Indian J. Genet., 79(1) Suppl. 192-196 (2019)
DOI: 10.31742/IJGPB.79S.1.8

Diverse sources of resistance to *Spodoptera litura* (F.) in groundnut

M. A. Saleem, G. K. Naidu*#, H. L. Nadaf and P. S. Tippannavar

AICRP on Groundnut, Main Agriculture Research Station, University of Agricultural Sciences, Dharwad 580 005

(Received: December 2018; Revised: March 2019; Accepted: April 2019)

Abstract

***Spodoptera litura* an important insect pest of groundnut causes yield loss up to 71% in India. Though many effective chemicals are available to control *Spodoptera*, host plant resistance is the most desirable, economic and eco-friendly strategy. In the present study, groundnut mini core (184), recombinant inbred lines (318) and elite genotypes (44) were studied for their reaction to *Spodoptera litura* under hot spot location at Dharwad. Heritable component of variation existed for resistance to *Spodoptera* in groundnut mini core, recombinant inbred lines and elite genotypes indicating scope for selection of *Spodoptera* resistant genotypes. Only 29 (15%) genotypes belonging to *hypogaea, fastigiata* and *hirsuta* botanical varieties under mini core set, 15 transgressive segregants belonging to *fastigiata* botanical variety among 318 recombinant inbred lines and three genotypes belonging to *hypogaea* and *fastigiata* botanical varieties under elite genotypes showed resistance to *Spodoptera litura* with less than 10% leaf damage. Negative correlation existed between resistance to *Spodoptera* and days to 50 per cent flowering indicating late maturing nature of resistant genotypes. Eight resistant genotypes (ICG 862, ICG 928, ICG 76, ICG 2777, ICG 5016, ICG 12276, ICG 4412 and ICG 9905) under *hypogaea* botanical variety also had significantly higher pod yield. These diverse genotypes could serve as potential donors for incorporation of *Spodoptera* resistance in groundnut.**

Key words: Groundnut, *Spodoptera litura*, resistance, *hypogaea, fastigiata*

Introduction

Groundnut is an important oilseed crop occupying about 9% of the world's oilseed crop area, and contributes to about 5 % of vegetable oil production (Birthal et al. 2010). It is grown in more than 100 countries in an area of 27.66 m ha with an annual production of 43.98 mt and productivity of 1590 kg ha^{-1} (FAO 2016). In India, it is grown in an area of 5.80 m ha, with the production of 6.85 m t and productivity of 1182 kg ha^{-1} (FAO 2016). Though, India is leading producer of groundnut, its productivity is low (1182 kg ha^{-1}) compared to USA (4118 kg ha^{-1}), China (3674 kg ha^{-1}) (FAO 2016) which could be ascribed to lack of availability of high yielding varieties, cultivation under low fertile soils, uneven rainfall distribution, mono-cropping without crop rotation, incidence of biotic and abiotic stresses.

Among the various biotic stresses affecting the groundnut productivity, *Spodoptera litura* has a major role in reducing the yield level to significant extent by feeding on foliage of groundnut. This pest occupies importance due to its polyphagous nature, high reproduction ability (12 generation per year) and higher migrational ability. Damage is done by larvae, which feed gregariously on leaves and fresh growth causing extensive damage. *Spodoptera litura* reduces the yield level up to 13-71 per cent in the states of Karnataka and Andhra Pradesh (Amin 1983). In Karnataka, transitional tract (Dharwad) has been identified as major hot spot for *Spodoptera litura* during *kharif* season. The yield losses due to this pest in groundnut can range from 26-100% (Dhir et al. 1992).

Many effective chemicals are suggested 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. Identification of diverse sources of resistance would help in avoiding break

*Corresponding author's e-mail: naidug@usad.in
#Present address: AICRP on Safflower, Agriculture Research Station, Annigeri 582 201, Karnataka
Published by the Indian Society of Genetics & Plant Breeding, A-Block, F2, First Floor, NASC Complex, IARI P.O., Pusa Campus, New Delhi 110 012; Online management by www.isgpb.org; indianjournals.com

down of resistance. In this regard, the present study is aimed at identifying the diverse resistant sources to *Spodoptera litura* using diverse genetic material *viz.*, groundnut mini core, recombinant inbred lines and elite breeding lines.

