Field evaluations of pigeon pea genotypes for resistance against pod borers[1]

Arístides M. Armstrong[2]

ABSTRACT

Two field plantings were established at Isabela (AES-UPR) (27 August 1984) to evaluate 27 genotypes (15 early bloomers and 12 late bloomers) for resistance to pod borer, *Heliothis virescens* and *Etiella zinckenella*. One planting of the 27 genotypes was treated with methomyl 90S (0.56 kg/ha). The second planting was untreated. Insecticide applications began at the flowering stage. The efficacy and resistance data were based on the number of larvae and damaged pods per plot at harvest. Eggs of *H. virescens* per pod per plot were counted. None of the untreated early bloomers tested were free from pod borer attack. The most tolerant genotypes were lines 82-26-1 and 82-1-24 Ponce 83, with 19 and 28% damaged pods, respectively. The most susceptible was line 69-73-1-B-D with 57% damaged pods. At harvest, genotypes 82-3-16, 29 Irradiado, 79 Irradiado, 99-1 Irradiado and 69-73-1-B-D were free or almost free of *E. zinckenella* larvae. Methomyl-treated early bloomer genotypes showed lower percentages of infestation. Line 69-73-1-B-D showed only 7% damaged pods. The most susceptible, with 55% damaged pods, was line 82-29. All the untreated late bloomer genotypes were attacked by pod borer larvae. Lines 69-68 and 7 had the best ratings with 21 and 24% damaged pods, respectively. Cultivar Amarillo Kaki was the most susceptible, with 57% damaged pods. At harvest, *H. virescens* larvae was more dominant except for lines 87-7 Ponce 83 and cv. Santa Isabel, where *E. zinckenella* larvae were more abundant. Methomyl-treated plants of the late bloomers showed lower percentages of damaged pods. Line 12 and cv. Amarillo-Kaki 1 each showed 11% damaged pods. Cultivar Santa Isabel and lines 82-7 Ponce and 77-1 Irradiado were the most susceptible.

RESUMEN

Evaluaciones de campo de genotipos de gandul para resistencia para los taladradores de las vainas

Se establecieron dos ensayos de campo en Isabela (27 agosto de 1984) para evaluar 27 genotipos (15 de maduración temprana y 12 de maduración tardía) para resistencia de los taladradores de las vainas, *Heliothis virescens* y *Etiella zinckenella*. Una de las siembras de los 27 genotipos se trató con metomilo 90S (0.05 kg./ha.) para compararla con el grupo sin tratar. Las aplicaciones del insecticida comenzaron en la etapa de floracion. La eficacia y resistencia se basó en el número de larvas y vainas dañadas por parcelas en la cosecha. Se contaron los huevos de *H. virescens* por vaina y parcela. Ninguno de los genotipos de maduración temprana sin tratar estuvo libre de estos insectos. Las líneas más tolerantes fueron 82-26-1 y 82-1-24 Ponce 83, con 19 y 28% de vainas dañadas, respec-

[1]Manuscript submitted to Editorial Board 16 November 1989.

[2]Assistant Researcher in Entomology, Department of Crop Protection.

tivamente. La línea 69-73-1-B-D fue la más susceptible, con 57% de vainas dañadas. En la cosecha, los genotipos 82-3-16, 29 Irradiado, 79 Irradiado, 99-1 Irradiado y la 69-73-1-B-D estaban libres o casi libres de larvas de *E. zinckenella*. Los genotipos de maduración temprana tratados con metomilo mostraron un menor porcentaje de infestación. La línea 69-73-1-B-D tuvo solo un 7% de vainas dañadas. La más susceptible fur la línea 82-29 con 55% de vainas dañadas.

Los taldradores atacaron las vainas de todos los genotipos de maduración tardía sin tratar. Las líneas 69-68 y 7 fueron las mejores, con 21 y 24% de vainas dañadas, respectivamente. El cv. Amarillo-Kaki 1 fue el más susceptible, con 57% de vainas dañadas. En la cosecha, larvas de *H. virescens* estuvieron dominando excepto en las líneas 87-7 Ponce 83 y el cv. Santa Isabel, en el cual *E. zinckenella* fue más numeroso. Los genotipos de maduración tardía tratados con metomilo obtuvieron porcentajes más bajos de vainas dañadas. La línea 12 y el cv. Amarillo-Kaki mostraron cada uno 11% de vainas dañadas. El cv. Santa Isabel y las lineas 82-7 Ponce y 77-1 Irradiado fueron los más susceptibles.

