Development of Varietal Screening Technique for Resistance of Sweet Potato to the Weevil, *Cylas formicarius elegantulus* Fabr.

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Abstract

Using the field screening technique, reactions of resistant sweet potato varieties/accessions were recorded. Reactions of some varieties were not consistent in the two to three trials completed. This suggests the need to improve the technique. Results showed a great variability in the degree of weevil infestation even among tubers of one variety. Since sweet potato is vegetatively propagated, individual plants of a variety should show fairly uniform reaction. Highly variable infestation among tubers of a variety may have been due to: unequal exposure to same level of pest population; weevils being relatively poor fliers; and the soil medium which hinders weevil movement to manifest varietal preference.

Weevils reared individually in sliced fresh tubers or stem pieces to determine antibiosis had very high mortality especially in later instars. This was possibly due to great physico-chemical differences between fresh host tissues and that normally fed on in the larval tunnel inside whole tuber or stem.

Varietal screening using potted plants artificially infested with weevils was not very successful because some plants did not produce tubers. Improved techniques for determining adult ovipositional preference on stems and antibiosis of stems and tubers to larvae and pupae are being developed.

Introduction

Among the most important requirements for success in selecting crop varieties resistant to insect pests are availability of test plants representing wide genetic variability which should include genes for resistance, and the use of reliable screening techniques. The first requirement is a responsibility of plant breeders while the second is the concern of entomologists. Thus, a "team approach" to varietal screening is often advantageous, even if not absolutely necessary.

Generally in the development of varietal screening techniques, the following are among the important factors to consider: (1) mode of reproduction of the crop (by seed or vegetative means), (2) manner of pollination (self or cross), (3) part of the plant attacked by the pest and (4) biology, characteristic habits, and behavior of the pest. In this paper, reference to the above factors are made in relation to the development of a varietal screening technique applicable to sweet potato and the weevil.

In general, techniques suited for varietal screening against insect pests that remain on the surface of the host plant are simpler than those applicable to borers. Techniques for borers become more complicated when the part of the plant attacked by the pest is underground. Thus, development of a reliable and practical technique for varietal screening against the weevil is not easy, but nonetheless, necessary.

Review of Literature

Magoon et. al (1970) reported three high yielding sweet potato hybrids with high degrees of resistance to the weevil based on weevil damage on tubers. Similarly, entomologists of the Asian Vegetable Research and Development Center (AVRDC Annual Report for 1974) observed 30 hybrids showing varying levels of resistance to the weevil. The criteria used for evaluating varietal reaction were mean number of weevils per kg tubers, mean number of weevil per 30-cm stem and damage rating on tubers. No other literature was found on other techniques used in varietal screening of sweet potato to the weevil.

Pointer (1951) stated that plants, in general, can be evaluated for resistance to insect pests based on the estimate of damage inflicted on the crop, estimate of the pest population infesting the crop, or a combination of the two. Yield should not be used as an index of resistance as there are inherent factors affecting yield other than resistance to pests. He also mentioned that the method of evaluation should consider, among other things, the characteristic, biology and feeding habits of the pest. The nature of plant growth, susceptible stage of the crop, and environmental requirements for plant growth are among the important factors to consider whether to screen varieties in the field or in the laboratory.

Materials and Methods

Field Screening. Varietal screening of sweet potato in the field for resistance to the weevil was started in March 1977 following a technique patterned largely after that reported by the Asian Vegetable Research and Development Center (AVRDC) in 1974. The susceptible check plant used was a local variety BNAS-51 most commonly grown by the farmers in the region and observed in earlier plantings to be relatively susceptible to the weevil. The check plants were planted ahead of the test materials in 3 m rows, 3 m apart. When the check plants were two months old, weevil infested tubers were placed along the check rows. After another month, two test varieties were planted one meter apart in unreplicated single rows between every 2 check rows. The test entries were evaluated for weevil resistance using the following criteria: (a) mean number of weevil

per kg tubers, (2) mean number of weevils per 30 cm stem, and (3) damage rating on the surface of the tubers (by adult weevils). The entries were tested in batches of 35 to 40 with BNAS-51 included in every batch.

Rearing Weevils on Vine Pieces and Harvested Tubers To Measure Antibiosis. Medium mature vines of BNAS-51 variety collected from the field were used. Uninfested portions were cut into about 10 cm pieces. A slit was made at about mid-point of each stem piece and a tiny excavation was made inside the slit. One first instar larvae was placed in the cavity and the slit was closed tightly by wrapping a small piece of scotch tape around that portion of the stem. The cut ends of the stem piece were wrapped with wet cotton to keep the host fresh longer. Each larva was inspected every 3 days and transferred to a fresh piece when the stem begins to dry or rot.

