RESISTANCE IN SWEET POTATOES TO THE SWEETPOTATO WEEVIL, *CYLAS FORMICARIUS ELEGANTULUS* (SUMMERS)[1]

Michael A. Mullen,[2] Alfred Jones,[3] Donald R. Paterson,[4]
and Thurman E. Boswell[5]
Stored-Product Insects Research and Development Laboratory
Agricultural Research Service, U. S. Department of Agriculture
Savannah, GA 31403
(Accepted for publication September 30, 1985)

ABSTRACT

Fourteen sweet potato *[Ipomoea batatas* (L.) Lam] cultivars and varieties were examined for resistance to the sweetpotato weevil *[Cylas formicarius elegantulus* (Summers)] in artificially infested fields in Yoakum, TX. One cultivar W-226, appeared to have a greater level of resistance than the other cultivars examined. The data are compared to earlier resistance trials to show that the germplasm presently available has greater levels of resistance than that in previous years. The resistance levels of "Resisto" and "Regal" for the past 4 years are discussed.

Key Words: Host plant resistance, *Ipomoea batatas,* sweetpotato weevil.

J. Entomol. Sci. 20(3): 345-350 (July 1985)

INTRODUCTION

Resistance to the sweetpotato weevil *Cylas formicarius elegantulus* (Summers) by commercially grown sweet potatoes, *Ipomoea batatas* (L.) Lam has been of interest to plant breeders since 1939 when Cockerham and Deen (1947) and later Cockerham and Harrison (1952) began searching for resistant genes. Despite some early indications that resistance was available, little additional research was conducted until the 1970's. At the Institute of Tropical Agriculture in Ibadan, Nigeria, 3,600 accessions were evaluated for resistance and 6 were identified as having some weevil resistance (Anonymous 1973). Waddill and Conover (1978) demonstrated resistance in white-fleshed sweet potatoes. They found that there was a wide variation in weevil resistance within the germplasm they tested, which would increase the possibility of developing resistant cultivars. They also identified 3 mechanisms of resistance (nonpreference, antibiosis, and tolerance) that existed in the cultivars tested. Later work by Mullen et al. 1980a, 1981, and 1982 demonstrated that resistance to the sweetpotato weevil does exist and has lead to the release of 2 new varieties "Resisto" (Jones et al. 1983) and "Regal" (Jones et al. 1985), with moderate levels of weevil resistance.

[1] COLEOPTERA: Curculionidae

[2] Research Entomologist, U. S. Department of Agriculture, Agricultural Research Service, Stored Product Insects Research and Development Laboratory, P. O. Box 22909, Savannah, GA 31403.

[3] Research Geneticist, U. S. Department of Agriculture, Agricultural Research Service, U. S. Vegetable Laboratory, Charleston, SC 29407.

[4] Professor, Texas A&M University System, Agricultural Research Center, Overton, TX 75684.

[5] Professor in Charge (Retired), Texas A&M University System, Plant Disease Research Station, Yoakum, TX 77995.

This report contains information on the most recent field tests for sweetpotato weevil resistance as well as summary data from the previous 4 testing years and is intended to give some indication on how the weevil resistance program is progressing. Also included are data on the varieties "Resisto" and "Regal" for the past 4 growing seasons.

MATERIALS AND METHODS

Field plots were planted in a randomized complete block design with 8 replicates. Each plot consisted of 10 plants spaced 30 cm apart. Rows were 90 cm apart and a 1.5 m alley was left between plots. Vine cuttings from selected cultivars were planted on May 17, 1984, at the Texas A&M University Plant Disease Research Station at Yoakum, TX. Standard commercial practices were used in growing the crop.

Twenty-nine cultivars were selected to be evaluated for weevil resistance. The cultivars were selected after applying the laboratory assay method developed by Mullen et al. 1980b. However, before harvest this number was further reduced to 14 because the remainder were eliminated for not sprouting or for having other undesirable horticultural characteristics. Four varieties were used as standards for sweetpotato weevil resistance. "Centennial" was considered a susceptible check and "Jewel" and an intermediate. Two new varieties "Resisto" (Formerly W-125) and "Regal" (formerly W-152) were used because of their moderately high levels of resistance to the sweetpotato weevil.

To insure substantial sweetpotato weevil populations approximately 8,000 weevils were released into the field 92 days after planting. The weevils were released from 4 wooden shelters containing about 26 liters (1/2 bu) of sweet potatoes. The shelters were arranged in the field in such a manner as to provide as uniform coverage as possible. This method ensured that weevils would be available for immediate infestation as well as subsequent infestations from the resulting 2nd generation emerging from the infested roots.

The sweet potatoes were harvested on October 10, 1984, (146 days) and were evaluated for resistance. The criteria used were the percent of weevil infested roots and damage to the crown. The total yield of each entry was also measured, but was not analyzed as a measure of resistance because there were no uninfested checks for comparison. Percent root infestation was determined by examining 30 potatoes from each plot for any signs of weevil damage as well as the presence of the various developmental stages. Crown damage was determined by examining each crown for evidence of weevil damage. Damage was rated on a 1 - 5 scale. Crowns with no weevil damage were rated as 1, and those severely damaged were rated as 5. A crown index was determined by dividing the total rating points scored for all crowns in a plot by the number of crowns examined.