INTRODUCTION

Pigeon pea (*Cajanus cajan* Millsp.) is the most common cultivated legume crop in Puerto Rico. Cultivars 2B-Bushy (determinate) and Kaki (indeterminate) exhibit good agronomic characteristics and are widely cultivated throughout the Island (3). Nevertheless, these cultivars are very susceptible to attack of pod borers, *Heliothis virescens* (Fabricius) (Lepidoptera:Noctuidae) and *Etiella zinckenella* (Treitschke) (Lepidoptera:Pyralidae), which account for around 50% loss of this crop (1). The larvae of these insects bore into the pods reducing quality and yield (2). This paper reports results on the evaluation of genotypes of pigeonpeas for resistance to the attack of these pod borers.

MATERIALS AND METHODS

In an attempt to identify genotypes resistant to the insects, two field plantings were established 27 August 1984 at the AES-UPR substation of Isabela to evaluate a total of 27 genotypes (15 early bloomers, November; and 12 late bloomers, December and January) for resistance to pod borers. One planting of the 27 genotypes was treated with methomyl 90S at the rate of 0.56 kg/ha (0.5 lb/A). The second planting was untreated. Each genotype was planted in a two-row plot 7.5 m long with 1.0 m between rows and 0.5 m between plants within rows (30 plants per plot). Insecticide applications began at the flowering stage and were made only when the number of eggs of *H. virescens* exceeded 0.1 to 0.2 per pod per plot. Oviposition of *E. zinckenella* was not taken into consideration because of the difficulty in finding the eggs. An average of 2.37 applications were made (ranging from 1 to 3 applications). The efficacy and resistance data were based on the number of larvae and damaged pods per plot at harvest in 100-pod random samples from each row. Plots were evaluated as follows: 0 = no larvae present; 1 = 1 to 9 larvae; 2 = 10 to 20 larvae; 3 = 21 to 30 larvae; 4 = 31 to 40 larvae; and 5 =

more than 40 larvae. This ranking served to calculate the percentage of frequency of infestation. Eggs of *H. virescens* per pod per plot were counted. Correlation analysis and t-test were made for infestation vs yield.

RESULTS AND DISCUSSION

None of the early bloomers tested were free from pod borer attack (tables 1 and 2). There were some genotypic differences in response to

TABLE 1.—*Evaluation of some genotypes of pigeon pea for resistance against the pod borers,* Heliothis virescens *and* Etiella zinckenella *at Isabela, P.R. (1984-85)*

Cultivars or lines	Rating	Percent infestation: Damaged pods[1]	*Heliothis*	*Etiella*	Eggs per pod[2]	Weight of 100 pods (g)
Early bloomers						
82-26-1	1	19(9)	67	33	0.4	185.0
82-1-24 Ponce 83	1	28(8)	62	38	1.0	165.3
82-44	2	27(22)	68	32	0.4	204.8
64-2B-Bushy	2	31(19)	89	11	0.8	217.5
82-25-1	2	32(14)	64	36	0.8	161.0
82-3-16	2	35(14)	100	—	0.4	173.0
29 Irradiado	2	41(17)	100	—	1.1	247.0
79 Irradiado	2	41(17)	94	6	0.3	191.0
92 Irradiado	2	51(18)	100	—	1.0	180.2
99-1 Irradiado	2	54(17)	94	6	0.7	166.8
82-45-1	3	39(26)	50	50	0.2	184.1
82-29	3	43(27)	48	52	0.3	304.4
147 Irradiado	3	44(29)	52	48	0.8	219.5
148 Irradiado	3	57(29)	62	38	0.4	206.7
69-73-1-B-D	4	53(33)	100	—	0.5	177.8
Mean		39.9 (19.9)	76.7	23.3	0.61	198.9
Late bloomers						
69-68	1	21(19)	89	11	0.3	268.5
Line 7	1	24(4)	50	50	0.4	247.0
Line 12	1	40(9)	89	11	0.6	295.0
77-1 Irradiado	2	26(11)	82	18	0.3	90.6
Kaki	2	34(10)	90	10	0.4	246.5
Amarillo Kaki-3	2	39(11)	73	27	0.2	312.0
Amarillo Kaki-4	2	40(19)	84	16	0.4	273.0
Amarillo Kaki-1	2	45(13)	92	8	0.4	262.0
82-7 Ponce 83	2	45(15)	40	60	0.2	136.5
98 Irradiado	2	46(16)	94	6	0.1	211.6
Santa Isabel	3	45(33)	12	88	1.0	286.0
Amarillo Kaki-2	3	51(23)	74	26	0.3	294.0
Mean		38 (14.4)	72.4	27.6	0.38	243.6

[1]Number in parenthesis indicates the number of podborer larvae per 100 pods.
[2]Based on the number of *H. virescens* eggs on 20 pods per plot.

pod borers in the untreated planting (table 1). The most tolerant genotypes from this planting (rating of 1) were lines 82-26-1 and 82-1-24 Ponce 83 with 19 and 28% damaged pods, respectively. The most susceptible (rating of 4) was line 69-73-1-B-D, with 57% damaged pods. Nevertheless, most plants showed more than 40% damaged pods regardless of the rating (number of larvae).

