Evaluation of Virginia-type Peanut Cultivars for Resistance to Southern Corn Rootworm[1]

T. A. Coffelt* and D. A. Herbert[2]

ABSTRACT

Southern corn rootworm (SCRW) (*Diabrotica undecimpunctata howardi* Barber) is the most damaging soil insect to peanut (*Arachis hypogaea* L.) in the Virginia-North Carolina production area. New cultivars and advanced breeding lines have not been evaluated for resistance to SCRW. The objective of this 3-yr study was to evaluate three new cultivars (NC-V 11, VA-C 92R, and AgraTech VC-1) and an advanced breeding line (VA 861101) for resistance to SCRW. NC 6 and NC 9 were used as resistant and susceptible checks, respectively. Pod damage, yield, market grade, and dollar value were obtained for each plot. AgraTech VC-1, VA-C 92R, and VA 861101 had less total pod damage from SCRW than NC 9. VA 861101 produced significantly higher yields and value per ha than all cultivars on soil types conducive to SCRW damage. Insecticide-treated plots had significantly higher value per ha and lower total pod damage than untreated plots. Results from this study indicate that VA 861101 may be an acceptable replacement for NC 6. AgraTech VC-1 is the most resistant of the newly released cultivars, but this is not reflected in higher yields.

Key Words: *Arachis hypogaea* L., *Diabrotica undecimpunctata howardi* Barber, groundnut, integrated pest management, insecticide, insect resistance, pest resistance, breeding.

The most damaging soil insect to peanut (*Arachis hypogaea* L.) in the Virginia-North Carolina production area is southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber) (10). It can attack pegs as well as pods. Damage sites can serve as focal points for secondary damage by disease-causing organisms. Although satisfactory insecticide treatments are available increasing environmental concerns may make these

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[2]Res. Geneticist, USDA-ARS, U.S. Water Cons. Lab; 4331 E. Broadway Rd., Phoenix, AZ 85040 and Asst. Prof., VPI&SU, Tidewater Agric. Exp. Stn., P. O. Box 7099, Suffolk, VA 23437-0099.

*Corresponding author.

Table 1. Split-plot analyses of variance F values for arcsin transformations of percentage mature pod damage (MPD), per immature pod damage (IPD), and percentage total pod damage (TPD) due to southern corn rootworm, percentage fancy pods (FP), percentage extra-large kernels (ELK), percentage total sound mature kernels (TSMK), yield per ha, and value per ha (1990-1992).

Source	d.f.	MPD	IPD	TPD	FP	ELK	TSMK	Yield	Value
Year	2	121.54***	88.51***	147.75***	37.70***	13.55***	41.26***	21.25***	14.03***
Rep (year)	9	1.57	2.91**	2.20*	5.30***	7.24***	1.99	3.45**	3.57**
Cultivar	5	4.57**	2.74*	4.29**	10.69***	10.96***	3.78**	6.86***	6.72***
Year x cultivar	10	1.58	3.72**	2.48*	1.81	2.78**	1.51	1.80	1.74
Error A	45								
Insecticide	1	130.98***	147.64***	200.82***	2.75	3.42	63.90***	5.49*	14.66***
Year x insecticide	2	49.68***	28.50***	58.82***	2.82	1.34	3.12	3.61*	3.86*
Cultivar x insecticide	5	3.07*	2.75*	4.32**	1.41	0.53	0.94	0.75	0.81
Year x cultivar x insecticide	10	1.30	1.88	1.74	0.46	1.03	0.67	0.64	0.78
Error B	54								
Total	143								

*, **, ***Significant at the $P \leq 0.005$, 0.01 and 0.001 levels, respectively.

pesticides unavailable or more expensive in the future. The use of resistant or partially resistant cultivars is an alternative control option (2).

One partially insect resistant cultivar, NC 6, was released in 1976 (4) and has been grown on as much as 20% of the peanut acreage in Virginia. Germplasm screening programs (5, 14, 15) have identified various levels of resistance to southern corn rootworm in the peanut germplasm. Three germplasm lines (GP-NC 343, Tifton-8, and VGP 7) with resistance varying from moderate to high have been released (3, 7, & 8).

