Insect Resistance as an Adjunct or Alternative to Insecticides for Control of Sweet Potato Soil Insects

F. P. Cuthbert, Jr. and Alfred Jones

U.S. Department of Agriculture, Charleston, SC 29407

Additional index words. Ipomoea batatas, southern potato wireworm, Conoderus falli, banded cucumber beetle, Diabrotica balteata, spotted cucumber beetle, Diabrotica undecimpunctata howardi, elongate flea beetle, Systena elongata, white grub, Electris aliena, sweet potato flea beetle, Chaetocnema confinis

Abstract. Insect resistance in sweet potatoes (Ipomoea batatas (L.) Lam.) was more effective than fonofos, O-ethyl-S-phenylethylphosphonodithioate, in reducing insect injury to the roots. The most recent resistant line tested did not sustain economic injury from relatively high insect infestations even without the protection of an insecticide. Fonofos at 2.24 and 4.48 kg/ha did not prevent economic injury to the susceptible ‘Goldrush’.

Materials and Methods

Three sweet potato lines were compared, each with and without fonofos, O-ethyl-S-phenylethylphosphonodithioate: W-13, a breeding line with a high level of resistance to most of the pests and previously released by the USDA as a source of multiple pest resistance (4), W-3, a line with moderate resistance to many of the major pests, and ‘Goldrush’, a susceptible commercial cultivar. Identical field plot tests were conducted in 1974 and 1975 at the Vegetable Research Laboratory. Four replications of randomized split-plots were used with the insecticide treatments as the main plots and the sweet potato lines as the sub-plots. Main plots consisted of 5 rows, each 1 m wide x 8 m long. The 3 center rows were the sub-plots, each planted with a different cultivar. The outside rows of each plot served as buffers against inter-plot interference in the form of insect mortality or migration, and no data were taken from them. All of the buffer rows were planted with ‘Cherokee’ sweet potato in 1974 and ‘Hopi’ in 1975. The 1974 experiment was planted on May 19 and the 1975 experiment on May 15. Slips pulled from bedded roots were spaced 30.5 cm apart in the rows, and the planting received normal fertilization and cultivation. The herbicide EPTC (S-ethyl-dipropylthiocarbamate) was applied at the time of planting at a rate of 3.36 kg/ha. Plots treated with fonofos at dosages of 2.24 and 4.48

1Received for publication February 1, 1978. This paper reports the results of research only. Mention of pesticides in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked advertisement solely to indicate this fact.

2Research Entomologist (retired) and Research Geneticist, respectively, U.S. Vegetable Laboratory, Science and Education Administration.

kg/ha were compared with an untreated control. A 10% granular formulation of the chemical was used; half of the total dosages was applied about the time of earliest root enlargement and the remainder about 1 month later (July 17 and Aug. 16, 1974 and July 10 and Aug. 14, 1975). The granules were broadcast over the vines and were not incorporated into the soil in any way. This method of application is commonly used in some of the major production areas and has been found to be most effective against the species present in the Charleston area. Insect populations in the plots were monitored by washing the larvae from 465 cm² of soil to a depth of 15.2 cm from around the roots of 2 sweet potato plants about 3 weeks after each application. Insect injury to the roots at harvest time (Sept. 30, 1974 and Sept. 29, 1975) was determined by examining all of the roots, up to 2.84 hectoliter from each sub-plot.

Results

The size of insect populations and the extent of their injury to the roots are shown in Fig 1 and 2. Larval populations shown are totals rather than averages of the 2 counts made, since they represent populations at 2 different times, both of which contributed to the total root injury. Wireworm, Diabrotica, and Systena populations were grouped together since it is virtually impossible to accurately differentiate their injury and because previous studies (2, 3) have shown that they respond to a common resistance factor(s). In 1974, the southern potato wireworm, Conoderus falli Lane, constituted 19% of the complex; the banded cucumber beetle, Diabrotica balteata LeConte, and the spotted cucumber beetle, Diabrotica undecimpunctata howardi Barber, together, 62%; and the elongate flea beetle, Systena elongata (F.), 20% (Fig. 1). In 1975, the southern potato wireworm constituted 50% of the complex; cucumber beetles, 20%; and the elongate flea beetle, 29% (Fig. 2). The injury figures shown for all species also include a small amount of injury by the white grub, Plectris aliena Chapin. However, populations and injury by this species were too low to draw conclusions as to control or resistance. Populations of the other species and the amount of injury they caused were higher than usually occurs in most areas of sweet potato production. Populations of the sweet potato flea beetle, Chaetocnema confinis Crotch, were averaged but caused less injury than is often encountered.