At harvest there were more *H. virescens* larvae (X = 76.7%) than *E. zinckenella* larvae (X = 23.3%) in the untreated early bloomers. Insignificant numbers or no larvae of *E. zinckenella* were recovered from genotypes 82-3-16, 29 Irradiado, 79 Irradiado, 99-1 Irradiado and 69-73-1-B-D. No correlation was obtained between the number of larvae of early bloomers and yield of the treated or untreated plots, indicating no relation between infestation and yield. Besides taking into consideration that we were dealing with different genotypes, higher yields (weight of 100 pods) were obtained even with a high number of damaged pods or larvae (table 1).

Plants from methomyl-treated plots of early bloomer genotypes showed lower percentages of infestation ($\bar{X}$ = 24.7%) than the untreated ones ($\bar{X}$ = 39.9%) (table 2). Seven genotypes showed less than 20% damaged pods. Line 69-73-1-B-D showed only 7% damaged pods. The most susceptible (rating of 5) with 55% damaged pods was line 82-29, it was the one that produced the highest yield. In these plots more *E. zinckenella* larvae ($\bar{X}$ = 71%) were obtained than *H. virescens* larvae ($\bar{X}$ = 29%). No larvae of *H. virescens* were recovered from lines 92 Irradiado, 29 Irradiado, and 82-44.

All the late bloomer genotypes were attacked by pod borer larvae. Most untreated plants had more than 40% damaged pods (table 1). Lines 69-68 and 7 had the best ratings with 21 and 24% damaged pods, respectively. Cultivar Amarillo-Kaki 2 was the most susceptible with 57% damaged pods. A weak negative correlation was obtained with the number of larvae of late bloomers and yield in the untreated plots (significance at 85-90%). At harvest, from all genotypes tested, *H. virescens* larvae were more dominant except for lines 87-7 Ponce 83 and cv. Santa Isabel, where *E. zinckenella* larvae were more abundant.

Methomyl treated plants of the late bloomers showed lower percentages of damaged pods ($\bar{X}$ = 30.8%) than the untreated ($\bar{X}$ = 38%). Five genotypes showed less than 15% damaged pods. Line 12 and cv. Amarillo-Kaki 1 (both with a rating of 1) each showed 11% damaged pods (table 2). Cultivar Kaki produced the highest yield, 311.0 g. Cultivar Santa Isabel and lines 82-7 Ponce and 77-1 Irradiado, both with a rating of 5, were the most susceptible. Line 77-1 Irradiado had an infestation of 89%. A negative correlation was obtained with the number of larvae of late bloomers and yield in the treated plots (significance at 90-95%). At harvest, *H. virescens* larvae were more abundant in 7 genotypes

TABLE 2.—*Evaluation of some genotypes of pigeon pea treated with methomyl for resistance against the pod borers,* Heliothis virescens *and* Etiella zinckenella *at Isabela, P.R. (1984-85)*

Cultivars or lines	Rating	Percent infestation: Damaged pods[1]	*Heliothis*	*Etiella*	Eggs per pod[2]	Weight of 100 pods (g)
Early bloomers						
69-73-1-B-D	1	7(9)	67	33	0.7	215.8
92 Irradiado	1	10(3)	—	100	0.6	240.0
29 Irradiado	1	13(5)	—	100	1.1	238.5
82-26-1	1	18(6)	33	67	0.7	212.1
82-3-16	1	18(5)	60	40	0.3	202.6
82-44	1	22(7)	—	100	0.3	234.6
82-25-1	1	25(6)	33	67	0.4	209.0
99-1 Irradiado	2	12(10)	50	50	1.2	263.3
148 Irradiado	2	18(12)	8	92	0.3	254.3
79 Irradiado	2	29(12)	33	67	0.5	225.5
82-1-24 Ponce 83	2	30(12)	25	75	0.4	208.2
82-45-1	2	40(18)	11	89	0.3	197.6
147 Irradiado	3	28(28)	14	86	0.9	301.5
64-2B-Bushy	3	46(27)	48	52	0.5	233.0
82-29	5	57(47)	53	47	0.1	469.3
Mean		24.7 (13.8)	29	71	0.55	247.0
Late bloomers						
Line 12	1	11(6)	83	17	0.6	241.0
Amarillo Kaki-1	1	11(8)	62	38	0.4	252.0
Amarillo Kaki-2	1	12(5)	60	40	0.3	276.0
98 Irradiado	1	13(3)	100	—	0.4	250.7
69-68	1	14(4)	75	25	0.3	283.5
Amarillo Kaki-3	1	21(7)	43	57	0.3	286.0
Kaki	1	28(8)	38	62	0.3	311.0
Amarillo Kaki-4	2	23(13)	69	31	0.5	267.0
Line 7	2	28(10)	30	70	0.4	243.0
Santa Isabel	5	59(59)	2	98	0.8	303.0
82-7 Ponce 83	5	60(22)	64	36	0.4	218.5
77-1 Irradiado	5	89(48)	25	75	0.5	236.8
Mean		*30.8 (16.1)*	*54.3*	*45.8*	*0.43*	*264.0*