NC 6 has been declining in popularity in recent years because its poor blanchability and tan seed coat color are undesirable to the peanut industry. In addition, higher-yielding cultivars have been released recently. The objective of this study was to evaluate three new high-yielding cultivars and an advanced breeding line for resistance to southern corn rootworm.

Materials and Methods

A 3-yr field study (1990-1992) was conducted at Suffolk, VA, to determine the resistance of three recently released peanut cultivars (NC-V 11, VA-C 92R, and AgraTech VC-1) (12, 16) and an advanced breeding line (VA 861101) to southern corn rootworm. NC 6 and NC 9 were used as the resistant and susceptible checks, respectively. All fields had a history of southern corn rootworm infestation. Soil types were a Myatt loamy sand in 1990, a Dendron loamy sand in 1991, and a Tomotley fine sandy loam in 1992.

A randomized complete block, split-plot design with four replications was used each year. Cultivars were whole plots and chemical treatment (with or without insecticide) were split plots. Years were treated as a main factor in analyses over years. Insecticide (Chlorpyrifos, Lorsban 15G®, DowElanco, Midland, MI) was applied at pegging at a rate of 14.6 kg/ha, in a 35.6-cm band over the row middle with a Noble applicator, then lightly soil incorporated with cultivator sweeps. Treatments were applied on 5 July 1990, 15 July 1991, and 21 July 1992. Split plots were two rows 0.9 m wide by 12.1 m long in 1990 and 1992 and 0.9 m wide by 9.1 m long in 1991. Plots were planted on 3 May 1990, 8 May 1991, and 15 May 1992.

Damage from southern corn rootworm was determined by randomly sampling 20 pods from each of five plants in each subplot on 18 September 1990, 11 September 1991, and 14 September 1992. The 100 pods in the sample from each subplot were classified as mature or immature and as damaged or undamaged based on visual inspection. If pods were punctured or showed signs of external pod scarification, they were considered damaged. The damage percentages of mature, immature, and total pods were calculated.

Peanuts were harvested on 26 September 1990, 15 October 1991, and 20 October 1992. Harvested peanuts were artificially dried, plot weights determined, and grade samples taken. Samples were graded according to Federal-State Inspection Service standards and value per ha determined according to the support price for each year.

Statistical analyses were carried out using the GLM procedure of SAS for personal computers (13). LSD tests were used for comparison of means.

Results and Discussion

Year significantly ($P \leq 0.01$) affected pod damage, market grade, and yield (Table 1). Most pod damage evaluations were significantly higher in 1990 than 1991 or 1992, and immature and total pod damage were significantly higher in 1992 than 1991 (Table 2). Yield and value per ha were higher in 1992 than 1990 or 1991 (Table 3).

Since year x insecticide treatment interactions were significant for southern corn rootworm damage evaluations, total sound mature kernel percentage, yield, and value, results for these traits are presented by year while percentage of fancy pod and extra-large kernel data are presented as 3-year means (Tables 2 and 3). The use of insecticide significantly reduced the amount of damage

Table 2. Mean percentage of mature pod damage (MPD), immature pod damage (IPD), and total pod damage (TPD) due to southern corn rootworm on peanuts for each of 3 yr with and without insecticide.

Insecticide treatment	MPD 1990	MPD 1991	MPD 1992	IPD 1990	IPD 1991	IPD 1992	TPD 1990	TPD 1991	TPD 1992
	%								
Without	40.4	7.0	7.0	39.3	9.4	21.1	39.9	7.5	13.1
With[a]	8.4	0.3	2.1	6.4	0.1	10.0	8.4	0.3	5.9
LSD[b]	6.7	1.6	3.5	7.4	3.3	4.2	5.9	1.7	2.5

[a]Chlorpyrifos applied at 14.6 kg/ha of 15 G at pegging.
[b]LSD = Least significant difference at $P \leq 0.05$ level.

