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GENOTYPIC AND ENVIRONMENTAL EFFECTS IN SEVEN COWPEA (*Vigna unguiculata* (L.) WALP) GENOTYPES UNDER NATURAL INFESTATION BY *Etiella zinckenella* TREITSCKE AT TWO LOCATIONS IN SOUTHERN EGYPT

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ABSTRACT

Seven cowpea genotypes (cultivars and lines) were screened for tolerance to *Etiella zinckenella* attack at two different locations over two years. It is clear that the variety effects were significant for all the studied traits. "Kobrosy" cv. produced the highest values of yield and yield components and it could be recommended as a commercial variety under the studied conditions. "IT85D-3850-2" line gave the highest ability to pest tolerance, so, it could be used as a source of pest resistance in a breeding programmes. Generally, the damaged seeds percentage was higher in Kena than Sohag region over both years of study under the field conditions (without any pesticides), however, no significant differences were existed between locations in this respect. On the other hand, the infested pods percentage was higher in Sohag than Kena region over the combined data but differential varietal response were observed from individual environment to another one across four studied environments. High heritability values were obtained in all studied characters - except- pod length character. The phenotypic and genotypic coefficient of variability show the obtained results.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp] is among the most important crops that supply the Egyptian people with protein in their diet. The most problem of cowpea crops is the dry yield unreliability and the way yields fluctuate from region to another. *Etiella zinckenella* Treitscke is one of the major constraints to cowpea production in mediterranian basin and most world countries (Masaki and Naite, 1964; Singh and Dohooria, 1971; Pai and Dhuri, 1991; Samia, 1993 and Nadia *et al.*, 1998). This study was planned to realize some genotypes performance under natural infestation by cowpea pods borer at four environments i.e. two locations over two years in the southern valley of Egypt, to determine the genotypes which may be depend upon in breeding program for pest resistance.

MATERIALS AND METHODS

The present study was carried out in the summer seasons of 2000 and 2001 at two different locations, i.e., Shandaweel (Sohag Governorate) and El-Mattaana (Kena Governorate) Research Stations belonging to Agric. Res. Center, Giza, Egypt. Five new cowpea lines viz., "IT81D-555-6"; IT85D-3850-2"; "Kobrosy"; "IT89KD-107" and "H6-16" were used beside both "Dokki 331 and Cream 7" cultivars which are recommended in Egypt. Seeds were

sown on 17th and 15th May at Sohag and Kena locations, respectively in 1st season, and on 20th May, at 2nd season, in both locations. A randomized complete block with three replications was laid out in the design of the experiments. The experimental plot consisted of 5 rows, each 4 meters long and 60 cm. apart with plants spaced 15 cm. in the row. Normal cultural practices in the field - without applying any pesticides - were followed. Determination of the studied characters was carried as follows:

1 - Percent damaged seeds: 100-pods randomly taken from each plot at dry harvesting times and then, the percentage of damaged seeds was recorded as the following equation:

$$\text{Damage seeds \%} = \frac{\text{No. damaged seeds}}{\text{Total number of seeds per 100-pods}} \times 100$$

2 - Percent infested pods: This character was computed on 100 dry pods, randomly taken, by equation:

$$\text{Infested pods \%} = \frac{\text{infested pods}}{\text{No. of tested pods}} \times 100$$

3 - Average of dry pod length, in cm.
4 - Number of dry seeds per pod.
5 - Number of dry pods per plant.
6 - Average of dry pods weight per plant, in gram.
7 - Average of 100-seeds weight, in gram, at dry harvest stage.
8 - Dry seeds weight per plant, in gram.
9 - Total dry seed yield (kg/feddan).

Statistical analysis:

Data of individual environment were statistically analysed according to Snedecor and Cochran (1968). Homogeneity was computed among error variance in the separate ANOVA for all characters according to Steel and Torrie (1960). Subsequently, combined analysis of variance for the four environments was performed on logarethmic data for some characters; [to give equal weight to genotypes performance in each environment (Yau, 1991)]; as well as actual data for other characters as outlined by Federrer (1963).

The genotypic σ^2_g and phenotypic σ^2_p variances, heritability in broad sense (h^2), and genotypic GCV and phenotypic PCV coefficient of variability were estimated for combined data according to Al-Jibouri *et al.* (1958); Hanson and Robinson (1956) and Burton (1952), respectively.