In the succeeding trial, longer vine pieces were prepared to allow soaking of the basal end in water inside a bottle. The same procedure of introducing the larvae inside the stem was used. The larva was observed every 3 days. Some stem pieces developed roots and remained fresh longer and so the larvae were not transferred to fresh vine pieces.

To test the tubers, peeled slices or blocks measuring 3 to 5 mm thick, as wide and about three-fourths the length of an ordinary glass slide, were prepared. Each slice was placed between 2 pieces of plastic sheets 3 mm thick, as wide and as long as a glass slide. The middle portion measuring 3 cm by 1.5 cm (oblong shape) of the upper plastic sheet was removed to expose the corresponding portion of the tuber block beneath. A weevil larva was introduced in the cavity and another solid plastic sheet was placed on top to close the opening. The three plastic sheets, with the tuber block between the upper two sheets, were tied with rubber bands at both ends. The larvae were transferred to fresh tuber blocks every three days until pupation as an attempt to provide the insects with a condition approximately like in a living plant.

To test the tubers, pieces measuring about 3 cm^3 were individually infested with a newly hatched larva. The insects were observed everyday for molting or death and transferred to fresh cubes when the tuber pieces dried up or rot. Usually this occurred when the larvae were in the third instar.

Potted Plants. Five tuber-producing sweet potato accessions representing varying levels of resistance to the weevil in the field trials were selected. Two cuttings of each variety were planted in 12-inch diameter clay pots replicated 10 times following the procedure described by Remoroza (1978), wherein the main stem and the tubers that developed were protected from weevil infestation by a piece of nylon tulle. However, the potted plants were kept in the open field where field screening was being conducted instead of in a partly shaded area where Remoroza kept her plants. When the plants were about 3 months old and expected to have produced tubers already, one potted plant per accession was set aside. The soil was carefully dug to determine if the tubers were ready for artificial infestation with weevils without uprooting the plants. When no tubers were found in the pots of two test accessions, all the plants were examined. For reasons to be presented later, the experiment had to be discontinued.

Results and Discussion

Field Screening. Out of the 372 varieties/accessions tested during the first trial, 105 were classified as resistant or moderately resistant while in the second trial, 28 of the 105 accessions again appeared resistant or moderately resistant. The third trial is in progress. While some varieties showed consistent reaction to the pest in the 2 screening trials completed, a number of them did not. Also, some varieties appeared more resistant on one criterion but susceptible on other aspects (Table 1). These observations suggest the need to improve the technique.

Probably, the most important factor responsible for the seemingly inconsistent reaction of some varieties in the trials conducted was the great variability in weevil infestation among the sample tubers or stems of one plant, and among sample plants of a variety. As shown in Table 2, the biggest range in weevil population (mostly larvae and pupae) was 0 to 101 per tuber and 0 to 9 per stem. Sweet potato is vegetatively propagated and theoretically there should be no genetic variability among plants of a variety. The great variation in weevil population suggests that the tubers or stems were not exposed equally to the same level of pest population, although artificial infestation was provided in the check rows. This can easily happen because in a typical sweet potato field, some vines are more exposed than others; the weevils are relatively poor fliers; and soil as a medium greatly hinders movement of adult weevils to be able to manifest varietal preference for feeding and/or egg deposition. The lesser weevil counts per stem compared to weevil counts per tuber may be explained by the fact that, the size of vines at maturity preferred by weevils is more uniform thereby eliminating variability in population associated with food abundance and available sites for insect development. Also, the vines are above ground and more equally exposed to weevils.

Inspite of adequate exposure to high weevil population, stems of host plants may be non-preferred by the adult weevil for oviposition and/or it has adverse effects on insect survival and development known as antibiosis. On tubers, low population may indicate primarily of antibiosis. Ovipositional preference should be rulled out. Also, unlike some insect pests, nonpreference of weevil larvae for feeding on certain varieties should not be considered as a possible mechanism for resistance in sweet potato since weevil larvae are legless and have to remain in the host where they were deposited as eggs, regardless of whether the host is preferred or not.

Based on the above considerations, the important mechanism of sweet potato resistance that should be measured through varietal screening are ovipositional non-preference of adult weevils on stems or vines and antibiotic effects of vines and tubers on the various developmental stages of the pest. It should be mentioned also that although the vine is not the part that a grower is after, its resistance to weevil is equally important since this will determine largely the initial insect population to infest the developing tubers.

Antibiotic Effects of Vines and Tubers on Weevil Larvae. The percentage survival of individual cultures in stems and tubers determined on the third day ranged from 40 to 60%. Survival rate further decreased with larval age and only about 3 to 6% of the cultures reached the adult stage. This high mortality suggests the need for refinement of the rearing technique. The cause of high mortality of the weevil cultures on a susceptible variety may be attributed to the physical injury that might have been inflicted when the larvae were transferred to fresh hosts every three days. However, the higher mortality among older and bigger larvae which are supposed to be less prone to injury than the younger and smaller ones suggests a cause of death other physical injury during handling.

