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CONTROL OF SOIL INSECT INJURY BY RESISTANCE IN SWEET POTATO

Alfred Jones, J. M. Schalk, and P. D. Dukes

SUMMARY

Soil insect root injury to resistant sweet potato [Ipomoea batatas (L.) Lam.] cultivars 'Regal' and 'Southern Delite' was compared to injury to 'Jewel' and 'Centennial' in trials with the resistant standard W-13 and the susceptible standard SC 1149-19. Injury by 3 groups of insects was evaluated: the wireworm-Diabrotica-Systena complex (WDS), which includes the southern potato wireworm (Conoderus falli Lane), the tobacco wireworm (C. vespertinus Fabricius), the banded cucumber beetle (Diabrotica balteata LeConte), the spotted cucumber beetle (D. undecimpunctata howardi Barber), the elongate flea beetle (Systena elongata Fabricius), the pale-striped flea beetle (S. blanda Melsheimer) and S. frontalis Fabricius (a flea beetle); the sweet potato flea beetle (Chaetocnema confinis Crotch.); and a white grub (Plectris aliena Chapin). Relative control estimates were obtained by comparison to the susceptible standard. 'Regal' and 'Southern Delite' provided good control of all 3 insect groups with control of all insect injuries of 79.2 and 81.0%, respectively. 'Jewel' and 'Centennial' were resistant to the sweet potato flea beetle and sustained less damage by WDS than the susceptible standard but would still be classed as susceptible to WDS. 'Centennial' was as susceptible to the white grub as SC 1149-19. The levels of resistance demonstrated for 'Regal' and 'Southern Delite' would provide growers an alternative to insecticides for the control of these insects.

INTRODUCTION

Commercial sweet potato, Ipomoea batatas (L.) Lam., plantings frequently sustain economic levels of injury from feeding scars of soil-inhabiting insects. At least 19 species of insects (2) are involved and insecticidal control is often inadequate (1, 16, 17). Insecticidal control has become even more unreliable since the removal of persistent chlorinated hydrocarbons from agricultural use. Recommendations for effective chemical treatment are complicated by large environmental effects on the population dynamics of each species, the many potential

combinations of species that can occur (6), and because damage can only be observed after harvest. Available soil insecticides are relatively nonpersistent which make synchronization with insect populations difficult (1). Likewise, it is not easy to determine the causal species at harvest because early season injuries are distorted by subsequent root enlargement, and the causal insect species may no longer be present.

Investigations of insect resistant sweet potatoes were begun in our laboratory in 1961 (3). Heritabilities of resistances in sweet potato to soil insects were determined to be moderately high (15). A recurrent selection program for soil insect resistances was initiated in 1966 through which resistance levels were increased (5). Inheritance of resistance to soil insects proved to be independent of other desirable characteristics and, as a consequence, there did not appear to be a major barrier to development of insect resistant cultivars equivalent in all other respects to those in commercial use (9). Selection for resistance to soil insects was given high priority in our breeding program (10, 11). Later tests (6, 17) demonstrated the value of resistance as an adjunct or alternative to insecticides. Recently, 3 standard cultivars and 2 specialty types with soil insect resistances have been released (7, 8, 12, 13, 14).

The purpose of this research was to study the level of soil insect injury control provided by 2 resistant cultivars in comparison to the 2 most popular cultivars and to resistant and susceptible standards.

MATERIALS AND METHODS

Two soil insect resistant cultivars, ('Regal' and 'Southern Delite'), the two most frequently grown cultivars ('Jewel' and 'Centennial'), a susceptible standard, (SC 1149-19), and a resistant standrad (W-13) were planted at the U.S. Vegetable Laboratory in 1983, 1984, and 1985 using randomized complete block designs with 4 replications and plots of 10 cuttings 30 cm long spaced 30 cm in rows 1 m apart. Plantings were made on 10 June, 30 May, and 31 May; and harvests were on 26 September, 20 September, and 15 October in respective years. Standrad cultural practices were followed.

At harvest all marketable sized roots were weighed and evaluated for 3 kinds of insect injury. The percentages of roots damaged by larvae of

the the wireworm-Diabrotica-Systena complex (WDS) were recorded along with an injury severity index as previously described (5). WDS injury is characterized by small round feeding holes or scars that may be enlarged or distorted by subsequent root growth (3, 11). The WDS insect complex includes the southern potato wireworm (Conoderus falli Lane), the tobacco wireworm (C. vespertinus Fabricius), the banded cucumber beetle (Diabrotica balteata LeConte), the spotted cucumber beetle (D. undecimpunctata howardi Barber), the elongate flea beetle (Systena elongata Fabricius), the pale-striped flea bettle (S. blanda Melsheimer) and S. frontalis Fabricius (a flea beetle). The percentages of roots injured by the sweet potato flea beetle (Chaetocnema confinis Crotch.) and by a white grub (Plectris aliena Chapin) were also recorded. Sweet potato flea beetles leave narrow channels or grooves just under the root skin while grubs gouge broad shallow channels in the root. Both kinds of injury are easily recognized (2, 11). In addition, the percentages of roots free of any insect injury were noted.

