MORPHOLOGICAL AND BIOCHEMICAL BASES OF RESISTANCE IN GROUNDNUT GERMPLASM AGAINST TOBACCO CATERPILLAR, *Spodoptera litura* (Fabricius) AND LEAF MINER, *Aproaerema modicella* (Deventer).

ABSTRACT

The screening experiment was conducted at College Farm, College of Agriculture, Rajendranagar, Hyderabad in *rabi*, 2019-20 and was laid in Randomized block design (RBD) with forty germplasm lines, each replicated twice. Among the forty germplasm lines screened against tobacco caterpillar and leaf miner, three germplasm lines *viz*., ICGV 16679 (13.71% leaf damage), ICGV 07222 (14.00% leaf damage) and ICGV 93468 (14.25% leaf damage) showed greater resistance than the resistant check, ICGV 86031 (15.04% leaf damage) against tobacco caterpillar and with respect to resistance against leaf miner, no germplasm line was found to be superior than the resistant check, ICGV 86031 (7.82% leaf damage). However, the germplasm line, ICGV 02266 (8.35% leaf damage) was next best to the resistant check. The various morphological and biochemical characters were recorded and correlated with insect pest damage and incidence to know their role in imparting resistance/susceptibility. Resistance to various insect pests in germplasm lines was due to significantly higher trichome density on leaf lamina, higher phenol and tannin content.

Keywords: Screening, tobacco caterpillar, leaf miner, groundnut, biochemical, morphological

Introduction

Groundnut (*Arachis hypogaea* L.) is an important leguminous food crop in India and is known as peanut, earthnut, monkey nut, and goobers [1]. It has originated in South America, where the genus *Arachis* is widely distributed. It is cultivated mostly in the semi-arid tropical and sub-tropical regions [2]. Low productivity in groundnut is attributed to several constraints and the attack of insect-pests is one among these. The avoidable yield loss due to major insect pests of groundnut was recorded to be 48.57 percent in pod and 42.11 percent in fodder [3].

Host plant resistance is an effective biological approach for plant protection [4] and using insect resistant varieties is an important strategy of integrated pest management [5]. The biophysical traits can be used as phenotypic markers to identify groundnut germplasm lines with resistance to tobacco caterpillar and leaf miner. The main reasons of variability in resistance shown by different genotypes were explained by Painter [6]. He pointed out three mechanisms of resistance, *viz*., non-preference (antixenosis), antibiosis and tolerance.

The morphological features of plants are associated with attraction, feeding and egg laying of the insect pests [7]. The identification of important morphological and bio-chemical characteristics of germplasm lines will help to understand the resistance mechanisms of plant against insect pests which in turn can be used in the breeding programmes for development of resistant varieties to these insect pests.

MATERIAL AND METHODS

The present investigations were conducted at College farm, College of Agriculture, Rajendranagar, Hyderabad (Telangana) under field conditions during *rabi*, 2019-20. Geographic location of Hyderabad pertains to 17.3850 ^{o} North latitude, 78.4867 ^{o} East longitude and elevation of 536 metres above mean sea level (MSL).

(a) Experimental layout:

The experiment was laid out in a randomized block design (RBD) with 40 treatments (Plate 1), each replicated twice. The plot size was 225 m^2. Each treatment was sown in two rows of 3 m each with row to row distance of 30 cm and plant to plant distance of 10 cm along with susceptible (ICGV 91114) and resistant (ICGV 86031) check. The crop was raised as per the package of practices recommended by PJTSAU (Vyavasaya Panchangam) except for the plant protection measures.

Observations:

(i)Tobacco caterpillar

The larval counts were recorded on five randomly selected plants in each line under each replication and also percent leaf area damaged was worked out by assessing leaf damage at top, middle and bottom leaves from ten randomly selected plants showing maximum damage due to tobacco caterpillar. By considering the mean percent leaf area damage, the germplasm was given damage rating by following the scale adopted by Sharma *et al*. [2].