Materials and methods

Experimental material consisted of groundnut mini core, recombinant inbred lines (RIL) and elite genotypes. Groundnut mini core consists of 184 accessions along with four control genotypes (ICG 11457, ICG 12370, ICG 13099 and ICG 13723) belonging to six botanical varieties *viz., hypogaea* (87), *vulgaris* (59), *fastigiata* (38), *peruviana* (2), *vulgaris* (1) *aequatoriana* (1) and *hirsuta* (1). In addition, three susceptible (JL 24, TMV 2, TAG 24) and five resistant checks (ICGV 86031, ICGV 87157, ICGV 87160, ICG 2271 and ICG 1657) were included. RILs comprised 318 lines derived from the cross TAG 24 × ICGV 86031 wherein, the female parent TAG 24 is a popular cultivar but susceptible to *Spodoptera litura*, while the male parent, ICGV 86031 is a multiple stress resistant genotype including resistance to *Spodoptera litura*. A total of 44 elite genotypes comprising of advanced breeding lines and released cultivars collected from ICRISAT, Hyderabad, BARC, Mumbai, University of Agricultural Sciences, Dharwad and Raichur.

These genotypes were sown during *kharif* 2017 at hot spot location, Main Agriculture Research Station, University of Agricultural Sciences, Dharwad (15^{o} 13’ N, 75^{o} 07’ E, 678 m above MSL, and 800 mm average annual rainfall). Mini core genotypes were sown by following unbalanced lattice design due to involvement of different botanical varieties necessitating to grow under different spacing. Elite genotypes and recombinant inbred lines were sown by following Randomized Complete Block Design (RCBD). Each genotype was sown in a row of two meter length with two replications and spacing of 30 × 10 cm was followed for bunch genotypes while, 60 × 10 cm for runner genotypes. 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 plant protection measures.

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) (Fig. 1). 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*., height of the plant, number of primary

Fig. 1. Leaf damage of visual scoring for *Spodoptera litura* damage in groundnut

branches per plant, number of pods per plant, pod yield per plant, shelling per cent and hundred seed weight were taken at or after harvest.

Statistical analysis

Analysis of variance and different components of genetic variation (PCV, GCV, H and GAM) were estimated using Windostat 9.1 version in case of elite genotypes and recombinant inbred lines while, Gen Stat 64-bit version 17.7 was used for analyzing the data of mini core. The genotypes were classified in to resistant (< 10% leaf damage), moderately resistant (> 10% to 25% leaf damage) and susceptible (> 25% leaf damage) categories based on extent of leaf damage. 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 both at 0.05 and 0.01 probability levels for their significance.

Results and discussion

Genetic variability

Analysis of variance for reaction to *Spodoptera litura* and productivity parameters in the mini core germplasm (196), recombinant inbred lines (320) and elite genotypes (44) indicated highly significant genotypic differences for these traits. The difference between the phenotypic and genotypic coefficient of variation was very low for reaction to *Spodoptera litura* and productivity parameters in groundnut mini core, recombinant inbred lines and elite genotypes (Table 1) indicating predominance of genetic component governing these traits. The extent of genotypic variability was high for response to *Spodoptera,* pod yield per plant in mini core, recombinant inbred lines and elite genotypes indicating scope for selection of genotypes with resistance to *Spodoptera litura* and also for pod yield per plant in this material. On the contrary, there was less genotypic variability for days to initiation of flowering, days to fifty per cent flowering and shelling per cent in mini core, recombinant inbred lines and elite genotypes revealing very less scope for identification of superior genotypes for these traits. High heritability coupled with high genetic advance for response to *Spodoptera litura* in the mini core, recombinant inbred lines and elite genotypes (Table 1) revealed relatively higher additive component of genetic variance and hence genetic improvement for these traits would be possible through simple selection based on phenotype.

Table 1. Genetic components of variation for *Spodoptera litura* damage in groundnut mini core, recombinant inbred lines and elite genotypes during *kharif* 2017 at UAS, Dharwad.

