

RECENT DEVELOPMENTS IN RESEARCH ON  
THE SPOTTED ALFALFA APHID AND RESISTANCE IN ALFALFA

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Research on the spotted alfalfa aphid, *Therioaphis maculata* (Buckton), and development of aphid-resistant alfalfa cultivars were initiated 20 years ago. Between the time the aphid was introduced in 1954 and until 1957 it had spread to all major alfalfa growing areas in over 30 states. The effect on the alfalfa industry was devastating. Control of the aphid was effective only after proper timing of several applications of pesticides a year. Introduced species of parasites and endemic species of predators kept incipient populations down temporarily, but they were not effective in preventing population explosions.

Successful suppression of the spotted alfalfa aphid was finally accomplished by the use of resistant alfalfa cultivars developed by the joint efforts of agricultural scientists working in the private, state, and federal sectors. Now, only an occasional outbreak occurs, and most of these develop in areas where susceptible cultivars are still being used. Other outbreaks were the result of new aphid biotypes which were able to develop on resistant cultivars.

At the present time about 35 cultivars of alfalfa have been developed for resistance to the spotted alfalfa aphid. No other insect in recent times has had a more positive influence in promoting host plant resistance as an effective method of insect control. Before 1950, most of the research on insect resistance was being done in Kansas by the late Dr. R. H. Painter and his students. Now there are numerous scientists in the United States working on resistance in a wide range of crop plants to many insects species. Also, new cultivars are being developed with multiple pest resistance.

Host plant resistance has several advantages over other conventional methods of insect control. Resistant cultivars are relatively cheap to develop in terms of manpower and facilities. Only \$50,000 was spent to develop 'Moapa,' the first cultivar developed for resistance to the spotted alfalfa aphid. A recent study has shown that for every \$1 spent on research and development of resistant cultivars, \$10 are returned in benefits. Resistant cultivars work hand-in-glove with biological control. Populations of parasites and predators are not destroyed but are maintained at levels where they can be useful. Host plant resistance prevents pollution of our agricultural environment, thus reducing or even eliminating the need for pesticides. Resistant plants give increased yields and higher quality by incorporating desirable agronomic characters during the developmental stages. Moreover, resistant cultivars give higher yields over susceptible cultivars in the presence of a damaging aphid population. Finally, host plant resistance is long lasting. Moapa alfalfa was free of aphid problems for 10 years before a biotype was able to reproduce on the cultivar.

Biology and Ecology of the Spotted Alfalfa Aphid

The spotted alfalfa aphid is a highly fecunditive species, reproduces by parthenogenesis or gives birth to living young, and is adaptable to warm climates. One generation is completed in 6 days, and 35 generations a year are possible when conditions are optimum (Nielson and Barnes, 1957). Alfalfa is the preferred host, and susceptible varieties are heavily damaged while the insect is feeding on the plant. Recent research has shown that the aphid ingests primarily from phloem sieve elements, approximately 15 minutes after the initial probe into the plant tissue. Ingestion is continuous and may last as long as 17 hours.

Before resistant cultivars were available to the growers, populations of the spotted alfalfa aphid often peaked 3 times a year on susceptible cultivars, generally in April, July, and October. However, heavy rainfall before the population buildup created ideal conditions for development of a fungus, which grew on the aphids and reduced or decimated the aphid population. These conditions occurred in many alfalfa fields in Arizona in July 1955, October 1957, and April and September 1958 (Nielson and Barnes 1961). Moapa was released in 1957. However, it was in 1959 that the full effect of the resistant

cultivar was felt in suppressing the aphid population below the economic threshold. In counts taken over a 3-year period, from 1959 to 1961, average populations were 5 to 13 times higher and foliage damage was 15 to 22 times greater on susceptible alfalfas than on Moapa (Barnes 1963).

#### Biotypes of the Spotted Alfalfa Aphid

Except for a few sporadic outbreaks on susceptible cultivars, populations of the spotted alfalfa aphid remained at subeconomic levels for a period of about 10 years from 1958 to 1968. In 1958, the first biotype (biotype A) was found on 3 parent clones of Moapa grown near El Centro, Cal. (Pesho et al. 1960). The problem did not appear to be serious since the population was restricted to that area. About 10 years later, however, another more virulent biotype (biotype F) was discovered at the Imperial Valley Field Station near El Centro. This strain almost completely killed out seedling stands of Moapa. In recent years, populations of biotype F have been discovered in several localities in southern California and southern Arizona.