(ii) Leaf miner:

Observations on leaf miner were made on top five leaves from ten randomly selected plants in each replication for the number of leaflets damaged by leaf miner and percent leaf damage was worked out. (AICRP on groundnut [8]; Chakravarthy and Selvanarayanan [9])

(iii) The morphological like plant height, no. of branches, main stem thickness, no. of trichomes on leaf lamina, midrib and petiole and biochemical parameters were estimated by following standard procedures as prescribed by Hedge and Hofreiter [10] (Total sugars), AOAC [11] and Mariotti *et al.* [12] (proteins); Sadasivam and Manickam [13] (phenols) and Schanderl [14] (tannins). These parameters were correlated with tobacco caterpillar and leaf miner incidence and infestation to study their relationship.

RESULTS AND DISCUSSION

(a) Incidence and infestation of tobacco caterpillar:

The mean no. of larvae per plant on all the germplasm lines were on par with the resistant check, ICGV 86031 (1.31) except ICGV 00351 (1.45), K 6 (1.47), ICGV 13189 (1.53), ICGV 10021 (1.55) and JCG 5834 (1.62). Similarly, considering the mean per cent leaf damage per plant, the germplasm lines ICGV 07222, ICGV 93468 and ICGV 02266 recorded 14.00, 14.25 and 16.96 percent leaf damage per plant, respectively and were on par with the resistant check, ICGV 86031 (15.04%) but significantly different from susceptible check, ICGV 91114 (34.50%) (table 1).

Plate 1: List of germplasm lines

Table 1: Incidence and infestation of tobacco caterpillar and leaf miner and morphological characters of groundnut

Genotype	Tobacco caterpillar		Leaf miner	Plant height (cm)	No. of branches	Main stem thickness (cm)	Trichome density (No. of trichomes / 0.25 cm^2)		
	Mean no. of larvae/ plant [a]	Mean leaf damage/ plant (%) [b]	Mean leaf damage/ plant (%) [b]				Leaf lamina	Midrib	Petiole
ICGV 15083	0.88 (1.37)	19.92 (26.42)	10.30 (18.42)	12.68	7.50	2.55	34.25	54.15	63.55
ICGV 181052	1.33 (1.53)	26.38 (30.79)	9.70 (17.60)	15.83	7.40	2.25	30.96	55.13	65.78
ICGV 181011	1.17 (1.47)	24.96 (29.93)	10.05 (18.15)	16.73	5.80	2.43	35.25	66.33	76.00
ICGV 171015	1.03 (1.42)	22.33 (28.15)	9.90 (18.09)	26.60	5.80	2.51	54.56	60.01	59.37
ICGV 16679	0.65 (1.28)	13.71 (21.67)	17.55 (24.58)	18.00	5.60	2.88	34.85	68.59	76.60
ICGV 03043	1.07 (1.44)	22.71 (28.37)	16.20 (23.58)	21.70	5.60	2.45	40.85	63.66	78.86
ICGV 07222	0.83 (1.35)	14.00 (21.92)	14.20 (22.05)	16.82	7.80	2.58	44.65	73.22	80.55
ICGV 06424	0.97 (1.40)	19.50 (26.04)	15.20 (22.74)	21.75	8.00	2.54	31.95	38.25	52.10
ICGV 13189	1.53 (1.59)	32.83 (34.90)	11.40 (19.52)	24.10	4.80	2.22	30.89	62.55	68.55
ICGV 13200	1.35 (1.53)	29.50 (32.85)	14.40 (22.04)	18.30	4.30	2.31	27.12	56.96	62.58
ICGV 14421	1.13 (1.46)	24.13 (29.32)	13.45 (21.23)	16.31	6.00	2.28	33.88	59.65	73.99

