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RESEARCH PAPER

Assessment of groundnut pre-breeding material for resistance to *Spodoptera litura* and productivity traits in northern transitional zone of Karnataka

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Abstract: *Spodoptera litura,* an important insect pest of groundnut causes yield loss up to 71% in India. Among the various management strategies, host plant resistance is the most desirable, economic and eco-friendly. In the present study, a set of pre-breeding genotypes (29), parents (2), checks (7) and advanced breeding lines (2) were assessed for their reaction to *Spodoptera litura* under hot spot location, Dharwad during rainy season. Heritable component of variation existed for resistance to *Spodoptera* in groundnut pre-breeding genotypes indicating scope for selection of *Spodoptera* resistant genotypes. Non-significant correlation between *Spodoptera litura* damage and pod yield per plant indicates availability of pre-breeding genotypes resistant to *Spodoptera litura* with high yield. Among the 29 pre-breeding genotypes, only three genotypes, ICGIL 17101, ICGIL 17107 and ICGIL 17111 showed less than 10 per cent leaf damage due to *S. litura* compared to resistant check ICG 2271 (16.0 % leaf damage). Among these, ICGIL 17101 recorded higher pod yield per plant (28.6 g) when compared to resistant checks, ICGV 86031 (21.4 g) and ICG 2271 (19.8 g) and could serve as potential donor for incorporation of *Spodoptera* resistance in groundnut.

Key words: Correlation, Genetic variability, Groundnut, Resistance, *Spodoptera*

Introduction

Groundnut (*Arachis hypogaea* L.) native of South America, is an important oilseed crop and commonly cultivated for its edible seeds in tropics and subtropics. It is known as king of oilseed crops, the kernels popularly called as poor man's almond as they are rich in protein (26%) and oil (40 to 49%).

In groundnut, there are 80 species and most of them are diploid (2n = 2x = 20) and only two species are allo-tetraploid (2n = 4x = 40). Among allo-tetraploids, *A. hypogaea* is the only cultivated species and grown widely for the seeds and oil purpose. At the world level, groundnut is cultivated in an area of 27.94 m ha with a production of 47.09 m t and productivity of 1686 kg ha^{-1} (Anon., 2019). In India, it is cultivated in an area of 4.81 m ha with a production of 6.89 mt and productivity of 1393 kg/ha (Anon., 2019). The productivity of India is low as compared to World and leading groundnut producing countries.

Several factors are related to poor yield levels in India, such as absence of highly productive cultivars, cultivation in deep soils with low fertility, irregular distribution of rainfall, mono-cropping without crop rotation, improper plant population, disease and pest incidence. Among the pests, *Spodoptera*, sucking pests and diseases late leaf spot, rust, *Aspergillus flavus* and *Sclerotium* cause severe yield loss. Among these, *Spodoptera litura* (F.), commonly referred as "Tobacco caterpillar" is regarded a pest of domestic importance as it attacks most agricultural and horticultural crops in a polyphagous way. During the seedling or flowering phase, an infestation level of one larva / plant may lead to 20 per cent yield reduction in groundnut. Severe pest outbreak can lead to a loss of 30-40% in pod formation (Joshi and Kumar, 2005). In India, *S. litura* has become a significant pest and the development of resistance to commonly used insecticides has depicted a severe threat to the agricultural industry (Ahmad *et al.,* 2007; Tong *et al*., 2013).

Many effective chemicals are recommended to control *Spodoptera litura*, but they are not eco-friendly and increase the cost of cultivation. Further, indiscriminate use of chemicals by the farmers affected the natural enemies like predator and parasitoids and also leading to pesticide residue in the food thus making food harmful for human consumption (Sharma 2007). In this context, breeding for innate resistance occupies significant importance and is an amenable approach. Identification of potential resistant sources for *Spodoptera litura* is a pre-requisite for developing resistant cultivars. Earlier, ICGV 91180, NC Ac 343, M 28-2 and M 45 (Prasad and Gowda 2006; Naidu *et al.,* 2016) were identified as resistant to *Spodoptera litura* with less leaf damage. Even screening of minicore germplasm has lead to identification of very few (29 genotypes out of 188 germplasm) resistant genotypes (Saleem *et al*., 2019). But these genotypes were either late maturing, less productive or having poor pod features. Meager work has been carried out on screening against *Spodoptera* in wild *Arachis* species. In this regard, present study has been carried out to identify resistant sources to *Spodoptera litura* in groundnut pre-breeding material derived from wild *Arachis* species.