RESULTS AND DISCUSSION

By examination the logarithmic data in Table 2, it is apparent that the values of percent damaged seeds in pods of different genotypes ranged from 1.1 to 1.6% and from 0.9 to 1.7% in Sohag and Kena regions, respectively with a mean value of 1.4% for two locations over both seasons of study. The combined analysis of variance of this character showed the significance of genotypes, years as well as the interaction effects of genotype x location, genotype x year and genotype x location x year (Table 2). Hence, it may be

concluded that important tolerance variation for infestation is existed (the significance among genotypes), and the interaction items demonstrate that behaviour of the genotype varied from environment to another one and particular genotypes must be sought for particular environments (Falconer, 1981). The results obtained from single location (over the two years) for this trait indicated that genotypes, generally sustained less damage in Sohag than Kena region, and "Kobrosy" line, the most tolerant to *Etiella zinckenella*, gave the highest total dry seed yield in both locations in this work, which had moderate infestation in both regions over the two years. On the other hand, "IT89KD-107" and "IT85D-3850" lines had the lowest values for damaged seeds percentage, in both regions (Table 2). It is noted that the low values of damaged seeds, in the two lines, were associated with low dry seeds yield value (Table 4). It was believed that such association was caused by performance of the lines under unsuitable geographical location of a place rather than to any connection with insects. The broadsense heritability for this character was 64.4% (Table 1) indicating that the character could be improved by phenotypic selection. Similar trend were reported by Painter (1951), Benepol and Hull (1967), Waly *et al.* (1983) and Jaglan *et al.* (1993).

Table (1): Mean of character, phenotypic (PCV) and genotypic (GPC) coefficient of variability, heritability in broadsense (h^2) and standard error obtained from the combined analysis of the four environments data under pest-insect stress.

Characters	$\bar{X}$		σ^2_p	σ^2_g	h^2	PCV	GCV	S.E.
1. % damaged seeds	(1.42)	29.6	0.045	0.029	64.4	15.2	12.2	0.033
2. % infested pods	(1.7)	47.1	0.017	0.013	76.5	7.7	6.7	0.020
3. Pod length (cm)		15.95	1.430	0.420	29.3	7.5	4.1	0.180
4. No. seeds/pod		8.55	1.490	0.940	63.1	12.5	9.9	0.190
5. No. pods/plant		51.55	0.139	0.091	65.5	22.2	18.0	0.060
6. Wt.pods/plant (gm)		61.6	0.162	0.136	84.0	22.5	20.6	0.060
7. 100-seedsweight (gm)		16.5	19.110	18.520	96.91	26.5	26.1	0.670
8. Seed weight/plant (gm)		30.68	0.188	0.183	97.8	34.4	34.0	0.070
9. Total yield (kg/feddan)		576.45	0.240	0.100	97.0	19.4	19.1	0.080

Figure in parenthesis is mean of translocated values.

As regards percent infested pods trait, results of Table 2 show a wide range among different genotypes in both locations. The mean values ranged from 35.7 to 56.5% (Actual values) in Sohag and from 37.6 to 53.8% in Kena over two years. However, "IT85D-3850" and "IT81D-555" lines had the lowest value in the infestation at the two regions. From combined analysis of variance (Table 2); highly significant differences among both year and location effects were existed. Also, there were significant genotype x location, genotype x year and genotype x location x year interaction effects.

Table (2): Mean performance (over two years) of the studied Infestation and pod length characters in 7 genotypes of cowpea grown at Sohag and Kena locations.

