

(6.7°C) in January to a high of 70.1°F (21.2°C) in August, with measurements taken at a depth of 5 inches (12.5 cm). Monthly air temperatures also hit a low in January at 50.9°F (10.5°C); the highest average monthly air temperature was 74.4°F (23.6°C) in July.

Results

Overall quality ratings are based on evaluation of all turfgrass quality components combined into one turf score. As indicated by the overall ratings, most of the newly developed cultivars produced a significantly higher quality turf than did the older cultivars. The same conclusion emerges from review of the individual quality components. The newer cultivars had a darker green color and produced a denser stand of grass. They also had a finer texture than did the older cultivars; the finest textured of all those studied, however, had less finely textured leaves than Kentucky bluegrass.

No disease or insect activity was detected on any of the cultivars during this study. Plots were heavily infested with various broadleaf weeds, however, at the time of seedling emergence and establishment. Some plots were actually covered up to 70 percent by weeds two to three months after seeding. Nevertheless, all cultivars eventually out-competed the weeds and most were weed-free by the beginning of the second growing season. Thereafter, the only weed was a minor infestation by annual bluegrass (*Poa annua* L.), and that only on some plots.

Conclusions

The results of this study suggest that newly developed tall fescue cultivars are well suited for use as turf under central coastal California conditions, characterized as a "transition zone" climate. These new cultivars perform significantly better as turfgrasses under such conditions than do old cultivars. Since all tall fescue cultivars competed well with weeds and none were affected by the area's common diseases and insects, this grass also may be considered an efficient species to maintain as far as pest control is concerned.

The newly developed tall fescue cultivars produce high-quality turf at a seeding rate of 10 pounds per 1,000 square feet, a mowing height of 2 inches, and nitrogen fertilization of 4 pounds per 1,000 square feet.

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The blue alfalfa aphid.

Jack Kelly Clark



Low temperature decreases CUF 101 alfalfa resistance to blue alfalfa aphid

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The blue alfalfa aphid was first discovered causing damage to California alfalfa in 1974-75. By 1978, the alfalfa cultivar 'CUF 101', containing resistance to blue alfalfa aphid, *Acyrtosiphon kondoi*, was developed and released by University of California researchers. Since its release, CUF 101 has occupied a significant portion of the alfalfa acreage in California's southern San Joaquin and Imperial valleys. Data collected during the development and field testing of CUF 101 suggest tolerance as a mechanism conferring resistance in this cultivar, but there is no information on the possible contribution of antibiosis as well.

The stability and effectiveness of resistance may well depend on the mechanisms involved. Spotted alfalfa aphid, *Therioaphis maculata*, has developed eight biotypes, so that researchers have had to reintroduce resistance into commercial alfalfa cultivars several times. Tolerance, depending on its level, may be overwhelmed by unusually large pest populations, resulting in unanticipated losses.

Perhaps of equal importance to knowledge of the mechanisms is knowledge of the stability of resistance over a range of climatic conditions. Temperature is known to bias the expression of alfalfa

The loss of resistance to blue alfalfa aphid could require additional pesticide treatments in unusually cool spring weather.

Host-plant resistance can be divided into three basic mechanisms: nonpreference (antixenosis), antibiosis, and tolerance. Antixenosis is a property making the plant an unacceptable host so that it is avoided by a potential pest. Antibiosis refers to an adverse effect of the host on pest biology, reducing survival or reproductiveness of the pest. Tolerance is the ability of the plant to withstand pest infestation levels that would significantly decrease yield or quality in a susceptible plant. These mechanisms may act singly or together to produce the observed resistance.

While probably of little importance in the short-term, commercial use of resistant cultivars, knowledge of the biological mechanisms has both biological and prac-

resistance to aphids. Researchers in California, Arizona, and elsewhere have found a decrease in the expression of resistance to spotted alfalfa aphid with decreasing temperatures. Aphid fecundity and survival were both greater at lower temperatures. In the 'Lahontan' clone C-902, resistance was completely lost at 50° and 60°F. In this report, we explore the possible contributions of antibiosis and examine the effect of temperature on CUF 101 resistance to the blue alfalfa aphid.