Material and methods

The experimental material comprised of pre-breeding genotypes (29), parents (2), checks (7) and advanced breeding lines (2). Twenty nine pre-breeding genotypes were collected from ICRISAT, Hyderabad. These pre-breeding material was generated from advanced backcross populations derived from synthetics ISATGR 121250 (*A. Kempffmercadoi* × *A. hoehnei*), ISATGR 278-18 (*A. duranensis* × *A.batizocoi*) and

ISATGR 265-5 (*A. duranensis* × *A. ipaensis*) as donors. Diploid wild *Arachis* accessions having A, B, and K genomes were crossed in different combinations, followed by chromosome doubling of the diploid intra and inter-genomic F_1 hybrids using colchicine treatment to generate tetraploid synthetics. Crossing between these allotetraploid synthetics and popular groundtnut cultivars (ICGV 91114 and ICGV 87846), these introgressed lines were developed (Sharma, 2017).

Genotypes were sown during *kharif* 2018 at *Spodoptera* hot spot location, Main Agriculture Research Station, University of Agricultural Sciences, Dharwad (15° 13' N, 75° 07' E, 678 m above MSL, and 800 mm average annual rainfall). Each genotype was sown in a row of two meter length with two replications and spacing of 30 × 10 cm in Randomized Complete Block Design. After every five rows, one row of susceptible check, JL 24 was sown to assure maximum incidence of the *Spodoptera litura*. Normal agronomic practices were followed to raise the crop avoiding insecticide spray. Visual observations were made on per cent leaf damage due to *S. litura* (0-100%) at 70 days after sowing (peak incidence period) by following the standard scale (0-9 where 0 - no damage; 1 - 1-10% ; 2 - 10-20% ; 3 - 20-30% ; 4 - 30-40% ; 5 - 40-50% ; 6 - 50-60% ; 7 - 60-70% ; 8 - 70-80% and 9 - 80-100% leaf damage) (Anon., 2015). The observation on per cent leaf damage was assessed by leaf damage at top, middle and bottom leaves from five plants showing maximum damage due to *Spodoptera litura* in each genotype and expressed as mean per cent leaf damage. Morphological and productivity parameters *viz*., plant height (cm), number of primary branches, number of pods per plant from five random plants, pod yield per plant (g), oil content, shelling per cent and hundred seed weight(g) from entire row were taken at or after harvest in each genotype in each replication and mean was calculated.

Table 1. Mean sum of squares for *Spodoptera* damage and productivity parameters during *Kharif* 2018 in pre-breeding material of groundnut

Source of variation	Degrees of freedom	Traits							
		Spodoptera damage at 70 DAS	Plant height	Number of primary branches per plant	Number of pods per plant	Shelling per cent	Hundred seed weight	Pod yield per plant	Oil content
Replication	1	98.73	3.61	4.05	8.19	11.92	9.78	18.60	2.54
Genotype	39	152.56**	39.09**	6.00**	16.30**	31.74**	82.62**	71.71**	7.25**
Error	39	9.21	1.03	1.31	3.53	6.13	2.73	6.24	3.25
Total	79	260.42	43.73	11.36	28.02	49.79	95.13	97.54	3.69

**- Significant at 1 per cent level of probability

Table 2. Components of variation for *Spodoptera* damage and productivity parameters in pre-breeding material of groundnut