All data were analyzed by analysis of variance and means were compared at the 5% level of Waller-Duncan K-ratio T. test. For statistical analysis data for percent root damage was transformed to square roots and crown damage was transformed to logarithim of X.

RESULTS AND DISCUSSION

The results of the 1984 field trials in Yoakum, TX, are presented in Table 1. The information in Table 2 summarizes the results for all cultivars examined for sweetpotato weevil resistance from 1980 - 1984. Some of the year to year variation in Table 2 can be accounted for by slight differences in growing conditions and level of sweetpotato weevil infestation. In 1984 (Table 1), one cultivar, W-226 generally appeared to have the highest level of resistance. The average yield of 13.2 kg per 10 plant plot was the third highest recorded and well over the 10.3 kg average for all cultivars studies. Very high resistance to crown damage was indicated by the fact that no crowns of W-226 showed any indication of weevil activity. The percentage of infested roots for W-226 was the lowest of any cultivar studied. Only W-219 with 7% root infestation equaled W-226. However, a small yield of only 3.0 kg indicates that the roots of W-219 probably escaped infestation because of low yields. Another cultivar, 83DW-252 demonstrated high levels of resistance to both root and crown damage although the yield was lower than average and the resistance may have been due to escape.

Table 1. Sweet potato lines with resistance to the sweetpotato weevil in Yoakum, TX (1984).*

Cultivar	Root damage (%)	Crown damage†	Yield (kg/plot)
W-226	7 a	1.00 a	13.2
W-219	7 a	1.38 ab	3.0
83DW252	8 ab	1.06 ab	6.1
W-224	11 ab	1.27 ab	12.5
"Resisto"	11 ab	1.63 bc	8.4
"Regal"	11 ab	1.55 abc	10.7
83SC22	11 ab	1.40 ab	11.7
83-SC1	14 abc	1.27 ab	13.7
83-251	20 abc	1.55 abc	8.5
"Centennial"	21 abc	2.14 c	7.8
"Jewel"	24 abc	1.13 ab	11.4
W-222	24 abc	1.47 ab	14.0
W-221	31 bc	1.65 bc	10.5
W-228	34 c	1.56 abc	12.5

* Means in each column followed by the same letter are not significantly different at the 5% level of the Waller-Duncan T test.

† 1 — no damage to, 5 — severe damage.

Table 2. Mean damage levels to the sweetpotato weevil for all sweet potato cultivars tested from 1980 - 1984.

Year	Root damage (%)	Crown damage*	Yield (kg/plot)
1984	17	1.28	10.3
1983	17	2.35	4.5
1982	55	3.07	5.2
1981	44	2.56	7.0
1980	45	1.70	–

* 1 — no damage to, 5 — severe damage.

"Resisto" and "Regal" continued to show good levels of resistance with only 11% of the roots infested. Crown damage for both varieties was higher than average. The yield for "Resisto" was below average and "Regal" was above average. As in past years "Centennial" continued to be one of the most susceptible varieties and "Jewel" somewhat intermediate in resistance. One cultivar, W-228, despite a high yield of 12.5 kg, was the most susceptible to root damage with 34% of the roots infested.

As shown in Table 2, damage levels have generally decreased over the past 5 years. Yield in 1984 was the highest recorded since the inception of the resistance trials. Percentage of damaged roots has dramatically dropped over the past 2 years and in 1984 the crown damage was the lowest it has ever been. In 1983 crown damage was high and yield was low indicating that in extreme cases yield may be effected by high crown damage. This is consistent with the earlier findings of Mullen et al. (1982) that heavy damage to the crown area reduced yield in "Centennial" and is somewhat contradictory to the findings of Cockerham et al. (1954) and Talekar (1982) who reported that severity of infestation had little effect on yield. However, others including Pillai and Nair (1981), Subramanian et al. (1977), Pillai et al. (1981) and Mullen (1984) reported yield losses of up to 100% due to weevil infestation. These differences can probably be explained by the timing and severity of the infestation.

The 2 new varieties, "Resisto" and "Regal," have shown good levels of resistance to the sweetpotato weevil for at least 4 years. The performance of these two varieties compared to the commercial varieties "Jewel" and "Centennial" is presented in Table 3. The resistance levels of "Resisto" and "Regal" are much higher than "Centennial." Not only were yields higher, but levels of damage were lower than for "Centennial." This is important when one considers that weevils reach the roots through cracks in the soil formed by the enlarging roots (Mullen et al. 1982). It would, therefore, be expected that if no mechanisms of resistance existed, the higher yielding varieties would be the most heavily infested.

The data presented in Tables 1 - 3 indicate that the breeding for resistance to the sweetpotato weevil is possible. The sweet potato germplasm presently available shows much less variability in resistance levels than in previous years and in fact many of the cultivars tested appear to be equal to or somewhat more resistant than "Resisto" and "Regal."