Three year average insect injury data were used to estimate levels of control provided by the various lines when compared to the susceptible standard SC 1149-19.

Control % = $\frac{a-b}{a}$ x 100 where a = % damaged roots of SC 1149-19 and b = % damaged roots of the other cultivar.

Standard analyses of variance and Duncan's multiple range test were used for mean comparisons of the 6 entries.

RESULTS

Injury levels from all 3 kinds of insects differed from year to year but resistant cultivars reacted similarly to the resistant standard in all comparisons (Table 1). 'Regal' and 'Southern Delite' displayed higher levels of resistance to the WDS complex than 'Jewel' or 'Centennial'. 'Jewel' and 'Centennial' were less damaged by WDS than the susceptible standard but were sufficiently injured to be classed as susceptible (18). Severity of injury to individual roots often tends to increase as the percentage of WDS damaged roots increases. That effect was apparent in this study and the WDS severity index mean differences were larger than those of the percentage data. However, mean separation

of cultivars within years and when averaged over years were similar with both measures. All cultivars, except the susceptible standard, were equally resistant to the sweet potato flea beetle. Demonstration of the grub resistance levels of the cultivars was not as clear as with the other insect groups, but 'Regal' and 'Southern Delite' were more resistant than SC 1149-19 and 'Centennial'. 'Regal' and 'Southern Delite' had higher percentages of roots free of any insect injury than did 'Jewel' or 'Centennial'.

When the differences in insect injury levels were expressed as relative % control estimates (Table 2) the high resistance levels of 'Regal' and 'Southern Delite' were apparent. Levels of control from genetic resistance appeared higher when severity of injury by WDS was considered than when percentage of roots injured was used.

Weights of marketable size roots of all cultivars were similar except for W-13 which consistently had lower root yields (Table 3).

DISCUSSION

WDS injury levels were lower in these trials than in previous trials at this location (5, 15). Variations in the relative abundance of the causal insect species as well as the life stages of the individual species affect injury levels (6). In previous trials 'Jewel' and 'Centennial' have sustained injury levels more like that of SC 1149-19 than occurred here (5, 15). This variation is similar to that experienced by commercial growers and serves to emphasize the value of genetic resistance levels available in 'Regal' and 'Southern Delite' which would reduce needs for growers to either predict WDS problems or routinely use preventive insecticidal applications.

Resistance to the sweet potato flea beetle is readily available in present cultivars but an industry problem would be created by release of susceptible cultivars. Thus, breeders should strive to attain resistance levels at least as good as that of 'Jewel' and 'Centennial' in all new releases. Infestation is often twice that of these trials.

Relatively low levels of white grub injury were observed in these trials which is not unusual in our location (5, 6, 15). Erratic white grub populations make selection for resistance as well as tests of progress more difficult. In our selection process, we considered the

highest damage rating of any replication in making judgements regarding white grub resistance. Apparently that practice was effective because the resistances of 'Regal' and 'Southern Delite' have been effective at other locations even when a different white grub species was prevalent (unpublished, L. H. Rolston, LSU). In Louisiana trials where the white grub, Phyllophaga ephilida Say, caused higher levels of injury than in these trials, cultivars with similar levels of resistances to that of 'Regal' or 'Southern Delite' provided control as good as or better than that from chemical treatment (17). Thus, we consider the white grub control levels estimated here (Table 2) for 'Regal' and 'Southern Delite' to be realistic.

Small roots are less vulnerable to soil insect injury because of a reduced surface area and because they are more likely to have escaped injury by early season insect populations (5, 9, 10). Thus, the low yields of the resistant control, W-13, were of some concern (Table 3). For that reason most comparisons were made to the susceptible standard which had more nearly comparable root sizes to the other cultivars. In future trials 'Regal' or 'Southern Delite' might be preferred as soil insect resistant standards because root sizes and yields are more like other commercial types.

Control of soil insect injury by use of host plant resistance levels like that of the resistant cultivars of these trials (Table 2) offer growers a feasible alternative to insecticidal treatment. This option may be of even greater value if presently used chemicals are withdrawn from the market or insects become resistant to them.

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Table 1. Comparison of soil insect injury to roots of resistant cultivars, 'Regal' and 'Southern Delite'; current cultivars, 'Jewel' and 'Centennial'; the susceptible standard, SC 1149-19; and the resistance standard, W-13, in 1983, 1984, and 1985 trials conducted at the U.S. Vegetable Laboratory, Charleston, SC.