Material/parameter	Mini core	Recombinant inbred lines	Elite genotypes
Minimum (%)	4.5	7.85	6.7
Maximum (%)	45.0	35.65	49.1
Mean (%)	19.1	18.0	19.1
PCV (%)	44.0	30.2	49.1
GCV (%)	42.0	28.0	48.1
H (bs)	91.1	86.2	96.0
GA	15.7	9.6	18.6
GAM	82.6	53.6	97.3

PCV = Phenotypic co-efficient of variation (%); GCV = Genotypic co-efficient of variation (%); GA = Genetic advance; GAM = Genetic advance as per cent of mean; H(bs) = Heritability (Broad sense)

Frequency of resistance against Spodoptera

Among the 188 accessions in the mini core, only 29 (15%) genotypes showed resistance to *Spodoptera litura* with less than 10% leaf damage. Among these 29 genotypes, 27 belong to *hypogaea* and one genotype each under *fastigiata* and *hirsuta* botanical varieties. None of the genotypes under the botanical varieties *vulgaris, aequatoriana and peruviana* were resistant to *Spodoptera* (Table 2). Mini core comprises 10 per cent of the core germplasm and has the desirable diversity for reaction to major biotic stresses due to their diverse genetic and geographic origin (Upadhayaya et al. 2014). The higher number of resistant genotypes under *hypogaea* botanical variety could be due to their indeterminate growth habit and longer duration to maturity. Earlier, Rajgopal et al. (1988) reported that highest resistance to *Spodoptera* in Virginia runner genotypes (NC Ac 17840, NFG 79 and EC 21989) belonging to *hypogaea* botanical variety. In case of recombinant inbred lines, only 15 (5%) transgressive segregants had less than 10 per cent leaf damage due to *Spodoptera litura* (Table 2) as against 14.1% leaf damage in resistant parent ICGV 86031 (Table 3). In elite genotypes, only 3 (7%) genotypes among 44 genotypes exhibited resistance to *Spodoptera litura* (Table 2).

Table 2. Frequency of resistant genotypes to *Spodoptera litura* in different subspecies of mini core, recombinant inbred lines and elite genotypes of groundnut

Botanical variety	Resistant	Moderately resistant	Susceptible
hypogaea (87)	27 (31)	55 (63)	5 (6)
vulgaris (59)	0 (0)	38 (64)	21 (49)
fastigiata (38)	1 (3)	22 (58)	15 (39)
peruviana (2)	0 (0)	2 (100)	0 (0)
aequatoriana (1)	0 (0)	1 (100)	0 (0)
hirsuta (1)	1 (100)	0 (0)	0 (0)
Mini core (188)	29 (15)	118 (63)	41 (22)
Recombinant inbred lines (318)	15 (5)	270 (85)	33 (10)
Elite genotypes (44)	3 (7)	34 (77)	7 (16)

Figures in parenthesis represent the number of genotypes in each botanical variety / per cent of total genotypes in each group for leaf damage due to *Spodoptera litura*

Correlation between Spodoptera resistance and productivity traits

Spodoptera litura damage had significant negative correlation with days to initiation of flowering, days to fifty per cent flowering (data now shown) in mini core, recombinant inbred lines and elite genotypes revealing that majority of the resistant genotypes were late in

Table 3. Mean performance of selected *Spodoptera litura* resistant genotypes from diverse sources for productivity traits