If a freshly gathered weevil infested stem or tuber is cut open to expose larval tunnel, the plant tissues surrounding the developing weevil range in color from brown to grayish brown and appear different in texture from that of uninfested tissues. There is a possibility therefore that another cause of high larval mortality of the individual cultures was the great physico-chemical difference between fresh tissue used in individual cultures and that normally fed on in the larval tunnel inside a whole tuber or stem. During the later instars, the accumulating feces and other waste materials inside the larval tunnel might have enhanced changes in the neighboring host tissues resulting in a condition different from what fresh tissues provide. Such a condition is difficult to simulate in individual cultures. These are mere speculations that should be proven by carefully planned experiments. If proven true, one may further speculate the great possibility that varietal effect on weevil survival may be greatest and manifested best during the first larval instar when the insect is still feeding on fresh host tissues. This means that, varietal screening based on survival of first instar larvae on fresh host tissues may provide a good measure of varietal resistance to the weevil. Also, for studies needing longer observation on weevil biology, it might be necessary to use living plants or fresh whole tubers to eliminate the need for frequent transferring of the larvae.

Potted Plants. Only one of the five accessions consistently produced tubers in the 10 pots. Two of the accessions did not produce tubers, 8 plants of 1 accession produced tubers and 2 did not, while some plants of 1 accession had slightly enlarged roots. Thus, the plan to infest individual tubers with equal number of weevils without detaching them from the plant was not carried out. Also, the plan to artificially infest with weevils some portions of the vines of the 5 accessions to correlate vine and tuber reactions to weevil was not implemented. However, it was observed that all the tubers harvested were weevil-free suggesting that uninfested tubers, for experimental purposes of some varieties may be produced that way.

It appears therefore, that an important factor limiting varietal screening using potted plants is the difficulty or inconsistency of individual plants of some varieties to produce tubers in pots. If this cannot be solved, a logical alternative probably is to use potted seedlings for evaluating the vine's reaction and the use of newly harvested whole tubers for evaluating tuber reaction against the early instar larvae. The remaining problem though, is the production of weevil-free tubers in the field without protecting the plants with insecticides.

Conclusion and Recommendations

Although it was observed that some susceptible varieties appeared resistant in the field possibly due to insufficient level or uneven distribution of weevil population or failure of the weevils to reach some tubers deep in the soil, or both, field screening may still be used if the purpose is mainly to eliminate the bulk of the most susceptible plant materials under study. However, the selected varieties should be tested several times and, if possible, the natural population should be augmented with laboratory reared insects to minimize varietal escape from weevil infestation.

Since there is a need to verify in the laboratory the observed varietal resistance in the field and determine, if possible, the mechanisms involved, factors affecting tuber production of potted plants should be investigated. If this problem of tuber production is solved, varietal screening using potted plants will be a great possibility for sweet potato. This is because, being a vegetatively propagated crop, one need not base the reaction of a variety on many individual plants.

Considering the largely sedentary habit of developing weevil larvae inside the tubers it is highly probable that, if present, antibiotic effects of a variety on the first and second larvae can be one of the most important mechanisms of host resistance to the pest.

References

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Table1. Observed Resistance or Susceptibility of Representative Sweet Potato Accessions to Sweet Potato Weevil During Two Field Plantings Based on Weevil Counts in Stems and Tubers and on Degree of Damage Inflicted on Tuber Surface.

Sweet Potato Accession No.	First Planting			Second Planting		
	Weevil Population in Tubers	Weevil Population in Main Stems	Weevil Damage on Tuber Surface	Weevil Population n in Tubers	Weevil Population in Main Stems	Weevil Damage on Tuber Surface
1	R	S	S	S	S	S
9	S	S	S	R	S	S
92	R	MR	S	R	R	R
118	R	R	MR	R	R	R
151	R	R	MR	S	R	S
182	R	R	R	R	S	S
235	R	R	S	R	R	S
251	R	S	S	S	S	S

Table 2. Ranges in Total Number of Weevils per Stem or Tuber of Some Sweet Potato Varieties

Variety or Accession No.	1st Planting		2nd Planting		3rd Planting	
	Tuber	Stem	Tuber	Stem	Tuber	Stem
1	0-10	0-9	0-29	0-10		
92	0-6	0-2	no inf.	no inf.		
118	no inf.	0-2	no inf.	0-2		
9	0-101	0-8	0-78	0-7		
151	no inf.	0-1	0-29	0-3	no inf.	0-2
182	no inf.	0-1	no inf.	0.3	0-15	0-1
235	no inf.	0-1	no inf.	0-1		
25 1	no inf.	0-3	0-27	0-2		
BNAS-51	0-29	0-2	0-13	0-6	0-57	0-4