Table 3. Mean percentages of fancy pods (FP), extra-large kernels (ELK), and total sound mature kernels (TSMK), and yield and value per ha of peanuts with and without insecticide (1990-1992).

Insecticide treatment	FP	ELK	TSMK 1990	TSMK 1991	TSMK 1992	Yield 1990	Yield 1991	Yield 1992	Value 1990	Value 1991	Value 1992
	%	%	%			kg/ha			$/ha		
Without	77.3	29.4	61.3	69.4	66.1	3752	3215	3973	2357	2296	2765
With[a]	76.3	28.2	65.3	71.3	70.3	3924	3144	4354	2629	2293	3099
LSD[b]	1.3	1.3	2.1	1.0	1.2	239	280	228	210	213	141

[a]Chlorophrifos applied at 14.6 kg/ha of 15 G at Pegging.
[b]LSD = Least significant difference at P ≤ 0.05 level.

from southern corn rootworm on all pods each year. These results confirm those of a previous study (1) that insecticides can be an effective control for southern corn rootworm in peanut. The major advantage to insecticide control in addition to increased yield and value was an increase in total sound mature kernels (TSMK). The increase in TSMK was due to a decrease in other kernels and damaged kernels in treated plots. Insecticide treatment did not affect the percentages of fancy pods or extra-large kernels. The interactions were probably due to the varying levels of pod damage between years. Environmental factors such as soil type, temperature, and soil moisture levels, or southern corn rootworm population levels, or a combination of these factors may have influenced the severity of pod damage.

Cultivar x year and cultivar x insecticide interactions were significant for pod damage ratings (Table 1). Therefore, cultivar results for pod damage ratings are presented as means within and across years (Table 4) and across years within insecticide treatment (Table 5). The susceptible check, NC 9, had more mature pod damage than the other entries each year and significantly more when data were averaged across years (Table 4). NC-V 11 had more immature pod damage than the other entries in 2 of the 3 yr, and significantly more than NC 6, VA 861101, and AgraTech VC-1 when data were averaged across years. VA 861101 had significantly less total pod damage than NC 9 in 2 (1990 and 1991) of the 3 yr and for the average across years. AgraTech VC-1 had significantly less total pod damage than NC 9, NC-V 11, and VA-C 92R in 1990, and

Table 4. Mean percentages of mature pod damage (MPD), immature pod damage (IPD), and total pod damage (TPD) due to southern corn rootworm on six peanut lines (1990-1992).

Entry	MPD 1990	MPD 1991	MPD 1992	IPD 1990	IPD 1991	IPD 1992	TPD 1990	TPD 1991	TPD 1992
	%								
NC 6	22.2	2.5	4.0	19.6	1.3	17.6	21.6	2.3	11.4
NC 9	33.8	6.9	8.8	26.7	6.8	14.6	31.5	6.4	11.9
VA 861101	20.0	1.7	4.3	17.8	1.7	20.6	20.6	1.8	9.6
NC-V 11	27.6	3.6	2.8	29.6	7.2	15.9	28.1	4.3	8.9
VA-C 92R	26.8	3.0	4.4	28.0	5.4	11.1	26.9	3.9	7.0
AT VC-1[a]	15.8	4.1	2.9	15.2	6.2	13.2	16.2	4.8	8.1
LSD[b]	11.6	2.8	6.0	12.9	5.8	7.2	10.2	2.9	4.2

[a]AT VC1 = Agra Tech VC-1
[b]LSD = Least significant difference at P ≤ .05 level.

Table 5. Mean percentages of mature pod damage (MPD), immature pod damage (IPD), and total pod damage (TPD) due to southern corn rootworm on six peanut cultivars treated with and without insecticide (1990-1992).

