-)0.87	(-)0.04	(-)1.38	(-)0.16	(-)2.05**
GG 2 x Co 2	0.98	0.08	0.53	1.66	1.48**
SE (ij)	1.18	0.2	0.94	1.28	0.17

*P<0.05; **P<0.01

Table 4. Reciprocal effects of hybrids

Cross	No. of mature pods	Kernel weight (g)	Pod yield (g)	Shelling out turn (%)	Oil content (%)
Girnar 1 x ICGS 44	4.02**	0.77**	3.88**	5.48**	(-)0.92**
ALR 2 x ICGS 44	1.62	(-)0.82**	0.03	(-)3.25*	0.57**
JL 24 x ICGS 44	6.00**	(-)0.02**	5.90**	(-)3.60*	0.77**
GG 2 x ICGS 44	0.48	0.03	2.88**	(-)0.63	4.58**
Co 2 x ICGS 44	4.33**	(-)0.75**	4.82**	(-)3.78*	(-)1.18**
ALR 2 x Girnar 1	(-)2.75**	0.73**	(-)3.38**	5.32**	(-)2.93**
JL 24 x Girnar 1	1.95	(-)1.05**	0.07	(-)5.48**	0.20
GG 2 x Girnar 1	(-)2.57	0.52*	0.18	(-)0.28	0.67**
Co 2 x Girnar 1	(-)3.62	(-)0.70**	(-)3.57**	(-)4.32**	2.23**
JL 24 x ALR 2	(-)0.45	0.35	2.78*	(-)6.10**	(-)0.90**
GG 2 x ALR 2	6.05**	0.37	4.47**	0.47	(-)0.72**
Co 2 x ALR 2	2.67	0.38	0.43	(-)2.68	0.63**
GG 2 x JL 24	1.00	(-)0.05	1.22	1.02	0.80**
Co 2 x JL 24	2.82*	(-)0.07	2.87*	(-)2.5	(-)0.82**
Co 2 x GG2	0.65	(-)0.58*	(-)1.25	(-)2.95	(-)1.15**
R(ij)	1.39	0.23	1.10	1.50	0.20

*P<0.05, **P<0.01

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Shelf-life of spicturin® (*Bacillus thuringiensis Berl. var. gallariae)* during storage and its efficacy against *Plutella xylostella* (L.) on cauliflower

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Abstract : The shelf-life studies were conducted to determine the shelf-life of SPICTURIN® (*Bacillus thuringiensis* Berl. var. *gallariae*) against *Plutella xylostella* L. on cauliflower by two methods *viz.,* from the unopened samples and opened sample of Spicturin. In the first method, 18 fresh samples of Spicturin were stored at room temperature (25 to 33°C) and each month one sample was opened for bioassay and enumeration of spore load. The bioassays were conducted for 18 months continuously by leaf-dip method. In the second method, first month opened sample was stored at room temperature and used for similar study. The present results indicated that Spicturin samples were found to maintain the spore load of 10^7 spores ml^{-1} for 18 months and there was not much reduction in viable spores in the first month opened sample. However, there were differences in the initial spore load itself in the first method. From the 18 months storage study on Spicturin, the results of both the methods exhibited that the mortality of the second and third instar larvae of *P. xylostella* varied from 95.00 to 85.00 and 85 to 75.00 per cent respectively for Spicturin 4ml L^{-1} which was higher when compared to lower doses of 3 and 2ml L^{-1}; however, it was on par with them. (***Key words** : Bacillus thuringiensis* Berl. var. *gallariae,* Storage, *Plutella xylostella* L, Cauliflower)

Bacillus thuringiensis Berliner (*B.t*) is one of the important biocontrol agents for the management of lepidopteran pests. The commercial formulations of *B.t.* should have the desirable qualities for effective storage and control of the pests. The product must be an excellent formulation with good shelf-life (Watkinson, 1991). The pathogen must remain viable during storage and in the environment long enough for better contact to the pest, the formulation should have been properly standardized with good shelf-life during storage (Fuxa, 1996). Moore and Prior (1996) reported that most of the mycoinsecticides having a short shelf-life even with cold storage, required an estimated range from three to 18 months or even longer period for effective storage. Bryant (1991a) reported that the stability of potency of liquid *B.t.* formulations was lower than that of dry formulations and requires temperature control for long term storage. Formulation of product affect the success of microbial insecticide approach to manage the pests. The new *B.t.* formulation, Spicturin was developed from *B.t.* var. *galleriae* which is specific to lepidopteron pests. The present study was taken to evaluate the shelflife of the new product against diamond back moth, *Plutella xylostella* (L.), a major pest of cauliflower.