ICGV 15423	1.57 (1.60)	31.50 (34.08)	13.05 (21.03)	22.88	5.80	2.19	27.67	48.54	64.20
ICGV 15426	1.18 (1.48)	24.58 (29.66)	9.60 (17.83)	18.15	4.60	2.42	31.39	48.56	65.23
ICGV 93468	0.75 (1.32)	14.25 (22.12)	11.85 (20.03)	13.15	4.50	2.94	47.56	68.26	84.75
ICGV 99195	1.00 (1.41)	21.25 (27.41)	10.95 (19.15)	22.70	5.60	2.54	47.35	66.89	71.64
ICGV 00298	1.18 (1.48)	25.46 (30.27)	10.90 (19.10)	21.89	4.80	2.43	30.93	61.50	70.25
ICGV 00350	1.23 (1.49)	26.66 (31.04)	11.45 (19.73)	16.43	5.00	2.38	33.96	60.36	68.95
ICGV 00351	1.45 (1.57)	29.08 (32.60)	9.80 (18.29)	16.57	5.20	2.31	38.23	44.15	61.96
ICGV 06040	1.30 (1.52)	28.58 (32.26)	9.20 (17.46)	18.71	5.00	2.07	34.37	48.70	62.58
ICGV 02266	0.77 (1.33)	16.96 (24.26)	8.35 (16.45)	14.97	5.00	3.12	45.66	78.55	83.55
ICGV 86015	1.27 (1.51)	25.50 (30.17)	14.10 (21.81)	18.18	4.80	2.45	27.57	62.55	94.84
ICGV 93437	1.27 (1.51)	26.92 (31.15)	17.00 (24.04)	21.25	7.50	2.47	34.25	40.66	57.97
ICGV 93382	1.13 (1.46)	23.83 (29.15)	12.70 (20.81)	20.85	7.00	2.55	31.17	66.95	73.84
ICGV 10001	1.22 (1.49)	28.63 (32.23)	14.35 (21.87)	26.16	5.50	2.36	29.54	53.98	69.31
ICGV 10021	1.55 (1.60)	34.92 (36.19)	11.50 (19.72)	22.90	4.20	2.35	31.56	40.56	61.11
ICGV 15264	1.42	33.33	18.15	19.65	4.50	2.28	32.25	63.56	77.17

	(1.56)	(35.22)	(25.13)						
ICGV 15307	1.15 (1.47)	26.96 (31.24)	15.30 (22.65)	18.40	4.40	2.51	29.58	55.89	66.31
ICGV 87141	1.37 (1.54)	32.21 (34.54)	15.15 (22.80)	21.90	4.60	2.29	41.56	51.65	71.38
ICGV SM 90704	1.15 (1.47)	25.71 (30.41)	10.35 (18.53)	20.00	5.40	2.18	36.25	70.65	86.17
ICGV 90320	0.90 (1.38)	21.75 (27.77)	12.35 (20.44)	21.40	4.50	2.56	38.65	72.68	87.31
JCG 4798	1.43 (1.56)	31.67 (34.22)	12.80 (20.57)	19.45	4.30	2.34	42.56	53.65	61.91
JCG 5834	1.62 (1.62)	37.46 (37.69)	14.35 (22.05)	25.60	4.30	2.43	36.90	66.95	80.33
JCG 2141	1.02 (1.42)	21.83 (27.76)	12.45 (20.58)	20.45	5.20	2.49	43.65	59.69	66.85
JCG 3341	1.23 (1.49)	28.08 (31.96)	18.40 (25.22)	20.65	5.20	2.33	30.65	66.94	87.97
K 6	1.47 (1.57)	35.33 (36.44)	15.95 (23.20)	23.65	4.20	2.37	25.68	50.65	56.87
K 9	1.13 (1.45)	22.75 (28.38)	14.45 (22.17)	18.10	5.60	2.45	44.25	71.25	81.56
KDG 128	0.98 (1.40)	21.54 (27.54)	9.75 (17.97)	13.37	5.20	2.51	34.68	76.43	87.25
Dharani	1.43 (1.56)	32.08 (34.42)	14.45 (22.26)	16.35	4.50	2.92	32.56	63.89	73.55
ICGV 86031 (RC)	0.72 (1.31)	15.04 (22.72)	7.82 (15.94)	22.45	4.60	3.33	48.65	96.01	102.87
ICGV 91114 (SC)	1.42 (1.56)	34.50 (35.95)	17.79 (24.88)	27.90	4.40	2.88	33.26	57.56	63.37
Mean	1.18 (1.48)	25.71 (30.42)	12.93 (20.99)	19.82	5.35	2.49	36.03	60.65	72.47

S.Em±	0.09	0.96	1.47						
CD (P=0.05%)	0.25	2.68	4.10						

RC- Resistant check, SC-Susceptible check; a - Figures in parentheses indicate square root transformed $\sqrt{(x+0.5)}$ values; b- Figures in parentheses indicate angular transformed values

(b) Infestation of groundnut leaf miner:

The overall mean leaf damage due to the leaf miner ranged from 7.82 to 18.15 percent. The resistant check, ICGV 86031 recorded the lowest per cent damage (7.82%) and it was on par with the germplasm lines *viz*., ICGV 15083, ICGV 181052, ICGV 181011, ICGV 171015, ICGV 13189, ICGV 15426, ICGV 99195, ICGV 93468, ICGV 00298, ICGV 00350, ICGV 00351, ICGV 06040, ICGV 02266, ICGV 10021, ICGV SM 90704 and KDG 128 (8.35-11.85%). The highest leaf damage was recorded in JCG 3341 (18.40%) (Table 1).

(c) Morphological parameters of groundnut germplasm lines:

Various morphological parameters *viz*., plant height, number of branches per plant, trichomes on leaf lamina, leaf midrib and petiole, main stem thickness were recorded and correlated with insect pests to know the morphological bases of resistance in forty germplasm lines.

The plant height, no. of branches and main stem thickness ranged between 12.68 cm (ICGV 15083) to 27.90 cm (ICGV 91114), 4.20 (K 6) to 8.00 (ICGV 06424) and 2.07 cm (ICGV 06040) to 3.33 (ICGV 86031), respectively with their mean values being 19.82 cm, 5.35 and 2.49 cm, respectively. The no. of trichome on leaf lamina, midrib and petiole per 0.25 cm^2 ranged between 25.68 (K 6) to 54.56 (ICGV 171015), 38.25 (ICGV 06424) to 96.01 (ICGV 86031) and 52.10 (ICGV 06424) to 102.87 (ICGV 86031), respectively with mean value being 36.03, 60.65 and 72.47, respectively. (Table 1)

Table 2: Relationship between morphological characters of germplasm lines and tobacco caterpillar incidence and infestation

S.No	Parameters (X)	Correlation coefficient		
		Tobacco caterpillar larva (Y)	Tobacco caterpillar leaf damage (Y)	Leaf miner leaf damage (Y)
1.	Plant height	0.3801*	0.4511**	0.2968
2.	No. of branches	-0.3150*	-0.4259**	-0.0431
3.	Main stem thickness	-0.6122**	-0.5434**	-0.0767
4.	Trichome density on lamina	-0.5262**	-0.5237**	-0.3325*
5.	Trichome density on midrib	-0.5294**	-0.4732**	-0.2213
6.	Trichome density on petiole	-0.4249*	-0.4005*	-0.1001

*Significant at 0.05 level; ** Significant at 0.01 level

(i) Tobacco caterpillar incidence and infestation:

The correlation studies indicated significant positive correlation between tobacco caterpillar larval population (no./plant) and percent leaf damage with plant height whereas significant negative relationship with no. of branches per plant, main stem thickness, trichome density on lamina, trichome density on midrib and trichome density on petiole (Table 2).

Krishnaiah [15] reported that plant height had positive correlation with *S. litura* damage in groundnut which corroborates with our studies. Similar to our studies, Sharma *et*

al. [2] reported significant negative relationship between *S. litura* damage and hairiness and main stem thickness of the groundnut varieties screened. The present findings are in line with Mohammad Saleem *et al*. [16] who reported negative significant correlation between damage due to *S. litura* and trichomes on midrib and leaf lamina indicating the role of trichomes in imparting resistance against *S. litura*. Near to midrib of the leaf, *S. litura* prefers to lay eggs. So, midrib trichome density hinders in the oviposition of the insect, thus imparting resistance to *S. litura*.

(ii) Leaf miner infestation:

Positive non-significant correlation was observed between plant height and damage due to mining by leaf miner. The correlation studies indicated negative relationship between no. of branches per plant (non-significant), main stem thickness (non-significant), trichome density on lamina (significant), trichome density on midrib (non-significant) and trichome density on petiole (non-significant) and damage due to mining (Table 2).

The present findings are in conformity with the results of Ranga Rao [17] and Vishalakshi [18] who recorded significantly greater number of trichomes on midrib as well as on leaf lamina in resistant genotypes to leaf miner. Peeru saheb *et al*. [19] reported that the trichomes had shown a negative correlation with fifth instar duration of groundnut leaf bud borer. In contrary to our findings, Sharma *et al*. [2] reported positive correlation between main stem thickness and trichome density on leaf lamina to *Spodoptera*.