S.No.	Genotypes	Botanical variety	*Spodoptera* damage (%)	Days to initiation of flowering	Days to 50 % flowering	No. of pods/ plant	Shelling per cent	100-seed weight (g)	Yield/ plant (g)
1	ICG 862	*hypogaea*	4.5	32.5	33.5	13.1*	72.6**	33.9	23.2*
2	ICG 928	*hypogaea*	5.0	32.5	34.5	18.6**	71.9*	42.7	28.2**
3	ICG 76	*hypogaea*	6.8	33.5	34.5	13.5**	72.9**	51.5**	25.2**
4	ICG 2777	*hypogaea*	7.7	33.5	35.5	29.3**	70.1	33.4	35.2**
5	ICG 5016	*hypogaea*	8.2	32.0	34.0	16.8**	71.8*	42.0	25.2**
6	ICG 12276	*hypogaea*	8.4	29.0	31.5	17.0**	73.4	43.4	26.3**
7	ICG 4412	*hypogaea*	9.0	32.5	34.5	33.1**	69.5	48.1**	26.2**
8	ICG 9905	*hypogaea*	9.3	32.5	34.0	14.9**	67.4	39.8	27.0**
9	RIL 34	*fastigiata*	10.0	30.5	32.0	13.8	66.9	36.4	16.6
10	DSG 1	*hypogaea*	6.8	31.5	33.5	15.2	71.1	36.4	11.4
11	Dh 216	*fastigiata*	7.0	28.0**	30.5*	16.0	76.0	35.2	19.8
12	ICGV 93468	*fastigiata*	9.5	29.5	31.5	19.9**	66.8	41.5	16.7
Checks/parents of RILs									
1	JL 24 (S)	*fastigiata*	43.4	29.0	30.5*	9.0	66.5	40.0	18.1
2	TAG 24 (S)	*fastigiata*	26.8	30.5	32	14.7	67.0	37.3	11.7
3	ICG 2271 (R)	*hypogaea*	7.8	31.5	33.0	12.3	63.7	33.1	13.2
4	ICGV 86031 (R)	*fastigiata*	16.6	28.5	30.0*	22.3**	69.9	40.8	12.7
	Mean		19.10	29.84	31.63	16.68	69.22	38.63	14.7
	CD (5%)		4.92	1.19	1.43	3.34	4.42	3.69	5.0
	CD (1%)		6.49	1.58	1.89	4.41	5.84	4.87	6.6
	CV (%)		12.58	1.99	2.29	9.94	3.24	4.49	17.19

*,** indicate genotype's significance of superiority for yield and other parameters compared to susceptible check (JL 24) at 5 per cent and 1 per cent level of probability, respectively. S = Susceptible; R = Resistant

flowering and eventually late in maturity. Naidu et al. (2016) reported that majority of interspecific derivates matured late which were showing resistance to different biotic stresses. *Spodoptera litura* damage had significant negative correlation with hundred seed weight in mini core indicating that there would be reduction in seed size in the *Spodoptera litura* susceptible genotypes. *Spodoptera litura* damage had non-significant correlation with yield per plant in the mini core germplasm and recombinant inbred lines revealing scope for selection of *Spodoptera litura* resistant genotypes with higher yield. But in the case of elite genotypes, *Spodoptera litura* damage had significant negative correlation with yield per plant indicating low yielding ability of resistant genotypes. This could be due to the fact that, during the development of cultivars and breeding lines, more importance given for yield improvement rather than tolerance to biotic stresses. Negative association between response to biotic stresses and pod yield in case of advanced breeding lines was reported by Iroume and Knauft (1987) suggesting the necessity to break the negative association between the resistance and productivity traits by hybridization or induced mutation followed by selection (Angadi et al. 2013).

Mean performance of Spodoptera resistant genotypes

Among the twenty nine *Spodoptera litura* resistant genotypes in the mini core, eight genotypes *viz*., ICG 862, ICG 928, ICG 76, ICG 2777, ICG 5016, ICG 12276, ICG 4412 and ICG 9905 belonging to *hypogaea* botanical variety recorded significantly higher pod yield per plant compared to high yielding check JL 24 (18.1g) (Table 3). Among these resistant genotypes, ICG 2777 had significantly higher pod yield per plant (35.2g) which was due to higher number of pods per plant (29.3) (Table 3). The number of pods per plant and hundred seed weight contribute mainly to pod yield in groundnut (Vekariya et al. 2010; Babariya and Daboria 2012). Among the resistant genotypes, ICG 76 had significantly high shelling per cent (72.9 %) over susceptible check JL 24 (Table 3). Among the 318 recombinant inbred lines of TAG 24 × ICGV 86031, fifteen transgressive segregants showed resistance to *Spodoptera litura* compared to resistant male parent ICGV 86031. None of the resistant RILs had significantly higher pod yield per plant when compared to high yielding check JL 24. Only one resistant line RIL 34 had higher pod yield per plant (16.6 g) compared to its parents (Table 3). In the case of elite genotypes, one released cultivar, DSG 1 under Virginia runner growth habit belonging to *hypogaea* botanical variety and two advanced breeding lines, ICGV 93468 and Dh 216 under Spanish bunch growth habit belonging to *fastigiata* botanical variety showed resistance reaction to *Spodoptera litura* with less than 10 per cent leaf damage. Among these, ICGV 93468 and DSG 1 are late in flowering while, Dh 216 is early in flowering (Table 3). Therefore, Dh 216 could be potential genotype for incorporation of *Spodoptera* resistance with early maturity under *fastigiata* botanical variety. The diverse *Spodoptera* resistant sources from different botanical varieties in the mini core can be effectively utilized in breeding for resistance to *Spodoptera* in groundnut and is first report of identification of resistant sources to *Spodoptera* from the groundnut mini core.