Year	Cultivar or standard line	Injury-free roots (%)	Wireworm-Diabrotica-Systena Injured roots (%)	Wireworm-Diabrotica-Systena Injured roots (index)	Flea beetle injured roots (%)	Grub injured roots (%)
1983[z]	Regal	90.8 A	9.2 E	0.10 GH	0.0 C	0.0 b
	Southern Delite	91.4 A	6.8 E	0.07 H	2.7 C	0.3 b
	Jewel	59.7 BC	38.4 CD	0.54 DEF	0.4 C	2.3 b
	Centennial	43.5 CD	46.0 BC	0.64 CDE	1.4 C	16.3 ab
	SC 1149-19	15.2 EF	78.0 A	1.48 A	30.1 B	1.9 b
	W-13	93.7 A	5.2 E	0.05 H	0.5 C	0.6 b
1984[z]	Regal	81.1 A	18.1 E	0.19 FGH	1.1 C	0.4 b
	Southern Delite	80.7 A	16.4 E	0.17 FGH	2.4 C	0.5 b
	Jewel	18.3 EF	78.5 A	1.26 AB	3.3 C	1.8 b
	Centennial	32.4 DE	65.6 AB	1.00 BC	2.9 C	5.9 ab
	SC 1149-19	7.2 F	79.8 A	1.31 AB	54.2 A	11.8 ab
	W-13	87.4 A	5.9 E	0.06 H	3.8 C	3.6 b
1985[z]	Regal	75.1 AB	24.5 DE	0.25 EFGH	0.0 C	1.9 b
	Southern Delite	79.7 A	16.6 E	0.17 EGH	0.9 C	3.7 b
	Jewel	45.9 CD	47.8 BC	0.50 DEFG	1.6 C	15.1 ab
	Centennial	32.0 DE	62.6 AB	0.82 CD	1.7 C	22.8 a
	SC 1149-19	22.8 EF	68.2 A	1.01 BC	16.0 BC	23.9 a
	W-13	78.4 A	13.1 E	0.14 FGH	2.6 C	6.3 ab
3-yr avg	Regal	82.3 A	17.3 C	0.18 C	0.4 B	0.8 c
	Southern Delite	83.9 A	13.3 C	0.13 C	2.0 B	1.5 c
	Jewel	41.3 B	54.9 B	0.77 B	1.8 B	6.4 abc
	Centennial	36.0 B	58.1 B	0.82 B	2.0 B	15.0 a
	SC 1149-19	15.1 C	75.3 A	1.27 A	33.4 A	12.5 ab
	W-13	86.5 A	8.1 C	0.08 C	2.3 B	3.5 bc

[z]Mean separation in columns by Duncan's multiple range test, 5% (lowercase letters) or 1% (uppercase letters) level. (Averages separate from yearly data.)

Table 2. Relative control[z] of soil insect damage by resistant sweet potatoes, 'Regal', 'Southern Delite' and W-13; popular cultivars, 'Jewel' and 'Centennial'; compared to the susceptible standard SC 1149-19 based on averages from 1983-1984, and 1985 trials.

Cultivar or standard	All soil insects	Wireworm-Diabrotica-Systena		Flea beetle	Grubs
		% injured	Injury index		
	% Control[z]				
Regal	79.2 A	77.0 A	85.8 A	98.8 A	93.6 a
Southern Delite[y]	81.0 A	82.3 A	89.8 A	94.0 A	88.0 a
Jewel	30.9 B	27.1 B	39.4 B	94.6 A	48.8 abc
Centennial	24.6 B	22.8 B	35.4 B	94.0 A	-20.0 c
SC 1149-19	0.0 C	0.0 C	0.0 C	0.0 B	0.0 bc
W-13	84.1 A	89.2 A	93.7 A	93.1 A	72.0 ab

[z] % control = $\frac{a-b}{a}$ x 100 where a = % damaged roots of SC 1149-19 and b = % damaged roots of the test cultivar. Mean separation in columns by Duncan's multiple range test, 5% (lowercase letters) or 1% (uppercase letters) level.

[y] % control of insects in 3 trials in Charleston.

Table 3. Total root weights from 10-plant plots of 6 sweet potato cultivars and standards differing in reaction to soil insects in 1983, 1984, and 1985 trials.[z]

Cultivar or standard	Year			3-year average
	1983	1984	1985	
	kg			
Regal	14.1 A	17.8 A	17.9 A	16.6 A
Southern Delite	12.1 A	13.7 A	15.7 A	13.8 AB
Jewel	16.6 A	13.8 A	16.5 A	15.6 AB
Centennial	13.6 A	17.8 A	17.4 A	16.3 A
SC 1149-19	12.2 A	13.8 A	12.5 A	12.8 B
W-13	6.5 B	7.0 B	5.9 B	6.5 C

[z]Mean separation in columns by Duncan's multiple range test, 1% level.