(d) Biochemical attributes of resistance/susceptibility in selected groundnut germplasm lines.

About 13 germplasm lines were selected under different levels of resistance and their biochemical attributes like total sugars, proteins, phenols and tannins were analyzed (table 3) and correlated with percent damage and population counts of insects to know their role in imparting resistance/susceptibility to germplasm lines.

Table 3: Biochemical characters of selected germplasm lines

S.No	Germplasm lines	Total sugars (mg/g)	Proteins (mg/g)	Phenols (mg/g)	Tannins (mg/g)
1	ICGV 15083	2.67	2.57	0.94	0.0026
2	ICGV 181011	4.90	2.39	0.82	0.0030
3	ICGV 13189	5.91	2.58	0.76	0.0028
4	ICGV 93382	2.50	2.89	0.68	0.0023
5	ICGV 10001	3.54	2.92	0.78	0.0032
6	ICGV 10021	4.81	2.98	0.64	0.0022
7	ICGV 02266	4.10	2.36	0.73	0.0040
8	ICGV 00298	3.15	2.35	0.90	0.0047
9	ICGV 93468	2.24	2.14	0.92	0.0050
10	K 6	3.85	2.52	0.75	0.0032
11	JCG 4798	6.82	2.82	0.81	0.0035
12	ICGV 86031 (R)	2.53	2.23	0.97	0.0045
13	ICGV 91114 (S)	4.86	2.94	0.61	0.0024

(i) Tobacco caterpillar incidence and infestation:

There was significant positive correlation between incidence and infestation of *S. litura* with total sugars and proteins and significant negative correlation with tannins. With respect

to phenols *S. litura* population showed significant negative correlation whereas with leaf damage it showed non-significant negative correlation (Table 4).

Our findings are in line with Mohammad Saleem *et al*. [16] who reported significant positive correlation with total sugars against *S. litura* in groundnut. Phenols are plant secondary metabolites that give resistance in plants towards herbivores including insects. Phenols affect the biology of insects in so many different ways. It can act as feeding deterrents, antifeedants and also can cause less damage by larva. Rao [20] showed that higher phenol content in the leaf reduced the incidence of *S. litura* in groundnut suggesting that biochemical components can be effectively utilized in breeding for resistance.

Table 4: Relationship between biochemical characters of selected germplasm lines and incidence and infestation of tobacco caterpillar and leaf miner.

Biochemical characters	***S. litura* (No./plant)**	***S. litura* leaf damage (%)**	**leaf miner damage (%)**
Total sugars	0.707**	0.672**	0.218
Proteins	0.677**	0.710**	0.594*
Phenols	-0.640*	-0.669**	-0.561*
Tannins	-0.602*	-0.626*	-0.411

*****Significant at 0.05 level; ** Significant at 0.01 level

(ii) Leaf miner infestation:

There was non-significant positive relationship between percent mining and total sugars whereas significant positive relationship was seen with proteins. Phenols were found to have significant negative correlation with percent mining while non-significant negative correlation occurred with tannins (Table 4).

Ravi Chandra Reddy [21] reported that phenols were significantly negatively correlated and total sugars were positively correlated with leaf miner damage in groundnut. Strong negative correlation between percent foliage damage by leaf miner with total phenol content in the leaf was reported in groundnut by Chandramani [22]. Praveen [23] reported significant positive correlation between total sugars and leaf miner damage in groundnut variety KRG 1. Similar results were reported by Ambenagare *et al.* [24] and Halder *et al.* [25] in soybean.

Among the forty germplasm lines screened against tobacco caterpillar and leaf miner, three germplasm lines *viz*., ICGV 16679 (13.71% leaf damage), ICGV 07222 (14.00% leaf damage) and ICGV 93468 (14.25% leaf damage) showed greater resistance than the resistant check, ICGV 86031(15.04% leaf damage) against tobacco caterpillar infestation and with respect to resistance against leaf miner, no germplasm line was found to be superior than the resistant check, ICGV 86031 (7.82% leaf damage). However, the germplasm line, ICGV 02266 (8.35% leaf damage) was next best to the resistant check.

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