Resistance in numerous alfalfa cultivars to these biotypes was recently evaluated, and the results showed that, among 52 cultivars and experimental alfalfas developed for resistance, 27 had only 40% or less seedling survival to the biotype that completely killed out Moapa (Table 1). Among this group 18 alfalfas were susceptible, whereas the remaining 9 were marginally resistant.

In 1971, another new biotype was discovered on Mesa-Sirsa alfalfa at Mesa and Poston, Arizona. There are now 3 virulent strains that have developed on resistant cultivars in the desert valleys of southern Arizona and southern California. All of the biotypes were initially discovered in the late fall - early winter. Recent experiments have shown that the level of resistance in resistant alfalfa plants was temporarily suppressed under the effect of low temperatures, and that aphids reproduced rapidly under such conditions. This unique environmental effect may be an important factor that causes a new strain to develop, thus allowing the population to gain a "foothold." In a few years a population outbreak occurs on a cultivar that was originally resistant.

The problem of biotypes is not considered a critical one for the alfalfa growers in the United States. However, in the desert areas of the Southwest, the situation is serious because new biotypes have occurred much more frequently there than in any other place in the U. S. Means of suppressing development of new biotypes are at our disposal, but means of preventing development are not. Germ plasm is continually being pooled by selecting resistant plant material as soon as the biotypes are found.

#### Development of Resistance in Alfalfa to the Spotted Alfalfa Aphid

Development of insect resistance in crop plants requires high populations of readily accessible insects, seed sources of promising plant material, good facilities and cooperating scientists of different disciplines, including entomologists, plant pathologists, nematologists, and plant breeders. Screening is the first step toward final development followed by individual tests of surviving plants. Polycross seed is produced from the parent material, then progeny tested for resistance. If the level of resistance desired is not obtained from the first polycross, the progeny is screened, tested, and repolycrossed.

Screening for resistance to the spotted alfalfa aphid is done in the greenhouse or in field plots. In the greenhouse, flats are planted with seed, and when the seedlings are in the unifoliate leaf stage 4 cc of a mixed population of nymphs and adults are "sprinkled" over the plants. Surviving plants are transplanted in pots and cage-tested individually to determine the level of resistance or antibiosis. Plants that have high antibiosis are put together to produce the first polycross. In the field, screening of plants is done by manual infestation or by buildup of natural populations. Final selection depends upon the level of resistance or antibiosis desired.

Aphid-resistant alfalfa cultivars developed in Arizona by these means include 'Sonora,' 'Moapa 69,' 'Sonora 70,' 'Mesa-Sirsa,' 'El-Unico,' 'Washoe,' and 'Hayden.' Since 1957, an average of one cultivar every 2 years has been developed and released by cooperating scientists in Arizona, California, and Nevada. Several sources of resistant germ plasm

have also been developed and released

Current research efforts are now being concentrated on multiple pest resistance. Cultivars with resistance to the spotted alfalfa aphid, pea aphid, lygus bug, and alfalfa weevil, as well as to fungi, bacteria, and nematodes, are possible within the next 10 years.

#### References Cited

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Table 1. Mean percentage seedling survival of 52 alfalfa cultivars and experimentals tested for resistance to biotype F of the spotted alfalfa aphid.<sup>1/</sup>

Entry	Percentage Survival	Entry	Percentage Survival
Caliverde 65	95	R.R. Syn Bonanza	38
Kanza	79	Resistador	38
UC-64	79	Caliente	34
SW-17	77	WL-501	35
T-3-12	74	N-162	34
UC-202	73	N-71	32
X-9206	69	Sonora	27
UC-201	65	Zia	25
Washoe	65	Res. Sonora (38 cl. PX)	24
Dawson	61	AS-13	24
M-56-11 TC	61	Mission 63	22
Mesa-Sirsa	57	Culver	22
N-78	56	Joaquin 11	21
Bonanza	55	El Camino	18
AS-49	55	Moapa 69	18
WL-508	54	Lahontan	18
Hayden	51	El Dorado	12
Cody	51	Scout	8
SW-44	48	Indian	8
El-Unico	46	N-77	6
UC-58	43	Cherokee	2
Sonora 70	43	Rambler	1
X-1000	42	Moapa	1
Mesilla	40	DeKalb 183	0
R. R. GPX	40	Team	0
WL-509	38	Caliverde (check)	0

<sup>1/</sup>These data were taken from Nielson et al. 1971. Resistance in Alfalfa to Four Biotypes of the Spotted Alfalfa Aphid. J. Econ. Entomol. 64: 506-510.