Entry	MPD	IPD	TPD
		%	
Without			
NC 6	16.2	19.4	18.7
NC 9	26.7	28.8	27.8
VA 861101	11.7	18.8	14.1
NC-V 11	18.3	26.6	21.3
VA-C 92R	21.4	26.6	22.4
AT VC-1[a]	14.4	19.4	16.7
With[b]			
NC 6	2.9	6.3	4.8
NC 9	6.3	3.3	5.4
VA 861101	5.6	8.0	7.2
NC-V 11	4.4	8.6	6.3
VA-C 92R	1.4	3.1	2.8
AT VC-1	0.9	3.7	2.7
LSD[c]	6.0	7.1	5.2

[a]AT VC-1 = AgraTech VC-1
[b]Chlorpyrifos applied at 14.6 kg/ha of 15 G applied at pegging.
[c]LSD = Least significant difference at P ≤ 0.05 level.

NC 9 and NC-V 11 for the average across years. NC-V 11 was not significantly different from NC 9 or NC 6. VA-C 92R was not significantly different from NC 9 or NC 6 in 1990 and 1991, but had significantly less pod damage than both in 1992 and NC 9 for the average across years.

VA 861101 had a significantly higher percentage of extra-large kernels in 1991 and 1992 and yield and value averaged over 3 yr than the other cultivars (Table 6). NC 9 had significantly lower yield and value, but a higher percentage of fancy pods. All of the newer cultivars produced higher percentages of total sound mature kernels than NC 6 or NC 9.

The cultivar x insecticide interaction was due primarily to the change in rank among the entries of VA 861101 and VA-C 92R (Table 5). VA 861101 had the least amount of pod damage without insecticide treatment but was among the highest with insecticide treatment, while VA-C 92R was among the most damaged without insecticide treatment and the least with insecticide treatment. However, it is important to note that significant differences among the entries occurred only in untreated plots and not in treated plots. Mature, immature, and total pod damage without insecticide was less than NC 6 for VA 861101 and AgraTech VC-1, indicating that they may offer some resistance to southern corn rootworm.

AgraTech VC-1 is a commercially developed cultivar with a complex pedigree. None of the parents have been evaluated for resistance to southern corn rootworm. However, based on the performance of AgraTech VC-1 in this study, they should be included in future germplasm screening studies.

The breeding line VA 861101 was developed from off-

Table 6. Mean percentages of fancy pods (FP), extra-large kernels (ELK), and total sound mature kernels (TSMK), and yield and value per ha of six peanut lines (1990-1992).

Entry	FP	ELK 1990	ELK 1991	ELK 1992	TSMK	Yield	Value
	%					kg/ha	
NC 6	70.1	23.1	37.8	27.9	65.3	3653	2464
NC 9	84.0	22.4	30.4	25.6	65.3	3109	2095
VA 861101	78.7	26.9	41.9	36.0	68.5	4349	3069
NC-V 11	76.0	28.6	29.0	32.6	67.9	3867	2671
VA-C 92R	74.4	30.3	30.3	28.5	68.3	3774	2646
AT VC-1[a]	77.4	21.3	23.4	22.1	68.4	3608	2493
LSD[b]	4.0	5.7	3.7	2.6	2.3	438	351

[a]AT VC-1 = AgraTech VC-1.
[b]LSD = Least significant difference at $P \leq 0.05$ level.

color seed in a NC 6 seed lot. Seed with a pink testa were picked out of the normal tan colored seed of NC 6, planted in a nursery, and individual plants selected. This change could have been due to a mutation in NC 6, a recombination event between genes, or to natural crossing between NC 6 and another genotype. Segregation patterns for several traits and appearance of the progeny indicated that the seed were probably the result of natural crossing. The performance of VA 861101 in this test supports a previous hypothesis that natural crosses can be used to supplement artificial hybrids in a breeding program for improving cultivars (6, 9).

Work from other studies has shown VA 861101 to have superior blanchability to NC 6 (11). Therefore, the more desirable pink testa color and blanchability should make VA 861101 more attractive to the peanut industry than NC 6, while the higher yields than NC 6 and AgraTech VC-1 should make it more attractive to growers.

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