[1]Number in parenthesis indicates the number of podborer larvae per 100 pods.
[2]Based on the number of *H. virescens* eggs on 20 pods per plot.

whereas *E. zinckenella* larvae were more abundant in 5 genotypes. No larvae of *E. zinckenella* were recovered from line 98 Irradiado, and very low numbers of *H. virescens* from cv. Santa Isabel.

The frequency of infestation (number of larvae per genotype) of the 27 genotypes showed that for the untreated early bloomers, only 13% of the plants tested had a rating of 1 (less than 9 larvae) (table 3). Most

TABLE 3.—*Frequency of infestation of 27 genotypes (15 early bloomers and 12 late bloomers) of pigeon pea*

		Frequency (%)[1]					
		Early bloomers			Late bloomers		
Infestation	Rating	Untreated	Treated	Total	Untreated	Treated	Total
0-9	1	13	47	60	25	58	83
10-20 larvae	2	53	33	87	58	17	75
21-30 larvae	3	27	13	40	17	0	17
31-40 larvae	4	67	0	67	0	0	0
more than 40 larvae	5	0	67	67	0	25	25

[1]Frequency of infestation (%) = $\frac{\text{Frequency of grades in tables 1 and 2}}{\text{Number of genotypes tested}} \times 100$

early bloomers were susceptible to attack by pod borers. Untreated late bloomers were more tolerant to the insects. Twenty-five percent of these genotypes had a rating of 1, 58% a rating of 2 and none with higher infestations.

Slight differences were obtained between the number of eggs per pod counted from the untreated and treated genotypes (tables 1 and 2). No correlation was obtained between the number of eggs per pod and yield, nor between the number of eggs per pod and the number of *H. virescens* larvae.

Breeding pigeon pea varieties resistant to *H. virescens* and to *E. zinckenella* was considered virtually impossible (4, 6). In the past, infestations of 50 to 63% were common in indeterminate types such as lines 7 and 12, and cv. Kaki grown in Puerto Rico (1). In India, plants with infestation levels of 48 to 67% were considered resistant groups (4). From our preliminary data, taking into consideration that this evaluation was in one location and that all groups were susceptible to attack even treated with insecticides, we now have promising genotypes with lower infestation levels than those previously reported. We must concentate within the maturity groups, determinate (early bloomers) and indeterminate types (late bloomers) in the future. Selection for resistance to insects is a dynamic process, one that may change every year. Genotypes expressing some degree of resistance to these insects this season may not necessarily be resistant next season (6). Many factors contribute to a genotype's response to an insect species. For example, environmental factors (5) and photoperiod affect the expression of resistance to insects (6); therefore continuous selection trials are recommended.

LITERATURE CITED

Cruz, C., 1975. Observations on pod borer oviposition and infestation of pigeon pea varieties. *J. Agric. Univ. P.R.* 59 (1): 63-68.

——, 1979. Thiodan y Lannate registrados para controlar los insectos del gandul. Adelantos Científicos, Núm. 89. Estación Experimental Agrícola, U.P.R., Mayagüez, P.R.

Estación Experimental Agrícola, 1977. Conjunto tecnológico para la producción de gandules: su situación económica y sus perspectivas. Publ. 116., Esta. Exp. Agríc., U.P.R., Mayagüez, P.R.

Jain, K. C., S. S. Lateef, D. G. Faris and W. Reed, 1984. *Heliothis* resistant pigeonpeas: A hope for the future. International Pigeonpea Newsletter No. 3 (March): 19-20.

Painter, R. H. 1959. Resistance of plants to insects. *Ann. Rev. Entomol.* 3: 267-90.

Talekar, N. S. and B. C. Chen, 1983. Identification of sources of resistance to lima bean podborer (Lepidoptera: Pyralidae) in soybean. *J. Econ. Entomol.* 76 (1): 38-39.