Effects	Log. and actual (in parenthesis) values of percent damaged seeds (%)						Log. and actual (in parenthesis) values of percent infested pods (%)						Actual values of pod length (cm)			
	Sohag		Kena		Mean		Sohag		Kena		Mean		Sohag	Kena	Mean	
Genotypes:																
Dokki 331	1.6	(38.7)	1.6	(43)	1.6	(40.85)	1.8	(56.5)	1.7	(50.2)	1.75	(53.35)	14.3	15.3	14.8	
IT81D	1.5	(32.5)	1.4	(23.4)	1.45	(27.95)	1.6	(42.2)	1.6	(37.6)	1.60	(39.90)	14.7	19.1	16.9	
IT85D	1.1	(13)	1.3	(18.8)	1.20	(15.9)	1.6	(35.7)	1.6	(42.6)	1.6	(39.15)	13.9	18.8	16.4	
Kobrosy	1.4	(24.7)	1.5	(35.1)	1.45	(29.9)	1.7	(51.1)	1.6	(44.3)	1.65	(47.7)	17.3	17.1	17.2	
IT89KD	1.3	(19.6)	0.9	(8.7)	1.10	(14.15)	1.7	(47)	1.7	(53.8)	1.7	(50.4)	15.2	18.7	17.0	
H6-16	1.6	(43.7)	1.6	(35.7)	1.6	(39.7)	1.8	(59.8)	1.6	(44.6)	1.7	(52.2)	14.0	15.7	14.9	
Cream 7	1.4	(27.7)	1.7	(50.1)	1.55	(38.9)	1.7	(48.5)	1.7	(44.8)	1.7	(46.65)	14.1	14.7	14.4	
LSD					5%	1%					5%	1%			5%	1%
Genotypes:					0.18	0.24					0.11	0.15			1.2	1.6
Locations					ns	ns					0.10	0.20			0.8	1.4
Year:																
1st year	1.4	(33.4)	1.6	(35.9)	1.52	(34.65)	1.8	(60.6)	1.8	(63.3)	1.8	(61.95)	14.1	16.9	15.5	
2nd year	1.4	(23.7)	1.2	(25.5)	1.3	(24.6)	1.6	(36.8)	1.4	(27.5)	1.5	(32.15)	15.5	17.3	16.4	
LSD					5%	1%					5%	1%			5%	1%
Years					0.17	0.21					0.19	0.28			0.8	ns
Interactions:																
G x L					**						*				ns	
G x Y					*						*				**	
L x Y					ns						*				ns	
G x L x Y					*						*				**	

Due to high heritability in this character, it can be concluded that the environmental conditions had little effect on the inheritance of this character. These results were confirmed by those of Singh and Dhooria (1971), Samia (1993), Talekar and Lin (1994) and Nadia *et al.* (1998).

It was observed that the differences in the pod length trait among the genotypes under studies were highly significant (Table 2). The longest and shortest pods were found in "Kobrosy" and "Cream 7" cvs, respectively. Highly significant differences between the two locations obtained through the combined analysis of variance for this character. It is interest to note that, some genotypes behaved constantly for both locations, i.e., the mean of "Kobrosy" cv. was 17.3 and 17.1 cms for the Sohag and Kena region (over both studied seasons), respectively; while some genotypes fluctuated from one location to another, i.e., the mean of "IT85D" line was 13.9 cm. for the first region and 18.8 cm. for the second one. Furthermore, genotype x year and genotype x location x year interaction effects were found highly significant for this character, revealing the necessity of evaluation in large diverse environments to select for longer pods. Moreover, the broadsense heritability for this trait (Table 1) was 29.3% indicating a remarkable environmental effect on this character.

The results in dry pod length character were reported by Kahn and Stofelia (1985), Gad El-Hak *et al.* (1988), Damarany (1994), Farghali and Hussein (1995), Hussein and Farghali (1995) and Samira and Faris (1995).

Data of the number of seeds per pod in the two locations of experimentation over both studied years are shown in Table 3. Significant differences were observed among genotypes. "IT89KD" line gave the highest value for number of dry seeds/pod with mean of 10.05 seeds/pod over four environments. On the other hand "H6-16" line gave the lowest value in this respect. The variation between locations was highly significant, but no significant differences were found between the two years of study. Also, the genotype x location interaction effect was insignificant. Heritability value for this trait was 63.1% (Table 1) indicating that the number of dry seeds/pod is a varietal character. Similar findings were recorded by Stino *et al.* (1971); Nasser (1981); Gad El-Hak *et al.* (1988) and Damarany (1994).

A wide range of variability was found among different genotypes, with respect to number of pods per plant, in both locations (Table 3). From combined analysis of variance, highly significant differences between different genotypes were observed. Also, the genotype x location, genotype x year and genotype x location x year interaction effects were significant indicating that the performance of some genotypes varied from environment to another one, e.g., the "IT89KD" line had the average of 79.7 pods/plant for Sohag region and 46.3 pods/plant for Kena, while, the "Kobrosy" cv. had the average of 71 pods/plant for Sohag and 92.1 pods/plant for Kena region. In other words, "IT89KD" cv. had best behaviour in Sohag than in Kena, whereas "Kobrosy" cv. had best behaviour in Kena than Sohag for this character. On the other hand, some genotypes performed nearly constantly over the two locations, e.g., the average of "Dokki 331 cv" was 76 and 82.8 pods/plant for the first and second locations, respectively. These data indicate that environment must be a major reason of location -to- location variation in pods per plant.

Table (3): Mean performance (over two years) of number of seeds per pod and number and weight of dry pods/plant characters in 7 genotypes of cowpea grown at Sohag and Kena locations.

