FALL ARMYWORM PLANT RESISTANCE PROGRAMS

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ABSTRACT

Plant resistance research programs in corn, sorghum, peanuts, bermudagrass, and rice are involved with screening, developing, and releasing germplasm resistant to the fall armyworm, Spodoptera frugiperda (J. E. Smith). Effort and progress in identifying, developing, and releasing germplasm resistant to the fall armyworm and program needs and benefits are discussed.

Wiseman and Davis (1979) reviewed the state of the art of plant resistance to the fall armyworm, Spodoptera frugiperda (J. E. Smith), at the 1978 Fall Armyworm Conference. I report here on the present commitment in the United States to the breeding of crop cultivars resistant to the fall armyworm, including progress in identifying and releasing germplasm sources to the public. I also discuss the needs and benefits of these programs. The information presented is based on Current Research Information System Project Reports and from personal communications with scientists conducting research within these programs.

Plant breeders and entomologists work as teams in identifying, developing, and releasing plant germplasm resistant to fall armyworm for corn, Zea mays L., sorghum, Sorghum bicolor (L.) Moench, peanuts, Arachis hypogaea L., bermudagrass, Cynodon dactylon (L.) Pers., and rice, Oryza sativa L. The total scientific effort (state and federal plant breeders and entomologists) working in this area is estimated as 0.50 and 1.40 scientific years, respectively. Table 1 shows these estimates broken down by crop.

CORN

The fall armyworm and other corn insect pests are a major concern of plant resistance teams of Agricultural Research (SEA, USDA) at Tifton, GA, and Mississippi State, MS. In addition, the International Maize and Wheat Improvement Center (CIMMYT) in Mexico has a team that is contributing to the US effort. Researchers in both countries are cooperating by sharing germplasm, infestation and evaluation techniques, and rearing techniques for the fall armyworm. Recently, the CIMMYT team developed a simple, efficient, and inexpensive method of plant infestation wherein first-instar lepidopteran larvae can be used (Mihm et al. 1978).

Also some commercial corn seed companies have demonstrated considerable interest in developing hybrids resistant to the fall armyworm. In fact, 3 companies have entomologists who are rearing this insect and are using it in their screening and hybrid development programs.

At Tifton, Wiseman et al. 1973 have conducted basic studies on the effect

1Lepidoptera: Noctulidae.
TABLE 1. ESTIMATED SCIENTIFIC EFFORT IN FEDERAL AND STATE AGENCIES IN THE UNITED STATES CONCERNED WITH IDENTIFYING, DEVELOPING, AND RELEASING CULTIVARS RESISTANT TO THE FALL ARMYWORM.* **

<table>
<thead>
<tr>
<th>Crop</th>
<th>Organization</th>
<th>Location</th>
<th>Estimated SY's</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plant Breeder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Entomologist</td>
</tr>
<tr>
<td>Corn</td>
<td>AR</td>
<td>Tifton, GA, Miss.</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mississippi State, MS</td>
<td>0.25</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.35</td>
</tr>
<tr>
<td>Sorghum</td>
<td>AR</td>
<td>Tifton, GA</td>
<td>0.05</td>
</tr>
<tr>
<td>Peanuts</td>
<td>AR</td>
<td>Tifton, GA</td>
<td>0.05</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>AR</td>
<td>Tifton, GA</td>
<td>0.05</td>
</tr>
<tr>
<td>Rice</td>
<td>SAES</td>
<td>Beaumont, TX</td>
<td>—</td>
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<tr>
<td></td>
<td></td>
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<td>1.40</td>
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</tbody>
</table>

*These estimates include only those programs that have CRIS projects which include plant resistance to the fall armyworm.
**Fall armyworm is one of several insects in which plant resistance research is being conducted within these programs.

of crop fertilizers on the resistance of 'Antigua 2D' to the fall armyworm. Wiseman et al. (1974, 1980) have developed techniques for artificially infesting corn plants with fall armyworm eggs and larvae that should enhance identification and development of fall armyworm resistant genotypes. At Mississippi State, 2 inbreds (Mp496 and Mp703) and 3 populations (MpSWCB-1, MpSWCB-2, and MpSWCB-4) that have leaf-feeding resistance to the fall armyworm and the southwestern corn borer, Diatraea grandiosella (Tylor), have been released (Williams, personal communication). The primary source of this resistance is 'Antigua Groups 1 and 2'. Also, Williams et al. (1978) have obtained genetic information on the resistant fall armyworm plant genotypes developed in Mississippi. Scott et al. (1977) reported that resistant hybrids yielded at least twice as much as susceptible commercial hybrids when the 2 types were planted late in the summer under large fall armyworm populations.