Trait	Minimum	Maximum	Mean	PCV (%)	GCV (%)	H(bs)	GAM
Leaf damage by *S. litura* at 70 DAS	7.1	39.5	20.6	42.8	40.3	88.6	78.2
Plant height (cm)	16.5	37.2	23.7	18.7	18.2	94.8	36.5
Number of primary branches per plant	5.7	13.4	9.0	19.2	17.0	64.2	28.0
Number of pods per plant	12.1	21.9	16.2	19.3	15.5	64.4	25.7
Shelling per cent	62.0	75.8	67.2	6.4	5.4	71.7	9.4
Hundred seed weight (g)	28.9	52.3	37.7	17.3	16.8	93.6	33.5
Pod yield per plant(g)	11.0	34.0	24.6	23.3	20.2	54.5	26.2
Oil content (%)	41.3	49.8	44.5	5.8	4.5	60.5	11.2

PCV- Phenotypic coefficient of variation (%)
GCV- Genotypic coefficient of variation (%)
GAM- Genetic advance as per cent of mean
H(bs)- Heritability in broad sense

Table 3. Phenotypic and genotypic correlation between *Spodoptera* damage and productivity parameters in pre-breeding material of groundnut

Trait	*Spodoptera litura* damage	Plant height	Number of primary branches per plant	Number of pods per plant	Shelling per cent	Hundred seed weight	Oil content	Pod yield per plant
Spodoptera litura damage	1.000	0.130	0.066	-0.293**	0.045	-0.032	0.123	0.045
Plant height	0.134	1.000	-0.014	0.087	0.085	0.145	0.111	0.085
Number of primary branches per plant	0.060	-0.049	1.000	0.466**	-0.365**	-0.013	-0.312**	0.365**
Number of pods per plant	-0.315**	0.150	0.633**	1.000	0.061	-0.078	-0.158	0.221*
Shelling per cent	0.075	0.088	-0.603**	0.232*	1.000	0.112	-0.186	0.287**
Hundred seed weight	-0.031	0.160	-0.023	-0.072	0.121	1.000	-0.029	0.221*
Oil content	0.109	0.110	-0.455**	-0.213	-0.317**	-0.039	1.000	-0.186
Pod yield per plant	0.075	0.088	0.603**	0.232*	0.306**	0.252*	-0.317**	1.000

*& **- Significant at 5 and 1 per cent level of probability, respectively
Values above the diagonal represent phenotypic correlation while, below the diagonal represent the genotypic correlation

Statistical Analysis

Analysis of variance and different components of genetic variation were estimated using Indostat statistical package. Based on the extent of leaf damage, the genotypes were classified as resistant (< 10% leaf damage), moderately resistant (> 10% to 25% leaf damage) and susceptible (> 25% leaf damage) categories. Genotypic and phenotypic correlations were calculated to determine the direction and magnitude of association between resistance to *Spodoptera litura* and other productivity parameters and tested against table 't' at n-2 degree of freedom at 0.05 probability level for their significance.

Results and discussion

Highly significant genotypic differences were observed for reaction to *Spodoptera litura* and productivity parameters (plant height, number of primary branches per plant, number of pods per plant, shelling per cent, hundred seed weight and pod yield

Table 4. Mean performance for *Spodoptera* damage and productivity parameters in pre-breeding material of groundnut