Effects	Actual values of number of seeds/pod			Number of dry pods/ plant			Weight of dry pods/plant (gm)		
	Sohag	Kena	Mean	Sohag	Kena	Mean	Sohag	Kena	Mean
Genotypes:									
Dokki 331	7.7	8.,3	8.0	76.0	82.8	79.4	93.2	101.5	97.35
IT81D	7.6	9.6	8.6	15.3	30.1	22.7	18.3	24.1	21.2
IT85D	7.9	8.5	8.2	19.3	20.2	19.8	22.5	32.0	27.25
Kobrosy	9.9	9.7	9.8	7.1	92.1	81.6	90.0	128.4	109.2
IT89KD	10.1	10.0	10.1	79.7	46.3	63.0	75.0	43.3	59.15
H6-16	6.9	8.1	7.5	32.7	41.6	37.2	60.0	76.8	68.40
Cream 7	7.4	8.4	7.9	52.7	61.9	57.3	45.0	52.4	48.70
LSD			5% 1%			5% 1%			5% 1%
Genotypes:			1.8 2.5			37.0 ns			36.2 60.0
Locations			0.3 0.43			Ns ns			ns ns
Year:									
1st year	8.2	8.6	8.4	45.7	50.5	48.1	57.3	64.9	61.1
2nd year	8.2	9.2	8.7	53.3	56.7	55.0	58.1	66.1	62.1
LSD			5% 1%			5% 1%			5% 1%
Years			ns ns			6.1 ns			1.0 ns
Interactions:									
G x L			ns			*			ns
G x Y			*			**			**
L x Y			*			ns			ns
G x L x Y			*			*			ns

The broad sense heritability for this trait was 65.5% (Table 1). Similar trends were reported by Viswanathan (1978), Nasser (1981) and Abo-Bakr *et al.* (1983).

Again, results in Table 3 showed a wide range of variation between the genotypes in respect of dry pods weight per plant in both locations over the two seasons. The values of this trait ranged from 21.2 gm. in "IT81D" line to 109.2 gm. in "Kobrosy" cv. The variation among the two years of study was significant, while the genotype x location, location x year and genotype x location x year interaction effects were insignificant for this character; then, the best genotypes in one environment must be the best in all. It is clearly noticed, from the results, that some genotypes fluctuated from one region to another, i.e. "IT89KD" line had the value of 75 gm. in Sohag location and 43.3 gm. in Kena region. This discrepancy in result may be due to sensitivity of the fluctuant cultivars than others to environmental differences from region to another one or from year to year, and this trend was to true for the interaction of genotype x year. So, the environmental variance is a properly of the genotypes. But the source of the variation is environmental and not genetic (Falconer, 1981). The broadsense heritability estimate was 84% for this trait (Table 1). These results agree with Viswanathan (1978).

It is clearly noticed from data shown in Table 4 that the differences in weight of 100-seeds among the genotypes under investigations were highly

significant. "H6-16" line gave the highest value for this character over all environments followed by "Dokki 331" cv. (in Sohag location) and "Kobrosy" cv. (in Kena location). On the other hand, "IT81D" line gave the lowest value of 100-seeds weight. The interaction effect of genotype x location was significantly exceeds genotype x year x location interaction, it is clear that the differential response of the genotypes at the individual location was sufficiently similar in the different years to warrant the conclusion that, these differential responses may be permanent features for these locations. However, a high heritability value of 96.9% was obtained through the combined analysis for this trait (Table 1). These results were confirmed by those of Abo-Bakr *et al.* (1983), Gamil and Gad El-Hak (1984), Gad El-Hak *et al.* (1988), Damarany (1994) and Zayed *et al.* (1999). As shown in Table 4, highly significant differences were existed in the mean of seeds weight per plant trait among the genotypes. "Kobrosy" line had a heaviest seeds per plant in both regions over the two studied years, while "IT89KD" line had the lowest weight of seeds per plant under insect infestation conditions.

Table (4): Mean performance (over two years) of seed index and seed yield characters in 7 genotypes of cowpea grown at Sohag and Kena locations.