The relative amount of insect injury to the 2 breeding lines and ‘Goldrush’ was as expected; W-13 sustained the least and ‘Goldrush’ the most. In every comparison the difference was statistically significant. The degree of control provided by fonofos was also comparable to that obtained in previous tests (unpublished), except that it was anticipated that the 4.48 kg dosage would be more effective than the 2.24 kg dosage. The fact that this was not true indicates that under the conditions of these tests the effectiveness of fonofos was limited, not by its toxicity to the insects, but by the distribution and residual life of the compound in the soil. Rainfall was extremely heavy in 1974 and may have influenced the results.

It is evident from the data that the level of resistance possessed by W-13 was more effective than fonofos in preventing insect injury to the sweet potatoes. Even in untreated plots W-13 sustained less injury than did ‘Goldrush’ in treated plots. If we arbitrarily select 50% root injury by all species as the economic injury level, W-13 did not need insecticide protection, W-3 was not injured when protected by fonofos, and ‘Goldrush’ suffered economic injury in spite of applications of the insecticide. It is difficult to arrive at an accurate economic injury level since this level depends on the nature of the injury and the supply and demand for the commodity. According to U.S. Market Standards, insect injury counts as a defect only when the feeding scars exceed an aggregate depth of 3.2 cm; however, any injury that seriously affects the appearance of the product may also cause downgrading. In this study we believe the 50% injury level to be realistic since much of the injury was shallow or cosmetic in nature and the one or two deeper scars per root usually found probably did not affect

![Graph showing injury to sweet potato roots by soil insects and larvae from soil samples](image-url)

Fig. 1. Injury to sweet potato roots by soil insects (above) and larvae from soil samples (below), 1974. Treatment 1 (4.5 kg/ha, fonofos) and Treatment 2 (2.2 kg/ha, fonofos) vs. the control (no treatment) on 3 cultivars known to differ in resistance levels. The numbers of insect larvae associated with the treatments are totals from 2 collections made July 17 and Aug. 16 (from 465 cm² x 15.2 cm deep soil samples from around the roots. Injury by all insects includes some injury by a white grub. Letters on bars indicate mean separation by Duncan's multiple range test, 5% level.
In spite of the differences in amount of injury to the roots of the 3 lines by the wireworm-Diabrotica-Systema complex there was only one instance in which the larval populations around the roots differed significantly (Fig. 1, 2). That is, the insects were present under the resistant lines but fed on them less. All of the members of the complex have a wide host range and are rather generally distributed in agricultural crops where they feed on germinating seeds, fibrous roots, and the crowns of both crops and weeds. Wireworms also feed on decaying organic matter. Therefore, we conclude that in the plots of resistant sweet potatoes, the larvae of this complex utilized food other than the enlarged roots, including quite possible the fibrous roots of the sweet potatoes. There was no indication that adult feeding or ovipositional preference was involved in the resistance. In the case of the sweet potato flea beetle, an insect whose only hosts are sweet potatoes and closely related plants, there was considerable evidence that larval populations were lower under W-13 than under the other two lines.

**Conclusions**

A commercial sweet potato cultivar with resistance equal to W-13 would probably not need the protection of insecticides under usual field conditions. A cultivar with resistance equal to W-3 could be grown without economic loss, but would require insecticide treatments. The use of resistant lines therefore increased the effectiveness of fonofos in reducing injury.

Even with insecticidal treatment, susceptible cultivars are likely to sustain economic losses when insect populations are high. Fonofos at 2.24 kg/ha will not always provide adequate protection for susceptible sweet potato cultivars and the use of higher dosages may be of no value. The use of resistant cultivars will probably have little impact on populations of wireworms, Diabrotica, and Systema, but may reduce populations of the sweet potato flea beetle.

**Literature Cited**