Sl. No.	Genotype	SD	PH	NBPP	NPPP	SP	HSW	PYPP	OC
1	ICGIL 17111	7.1*	19.5	9.3	15.4	63.8	30.9	17.2	44.6
2	ICGIL 17101	7.5*	26.3	7.8	16.8	65.0	31.3	28.6	44.8
3	ICGIL 17107	8.6*	21.9	5.7	12.7	68.4	36.1	20.6	43.2
4	ICGIL 17103	10.8	19.8	12.4*	21.9*	65.7	28.9	25.1	41.3
5	ICGIL 17112	12.0	20.7	9.1	17.1	63.0	36.0	26.5	44.2
6	ICGIL 17105	12.3	25.5	10.4	20.8	64.4	44.9*	32.9*	42.3
7	ICGIL 17108	12.8	20.8	7.3	15.9	68.2	40.5	21.3	44.5
8	ICGIL 17110	12.8	27.1	10.7	18.0	63.8	42.6*	32.9*	45.6
9	ICGIL 17102	13.3	25.1	11.9*	17.5	63.8	35.8	33.2*	42.3
10	ICGIL 17109	13.3	21.5	7.9	13.7	70.8	35.3	22.9	43.8
11	ICGIL 17116	13.3	25.3	11.1	15.9	72.6*	41.3	32.5*	44.5
12	ICGIL 17113	13.5	24.6	8.9	15.7	73.8*	41.5*	26.8	45.3
13	ICGIL 17115	13.6	23.7	9.0	13.0	65.9	37.9	25.4	42.3
14	ICGIL 17104	15.0	19.9	8.5	17.9	71.4	50.1*	21.5	44.7
15	ICGIL 17114	15.1	24.2	7.5	17.1	75.8*	43.0*	18.5	43.3
16	ICGIL 17106	16.1	23.8	6.9	15.8	71.6	41.3	15.0	49.8*
17	ICGIL 17126	16.1	26.7	9.2	13.9	66.2	32.4	32.8*	43.1
18	ICGIL 17129	18.5	17.6	7.8	14.9	67.2	35.8	20.8	44.0
19	ICGIL 17117	20.0	16.5	10.9	18.5	62.9	39.8	18.8	43.9
20	ICGIL 17120	20.5	22.4	10.8	17.5	63.4	41.4*	19.7	43.3
21	ICGIL 17128	22.1	27.4	9.1	18.3	66.8	50.7*	29.6	45.2
22	ICGIL 17119	22.8	21.9	8.3	13.5	65.9	36.0	20.2	43.5
23	ICGIL 17127	27.3	22.5	8.3	18.6	64.8	30.9	25.4	43.9
24	ICGIL 17121	27.6	23.7	9.2	12.1	69.1	36.8	32.0	44.8
25	ICGIL 17124	30.0	20.8	10.7	19.6	63.4	31.3	24.5	45.0
26	ICGIL 17125	30.5	23.1	8.8	19.7	69.4	50.2*	25.6	45.3
27	ICGIL 17118	31.6	26.2	9.4	15.5	65.1	52.3*	29.3	42.6
28	ICGIL 17122	32.0	24.9	13.4*	17.8	65.0	30.7	24.9	42.3
29	ICGIL 17123	36.0	22.0	11.5*	21.5*	65.1	35.8	34.0*	44.2
30	ICGV 91114 (P)	18.3	26.7	7.1	17.3	65.3	49.2*	24.9	43.8
31	ICGV 87846 (P)	25.3	19.0	8.2	17.0	70.6	31.5	18.8	47.5
32	TMV 2 (C)	30.6	34.9*	10.4	18.3	71.8	42.8*	26.8	46.4
33	ICGV 86031 (RC)	19.8	26.0	8.1	19.4	68.1	36.9	21.4	48.2*
34	ICG 2271 (RC)	16.0	25.5	7.1	15.7	66.4	32.8	19.8	48.1*
35	GPBD 4 (C)	21.3	34.6*	7.2	17.2	72.6*	37.3	20.4	46.2
36	JL 24(C)	32.6	37.2*	8.5	19.8	70.3	38.8	20.0	45.3
37	Dh 256 (A)	28.3	26.7	8.1	12.7	72.3	40.2	19.3	44.5
38	Dh 257 (A)	31.3	28.0	8.3	13.9	73.3*	30.9	19.9	46.8
39	R 9227 (C)	39.5	21.9	5.9	12.2	62.0	32.7	11.2	45.1
40	ICG 02207 (C)	32.8	25.4	7.8	12.4	71.4	30.2	11.0	43.2
	Mean	20.6	23.7	9.0	16.2	67.2	37.7	24.6	44.5
	C.D. (5%)	6.1	4.5	2.3	4.9	5.0	3.7	7.8	3.3
	C.V. (%)	14.4	9.5	12.6	15.1	3.6	4.8	15.7	3.6

*- Indicates significant superiority over best check (ICG 2271) for *Spodoptera* and significant superiority over mean for yield parameters

SD - *Spodoptera* damage (%) SP- Shelling per cent (%) PH- Plant height (cm) HSW- Hundred seed weight (g)

OC- Oil content (%) PYPP- Pod yield per plant(g) NBPP- Number of branches per plant