Effects	Seed weight/plant (gm)			100-seeds weight (gm)			Total seed yield (kg/feddan)		
	Sohag	Kena	Mean	Sohag	Kena	Mean	Sohag	Kena	Mean
Genotypes:									
Dokki 331	43.2	46.0	44.6	20.0	18.2	19.1	864.5	919.8	892.15
IT81D	13.0	20.5	16.75	10.0	10.2	10.1	304.0	352.5	328.25
IT85D	11.3	17.2	14.25	13.4	13.6	13.5	243.0	251.4	247.2
Kobrosy	50.4	58.7	54.55	17.9	21.1	19.5	1007.6	1174.0	1090.8
IT89KD	16.2	12.8	14.5	19.4	19.0	19.2	235.9	158.8	197.35
H6-16	33.6	38.9	36.25	21.2	22.0	21.6	609.3	721.2	665.25
Cream 7	32.0	35.7	33.85	12.9	12.2	12.5	574.5	653.5	614.0
LSD			5% 1%			5% 1%			5% 1%
Genotypes:			19.2 26.0			3.2 4.4			397.9 541.7
Locations			ns ns			ns ns			ns ns
Year:									
1st year	28.02	32.30	30.16	16.0	16.2	16.1	544.42	604.1	574.26
2nd year	29.04	33.36	31.20	16.8	17.0	16.9	552.38	604.9	578.64
LSD			5% 1%			5% 1%			5% 1%
Years			1.0 ns			0.7 ns			4.21 ns
Interactions:									
G x L			*			*			*
G x Y			ns			ns			ns
L x Y			ns			**			ns
G x L x Y			ns			*			ns

However, the interaction location x genotype was significant for this character, revealed that some genotypes were superior at all locations, as an average of all years. Moreover, nonsignificance of genotype x year and genotype x year x location interaction effects make it evident to improve such trait through selection. Also, a high heritability value of 97.8% was obtained for the combined data indicated that selection can be used for improving seeds weight per plant under these environment conditions. Estimated

phenotypic and genotypic coefficient of variability (Table 1) were observed with slight repugnancy between them for this trait reffering to highly genotypic variances as calculated from the combined analysis of variance (Zayed *et al.*, 1999). Varietal differences in weight of dry seeds per plant were mentioned by Damarany (1994) and these results are in coincided with those reported by Hussein and Farghali (1995) and Zayed *et al.* (1999).

In respect of total dry seed yield per feddan, data in Table 4 indicated that highly significant differences were observed between the different genotypes. "Kobrosy" cv. produced the highest value for total dry seed yield followed by "Dokki 331", "H6-16" and "Cream 7" genotypes. On the other hand, "IT89KD" line gave the lowest value in this trait. Insignificant differences neither among locations nor the interaction effects of GxY, LxY and GxLxY were obtained for this character, revealed the same performance of previously mentioned trait, i.e. seeds weight/plant, for the studied environment conditions. A high heritability value of 97.0% was obtained for this character (Table 1). Also, the data of PCV and GCV revealing the high estimates of genotypic variances. The results in this character were in agreement with those obtained by Kohli *et al.* (1971); Malash (1971); Gamil and Gad El-Hak (1984); Gad El-Hak *et al.* (1988); Damarany (1994) and Hussein and Farghali (1995).

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دراسة التأثير الوراثى والبيئى فى سبعة أصناف من اللوبيا تحت ظروف الاصابة الطبيعية بدودة قرون اللوبيا فى منطقتين بجنوب مصر

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أجريت هذه الدراسة بمحطتى بحوث شندويل والمطاعنة لدراسة السلوك البيئى والوراثى لسبعة أصناف وسلالات من اللوبيا تجاه الاصابة بدودة قرون اللوبيا .

وأوضحت الدراسات الاحصائية (التحليل المشترك والقياسات الوراثية) وجود اختلافات معنوية بين معظم التراكيب الوراثية (أصناف وسلالات) فى جميع الصفات تحت الدراسة . وكان الصنف " قبرصى " أعلى الأصناف فى كل الصفات الهامة تحت ظروف الاصابة ، كما أظهرت السلالة "IT85D-3850" قدرة عالية فى تحمل الاصابة ورغم قلة المحصول والصفات الأخرى والتى ترجع الى الصنف نفسه وليس الى التأثير الحشرى إلا أن هذه السلالة تعتبر هامة لمربى النبات كمصدر مقاومة للحشرة يمكن ادخاله فى برامج تربية متقدمة لتحسين المحصول . كانت درجة التوريث " فى المعنى الواسع " عالية فى جميع الصفات ماعدا صفة طول القرن وبالتالى كان للبيئة تأثيراً على هذه الصفة وتعتبر الاختلافات فى باقى الصفات وراثية - كما يؤكد هذه النتائج معامل الاختلاف الوراثى والبيئى - مما يؤكد أهمية هذه الاختلافات لمربى النبات .