ACKNOWLEDGMENTS

We express our appreciation to R. T. Arbogast, of the Savannah Laboratory and to D. R. Earhart, Texas A&M Overton, TX, for their help and support. We are particularly indebted to Will Roberson and Gary Rowland, Overton, TX, and to the personnel at the Plant Disease Research Station at Yoakum, TX, without whose help this project would not have been possible.

Table 3. The performance of 2 sweetpotato weevil resistant varieties "Resisto" and "Regal" compared to the varieties "Jewel" and "Centennial."

Variety	Year	Root damage (%)	Crown damage index*	Severity index*†	Yield (kg/plot)
"Regal"	1981	24	–	1.43	14.6
	1982	25	1.77	2.75	5.1
	1983	4	1.10	1.25	5.5
	1984	11	1.55	–	10.7
	Mean	16	1.47	1.81	9.0
"Resisto"	1981	59	–	2.00	8.6
	1982	63	1.66	3.00	7.5
	1983	23	1.63	1.50	6.1
	1984	11	1.63	–	8.4
	Mean	39	1.71	2.17	7.7
"Jewel"	1981	62	–	3.25	5.2
	1982	59	2.93	3.88	6.4
	1983	16	1.73	1.92	8.0
	1984	24	1.13	–	11.4
	Mean	40	1.93	3.02	7.7
"Centennial"	1981	52	–	3.25	2.1
	1982	69	4.63	3.72	2.0
	1983	29	2.35	1.77	4.2
	1984	21	2.14	–	7.8
	Mean	43	3.04	2.91	4.0

* 1 — no damage to, 5 — severe damage.
† Subjective measure of damage to entire plant.

LITERATURE CITED

Anonymous. 1973. Report of the root and tuber improvement program of the International Institute of Tropical Agriculture, Ibadan, Nigeria.

Cockerman, K. L., and O. T. Deen. 1947. Resistance of new sweet potato seedlings and varieties to attack by the sweetpotato weevil. J. Econ. Entomol. 40: 39-41.

Cockerman, K. L., and P. K. Harrison. 1952. New sweet potato seedlings that appear resistant to sweetpotato weevil attack. J. Econ. Entomol. 45: 132.

Cockerman, K. L., P. K. Harrison, M. B. Christian, and L. D. Newson. 1954. The biology of the sweetpotato weevil. Louisiana Tech. Bull. 483: 1-30.

Jones, A., P. D. Dukes, J. M. Schalk, M. G. Hamilton, M. A. Mullen, R. A. Baumgardner, D. R. Paterson, and T. E. Boswell. 1983. "Resisto" Sweet Potato. HortScience 18: 251-2.

Jones, A., P. D. Dukes, J. M. Schalk, M. A. Mullen, R. A. Baumgardner, D. R. Paterson, and T. E. Boswell. 1985. "Regal" Sweet Potato. HortScience 20: 781-82.

Mullen, M. A. 1984. Influence of sweetpotato weevil (Coleoptera: Curculionidae) infestation on the yields of 12 sweet potato lines. J. Agric. Entomol. 1: 227-30.

Mullen, M. A., A. Jones, R. T. Arbogast, J. M. Schalk, D. R. Paterson, T. E. Boswell, and D. R. Earhart. 1980a. Field selection of sweet potato lines and cultivars for resistance to the sweetpotato weevil. J. Econ. Entomol. 73: 288-90.

Mullen, M. A., A. Jones, R. Davis, and G. C. Pearman. 1980b. Rapid selection of sweet potato lines resistant to the sweetpotato weevil. HortScience 15: 70-71.

Mullen, M. A., A. Jones, R. T. Arbogast, D. R. Paterson, and T. E. Boswell. 1981. Resistance of sweet potato lines to infestations of sweetpotato weevil, *Cylas formicarius elegantulus* (Summers). HortScience 16: 539-40.

Mullen, M. A., A. Jones, D. R. Paterson, and T. E. Boswell. 1982. Resistance of sweet potato lines to the sweetpotato weevil. HortScience 17: 931-32.

Pillai, K. S., S. S. Lal, and M. S. Palaniswami. 1981. Evaluation of new insecticides and soil amendments for the control of sweetpotato weevil, *Cylas formicarius* Fab. Entomon. 6: 69-72.

Pillai, K. S., and S. G. Nair. 1981. Field performances of some prereleased sweet potato hybrids to weevil incidence. J. Root Crops. 7: 37-39.

Subramanian, T. R., B. V. David, P. Thagavel, and E. V. Abraham. 1977. Insect pest problems of tuber crops in Tami Nudu. J. Root Crops. 3: 43-50.

Talekar, N. S. 1982. Effects of sweetpotato weevil (Coleoptera: Curculionidae) infestation on sweet potato root yields. J. Econ. Entomol. 75: 1042-44.

Waddill, V. H., and R. A. Conover. 1978. Resistance of white-fleshed sweet potato cultivars to the sweetpotato weevil. HortScience 13: 476-77.