In conclusion, the present study identified many diverse sources of resistance to *Spodoptera* from mini core, recombinant inbred lines and elite breeding material in groundnut under different botanical varieties. Some of these resistant genotypes also had higher pod yield per plant. These diverse resistant genotypes need to be confirmed for their resistance under artificial conditions for utilization in *Spodoptera* resistance breeding program of groundnut.

Authors' contribution

Conceptualization of research (GKN, HLN, PST); Designing of the experiments (GKN, HLN, PST); Contribution of experimental materials (GKN, HLN); Execution of field/lab experiments and data collection (MAS); Analysis of data and interpretation (GKN, MAS); Preparation of manuscript (GKN).

Declaration

The authors declare no conflict of interest.

Acknowledgement

The authors sincerely thank the Genetic Resources Unit of ICRISAT for providing the groundnut mini core for study. The authors also wish to acknowledge the University of Agricultural Sciences, Dharwad for providing financial support in the form of staff research project.

References

Amin P. W. 1983. Major field insect pests of groundnut in India and associated crop losses. Indian J. Entomol., **2**: 337-344.

Angadi C. C., Motagi B. N., Naidu G. K. and Shashidhar R. 2013. Genetic variability and association of late leaf spot resistance and productivity in groundnut (*Arachis hypogaea* L.). Int. J. Plant Protec., **6**(1): 145-147.

Anonymous. 2015. Proc. Annual Groundnut Workshop. Crop Protection, 13, April, 2015, Junagadh Agric. Univ., Junagadh, India, pp. 22-23.

Babariya C. A. and Daboriya K. L. 2012. Correlation coefficient and path coefficient analysis for yield components in groundnut (*Arachis hypogaea* L.). Electronic J. Pl. Breed., **3**(3): 932-938.

Birthal P. S., Parthasarathy Rao P., Nigam S. N., Bantilan M. C. S. and Bhagavatula S. 2010. Groundnut and Soybean Economies in Asia: Facts, Trends and Outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 92 pp. ISBN:978-92-9066-531-1. Order code: BOE 050.

Dhir B. C., Mohapatra H. K. and Senapati B. 1992. Assessment of crop loss in groundnut due to tobacco caterpillar, *Spodoptera litura* (F.). Indian J. Plant Protec., **20**(2): 215-217.

FAO. 2016. FAOSTAT data base. http://www.faostat.org.

Iroume R. N. and Knauft D. F. 1987. Heritability and correlations for pod yield and leaf spot resistance in peanut (*Arachis hypogaea* L.) germplasm. Chinese J. Oil Crop Sci., **20**: 31-35.

Naidu G. K., Motagi B. N. and Gowda M. V. C. 2016. Potential sources of resistance to biotic stresses in groundnut (*Arachis hypogaea* L.). The Ecoscan, **IX** (Special Issue): 509-515

Prasad M. N. R. and Gowda M. V. C. 2006. Mechanisms of resistance to tobacco cutworm (*Spodoptera litura*) and their implications to screening for resistance in groundnut. Euphytica, **149**: 387-399.

Rajgopal K., Nandagopal N. and Bhagat N. R. 1988. Preliminatry screening of Virginia groundnut genotypes against tobacco caterpillar, *Spodoptera litura* (F.). J. Oilseeds Res., **5**: 162-165.

Sharma H. C. 2007. Host Plant Resistance: Modern Approaches and limitation. Indian J. Plant Protec., **35**: 179-184.

Upadhyaya H. D., Dwivedi S. L., Vadez V., Hamidou F., Singh S., Varshney R. K. and Liao B. 2014. Multiple resistant and nutritionally dense germplasm identified from mini core collection in peanut. Crop Sci., **54**(2): 679-693.

Vekariya H. B., Khanpara M. D., Vachhani J. H., Jivani L. L., Vagadiya K. J. and Revar H. J., 2010. Correlation and path analysis in bunch groundnut (*Arachis hypogaea* L.). Intl. J. Pl. Sci., **6**: 11-15.