Sorghum

Resistance to the fall armyworm in sorghum is being investigated by the same Tifton team that works on corn. Even though statistical differences between sorghum lines for leaf-feeding by the fall armyworm have been reported (McMillian and Starks, 1967), the level of resistance is not very high. Therefore, the Tifton team is in the process of screening seedlings of some 4,000 entries of the world sorghum collection (obtained from CIMMYT and U.S. Plant Introduction Stations) for a higher source of resistance. A new infestation procedure developed by Roberson et al. (1978) for this work should enhance the chances of identifying resistant sources. Agricultural Research entomologists at Stillwater, OK have also recently begun a limited screening of sorghum lines for fall armyworm leaf-feeding resistance.
PEANUTS

Resistance to fall armyworm in peanuts is being studied at Tifton by another AR plant breeder-entomologist team. Leuck et al. (1967) reported resistance to a complex of leaf-feeding insects including the fall armyworm in peanuts. Hammons (1970) registered ‘Southeastern Runner 56-15’ peanut cultivar, which exhibits more fall armyworm resistance than any other commercial peanut variety developed in U. S. breeding programs. As a result, this cultivar was planted on ca. 10-15% of the peanut acreage during the period (1955-1970) it was grown (Hammons, personal communication). Leuck and Skinner (1971) showed in laboratory tests that continuous feeding of this insect through 3 successive generations on foliage of ‘Southeastern Runner 56-15’ had an adverse effect on the biology of insect because the larval development period was lengthened and reduced numbers of adults emerged.

BERMUDAGRASS

Resistance in bermudagrass to the fall armyworm is also being studied by AR scientists at Tifton, GA. Leuck et al. (1968b) screened 441 bermudagrass clones and found 2 to be resistant, 9 to be intermediate in resistance, and the rest to be susceptible. Leuck and Skinner (1970) compared the development and mortality of larvae reared on the susceptible ‘Coastal’ bermudagrass and on a resistant bermudagrass clone ‘Georgia accession No. 239’. They observed higher larval and pupal mortality on the resistance clone. No releases of fall armyworm resistant bermudagrass cultivars have yet been made.

RICE

Resistance research concerned with the fall armyworm in rice is now underway at the Texas Agricultural Experiment Station at Beaumont. Rowling (1978) simulated feeding by the fall armyworm by artificially removing various portions of the photosynthetic surfaces during the seedling and tillering stage of growth. Sometime in the future, they plan to begin screening rice varieties for fall armyworm resistance.

Also, a joint effort by AR scientists at Crowley, LA and scientists at the Louisiana Agricultural Experiment Station, Baton Rouge has recently been initiated. These scientists are in the process of greenhouse screening of rice lines including those that have shown resistance to the rice stalk borer, Chilo plejadellus Zincken and the sugarcane borer, Diatraea saccharalis.

MILLET

Limited research on resistance in millet to the fall armyworm has been conducted and is continuing at AR laboratories at Tifton and at Stillwater. Leuck et al. (1968a) screened 1436 pearl millet inbreds at the seedling stage for fall armyworm resistance of which 4% were resistant, 28% were intermediate, and 68% were susceptible to larval feeding. Later Leuck (1970) studied the effect of 1 of these resistant inbreds (No. 240) on the fall armyworm. He found that the cumulative effects of exposure to the resistant inbred resulted in lower pupal weights, longer times to first moth emergence.
and to peak moth emergence, and more days to develop from egg to egg. The research group in Oklahoma has identified an intermediate resistance source in Proso millet cultivars (Wilson, personal communication). No releases of fall armyworm resistant millets have yet been made.

**PLANT RESISTANCE PROGRAMS NEEDS AND BENEFITS**

Plant resistance researchers asked about their needs or about limiting factors respond with an array of answers. A major concern among some is the difficulty in maintaining team continuity when a member is lost because of retirement, transfer, or resignation. Also concern is expressed about the need for additional scientists when existing programs become large and phases of the program must suffer from lack of concentrated attention. Others have expressed the need for more funds or new funds. There is sometimes need for more rearing capabilities. Infestation and evaluation techniques are mentioned as a limiting factor. Time is another limiting factor because it takes time to develop new techniques and resistant germplasm.

As most of these comments make plain, plant resistance research is strictly a team effort, and a given program must extend over many years. The benefits, however, are great for fellow scientists, farmers and consumers.

New knowledge about the biology of the insect and its interactions with its host plant(s) (including economic thresholds) is generated. More efficient techniques of infestation (including artificial rearing) and evaluation are produced. Most important resistant germplasm is made available that can be incorporated into cultivars for farmer use.

**ACKNOWLEDGEMENTS**

The author would like to thank the following scientists who contributed information about their plant resistance programs:

*Corn—W. W. McMillian, N. W. Widstrom, and R. R. Wiseman, AR, SEA, USDA, Tifton, GA; W. P. Williams, AR, SEA, USDA, Mississippi State, MS; J. A. Mihm, CIMMYT, Mexico; G. L. Beland, Funk Seeds International, Bloomington, IL; J. E. Cambell, Pioneer Hi-Bred, Johnston, IA; J. L. Overman, DeKalb Ag. Research Inc., Union City, TN.*

*Sorghum—W. W. McMillian, N. W. Widstrom, and R. R. Wiseman, AR, SEA, USDA, Tifton, GA; R. L. Wilson, AR, SEA, USDA, Stillwater, OK.*

*Peanuts—R. O. Hammons, and R. E. Lynch, AR, SEA, USDA, Tifton, GA.*

*Bermudagrass and Millet—G. W. Burton, and R. E. Lynch, AR, SEA, USDA, Tifton, GA; R. L. Wilson, AR, SEA, USDA, Stillwater, OK.*

*Rice—C. C. Bowling, TX Agric. Exp. Sta., Beaumont, TX; C. M. Smith, LA Agric. Exp. Sta., Baton Rouge, LA; J. F. Robinson, AR, SEA, USDA, Crowley, LA.*

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