

Table 2 continued:

Entry	Forage Production (lbs Gr. wt/plot)			3-year Total
	1976	1977	1978	
Low ADP:0 High Res	207.7	160.7	108.9	477.3
Low ADP:0 Low Res	218.1	159.3	92.6	470.0
Check Cultivar:				
Mesa-Sirsa	240.2	208.7	130.7	579.6

a/ Planting date: November 4, 1975 at the University of Arizona Mesa Farm, N½ Border E-17.

b/ Plots were 4' x 5' with four replications.

Progress in the Development of Multiple Insect Resistance in Alfalfa

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Before 1950 there were no insect resistant varieties of alfalfa anywhere in the world. Today there are over 40 varieties grown throughout various parts of the world that have resistance to one or more insect pests. This rapid progress in the development of insect-resistant alfalfa varieties over the past 25 years has been unprecedented. Ironically, much of this success can be attributed to a tiny insect, the spotted alfalfa aphid, that was introduced into the United States in 1954. While this insect was devastating alfalfa fields across the nation, two USDA scientists, the late Dr. Oliver Smith at Reno, Nevada, and Dr. Wayne Howe at Irvine, California, were carefully selecting and breeding alfalfa plants for resistance to this insect and to other pests. As a result of their efforts, two new varieties, Lahontan and Moapa, were developed and released to the farmers. Numerous varieties with resistance to the spotted alfalfa aphid have since been developed and released. A partial list of insect-resistant varieties is given in Table 1.

Table 1. Some Alfalfa Varieties Developed
for Resistance to Alfalfa Insects

Variety	Year Released	Insect
Lahontan	1954	Spotted Alfalfa Aphid
Culver	1955	Meadow Spittlebug
Moapa	1957	Spotted Alfalfa Aphid
Zia	1958	Spotted Alfalfa Aphid
Cody	1959	Spotted Alfalfa Aphid
Cherokee	1962	Potato Leafhopper
Sonora	1963	Spotted Alfalfa Aphid
El Unico	1964	Spotted Alfalfa Aphid
Mesa-Sirsa	1966	Spotted Alfalfa Aphid
Caliverde 65	1966	Spotted Alfalfa Aphid
Washoe	1966	Spotted Alfalfa Aphid, Pea Aphid
Dawson	1967	Spotted Alfalfa Aphid, Pea Aphid
Bonanza	1967	Spotted Alfalfa Aphid, Pea Aphid
Kanza	1970	Spotted Alfalfa Aphid, Pea Aphid
Team	1970	Alfalfa Weevil
Moapa 69	1971	Spotted Alfalfa Aphid
Hayden	1971	Spotted Alfalfa Aphid
Sonora 70	1970	Spotted Alfalfa Aphid
UC Salton	1973	Spotted Alfalfa Aphid
ARC	1974	Alfalfa Weevil
UC Cargo	1975	Spotted Alfalfa Aphid, Pea Aphid
CUF-101	1977	Spotted Alfalfa Aphid, Pea Aphid, Blue Alfalfa Aphid
WL-514	1978	Spotted Alfalfa Aphid, Pea Aphid, Blue Alfalfa Aphid

Success in the development of alfalfa resistant to the spotted alfalfa aphid encouraged scientists to breed plants for resistance to the pea aphid, another serious alfalfa pest of long standing in the United States. In 1966, the first variety developed for resistance to the pea aphid was released. This variety, named Washoe and developed by USDA scientists in Nevada and Arizona, also has resistance to the spotted alfalfa aphid and; in addition, reflects the first successful attempt to breed resistance to 2 different insect species. Now several other varieties including Dawson, Bonanza, and Kanza also have resistance to both aphid species.

In 1975, a new aphid pest of alfalfa was found in California. Shortly thereafter it spread to Arizona and Nevada where it caused serious crop loss in these states. Today the insect, called the blue alfalfa aphid, has spread to the midwest and now occurs in 12 states. Recently a new variety, CUF-101, was developed for resistance to the blue alfalfa aphid. This variety also has resistance to the spotted alfalfa aphid and pea aphid and is the first variety of plant ever bred with resistance to 3 aphid species. CUF-101 was developed by University of California and USDA scientists and released after only 2 years of development, an indication of the striking improvements that have occurred in the techniques used for breeding multiple insect resistance in alfalfa. Presently some alfalfas are being developed for resistance to other insects. There is a variety developed for resistance to the alfalfa weevil, Cherokee for resistance to the potato leafhopper, and Culver for resistance to the meadow spittlebug.

Three years after Moapa alfalfa was released, a new strain of the spotted alfalfa aphid appeared in the Imperial Valley near El Centro, California. This strain caused sufficient damage to Moapa to render the variety "susceptible." Several other varieties that were subsequently developed were also susceptible to the new strain. In 1964, El Unico was released as the first variety with resistance to the new strain. This variety was developed in Arizona by University and USDA scientists. After the release of El Unico, still another and more virulent strain of the spotted alfalfa aphid was found in 1968 in the Imperial Valley in the same area where the first new strain was discovered. Moapa alfalfa was almost completely killed out by the strain. However, new varieties including Mesa-Sirsa and Caliverde 65 were moderately and highly resistant, respectively. Mesa-Sirsa was an Arizona-USDA developed variety whereas Caliverde 65 was developed by California scientists.

In 1973, a third and even more virulent strain of the spotted alfalfa aphid was discovered in Mesa, Arizona. Mesa-Sirsa was susceptible to the strain as were many other varieties that were developed before 1973. However, two new varieties, UC Cargo and CUF-101, have been developed and released that have high resistance to this strain.

Thus several virulent strains of the spotted alfalfa aphid have developed in alfalfa over the past 20 years, but most of these populations are localized geographically and do not pose a serious threat to the alfalfa industry of the southwest. Moreover, varieties can be developed rapidly for resistance to new strains. A number of these varieties and their resistance or susceptibility to these strains are shown in Table 2.

Table 2. Resistance in Some Alfalfa Varieties to Biotypes of the Spotted Alfalfa Aphid

Variety	Year	Resistant to Biotype				
		B	A	E	F	H
Lahontan	1954	Yes	No	No	No	No
Moapa	1957	Yes	No	No	No	No
Cody	1959	Yes	No	No	No	No
Sonora	1963	Yes	No	No	No	No
El Unico	1964	Yes	Yes	Yes	No	No
Mesa Sirsa	1966	Yes	Yes	Yes	Yes	No
Caliverde 65	1966	Yes	Yes	Yes	Yes	?
Kanza	1970	Yes	Yes	Yes	Yes	?
Moapa 69	1971	Yes	No	No	No	?
UC Cargo	1975	Yes	Yes	Yes	Yes	Yes
CUF-101	1977	Yes	Yes	Yes	Yes	Yes

Progress in the development of alfalfa with resistance to multiple insect species, particularly in western United States, has been remarkable. Scientists are optimistic that progress will continue as breeding techniques provide the means of developing resistance to more difficult insect pests such as the alfalfa weevil, lygus bug, alfalfa butterfly, alfalfa seed chalcid, and leaf feeding caterpillar. Alfalfas in the future will have resistance to a multitude of pests and will give the farmers high yields of good quality forage at lower costs.