NPPP- Number of pods per plant ; P - Parent C- Check A- Advanced breeding line

RC - Resistant check

per plant (Table 1), which is essential for genetic improvement through plant breeding. The difference between the phenotypic and genotypic coefficient of variation was very low for reaction to *Spodoptera litura* and productivity parameters (Table 2). High heritability coupled with high genetic advance for response to *Spodoptera litura* and for productivity parameters in pre-breeding genotypes revealed relatively higher additive component of genetic variance and hence genetic improvement for these traits would be possible through simple selection based on phenotype indicating the predominance of genetic component governing these traits with least influence of environment. Earlier, similar finding was reported by Saleem *et al.,* 2019 in studying mini core germplasm, recombinant inbred lines and elite genotypes. Hence, selection for these traits would be effective based on phenotypic observation.

Correlation between *Spodoptera* resistance and productivity traits

S. litura damage had significant negative correlation both at genotypic and phenotypic level with number of pods per plant (Table 3) indicating reduction in number of pods in the *S. litura* susceptible genotypes. On the other hand, *S. litura* damage had non-significant positive correlation with pod yield per plant and oil content suggesting that *S. litura* damage does not have major impact on pod yield and oil content. Though, there is reduction in number of pods per plant, no significant effect on pod yield was observed due to non-significant effect of *Spodoptera* damage on other yield component traits like hundred seed weight and shelling per cent (Table 3). Earlier, non-significant correlation between *Spodoptera litura* damage and pod yield per plant was also reported by Saleem (2018).

Mean performance of *Spodoptera litura* resistant genotypes

Among the forty genotypes studied, only three pre-breeding genotypes, ICGIL 17101, ICGIL 17107 and ICGIL 17111 had less than 10 per cent leaf damage by *S. litura* compared to resistant check ICG 2271 (16.0 % leaf damage). Both ICGIL 17107 and ICGIL 17111 have ISATGR 121250 (data not provided) in its pedigree which in turn derived from two diploid 'A' genome species of groundnut *A. kempffmercadoi* and *A. hoehnei.* Among these one of the wild species *A. kempffmercadoi* was reported as resistant to *Spodoptera* (Anon., 1990). The other resistant genotype ICGIL 17101 has ISATGR 265-5 in its pedigree which in turn derived from 'A' genome (*A. duranensis)* and 'B' genome (*A. ipaensis*) donors of groundnut. They could have introgressed resistance genes from these wild diploid species (Sharma *et al.,* 2003). These identified sources of resistance need to be studied under artificial conditions before employing them as sources of *Spodoptera litura* resistance in breeding programme. But, these resistant genotypes does not have significantly higher yield (17.2 to 28.6 g/plant) which could be due to diversion of energy towards resistance against insect pest. Many reports suggested a strong negative association between resistance and desirable agronomic features (Shew *et al*., 1995; Gowda *et al*., 1996). Interestingly, one of the susceptible genotype, ICGIL 17123 with 36 % leaf damage due to *Spodoptera* has significantly higher yield (34 g) which could be attributed to higher yielding potential of this genotype besides exhibiting tolerance mechanism to *Spodoptera* which needs to be established. ICGIL 17116 with moderate resistance to *Spodoptera litura* (13.3 %) has significantly higher pod yield (32.5 g) and could be a potential genotype for cultivation under farmer's field after testing over locations and years for its consistent performance.

Conclusion

Significant genetic variability existed among the pre-breeding material for *Spodoptera litura* infestation and productivity parameters indicating scope for selection of resistant genotypes. Narrow difference between the phenotypic and genotypic coefficient of variation indicated predominance of genetic component governing these traits. High heritability coupled with high genetic advance for response to *Spodoptera litura* and number of pods per plant and yield per plant revealed higher additive component of genetic variance and hence genetic improvement for these traits would be possible through simple selection based on phenotype. Non-significant correlation between *Spodoptera litura* damage and yield per plant indicates availability of germplasm resistant to *Spodoptera litura* with high yield. Among the 29 pre-breeding genotypes, three genotypes ICGIL 17101, ICGIL 17107 and ICGIL 17111 were resistant to *S litura*.

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