Methods

We started the first generation of aphids, hereafter referred to as the parental generation (P), by selecting four-hour-old nymphs from stock colony stem mothers. The next (F₁) generation was initiated

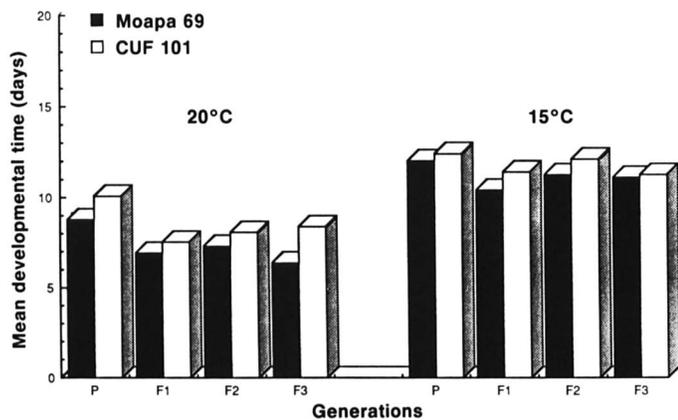


Fig. 1. Blue alfalfa aphid developmental time was longer on resistant alfalfa variety CUF 101 than on susceptible Moapa 69 at 68°F (20°C), but about the same at lower temperatures.

by selecting four-hour-old nymphs produced by the parental stem mothers. F₂ and F₃ generations were likewise started from F₁ and F₂ stem mothers, respectively. In each case, nymphs were selected from aphids in their second and third day of reproduction.

Nymphs were placed singly on each of 10 plants of CUF 101 and the susceptible Moapa 69 for comparison. Mature (about six months old), vigorously growing plants were used in the tests. Before each experiment began, plants were conditioned for six days at the temperature at which the test would be conducted. Before infestation, plants were trimmed to a single stem and, following infestation, were enclosed in a plastic frame and nylon-organandy cage. Plants were then placed in a 2-inch-thick Styrofoam board drilled to accommodate the vials. Each plant was randomly positioned on the board, and a new location was assigned daily. Plants were replaced if they became too large for the cage or showed signs of deterioration, such as yellowing or spindly growth. Replacement plants were also conditioned at the appropriate temperature for six days before use.

Studies took place at 68° and 59°F (20° and 15°C) in growth chambers with a 12-hour light (fluorescent and incandescent lamps), 12-hour dark cycle. During the developmental period, cages were checked twice daily for cast skins to determine when molting occurred. After reproduction began, mortality and fecundity were recorded daily and all young removed. Cohorts in each generation were followed until the last member died.

Developmental times

At 68°F, total aphid developmental time was significantly longer ($P < 0.01$) in all four generations reared on CUF 101 than in those reared on Moapa 69 (fig. 1). Prolonged developmental times on CUF 101 resulted from extended third and/or

fourth nymphal stages. At 59°F, only the first generation had a significantly longer total developmental time ($P = 0.01$) on CUF 101 than on Moapa 69. While the fourth nymphal stage in the third generation was significantly longer ($P < 0.05$) on CUF 101, total developmental time was not affected.

Survival and reproduction

At 68°F, aphid survival was as much as 280 day-degrees shorter on CUF 101 than on Moapa 69. In addition to a shorter survival time, mortality on CUF 101 began earlier and progressed at a much more rapid rate. At 59°F, however, survival rates were nearly identical on both cultivars.

Reproductive patterns on the two cultivars were distinctly different at 68°F. Fecundity curves on Moapa 69 were typical for aphids, with the reproductive maximum occurring early (within two to three days of reaching adulthood) followed by a gradual decline. Aphids reared on CUF 101 exhibited a less normal fecundity pattern. Peak reproduction was delayed until shortly before the midpoint of the reproductive cycle. Once reproduction on CUF 101 began, it appeared to remain at a more or less consistent level, followed by a precipitous decline and abrupt cessation. At 59°F, however, reproductive patterns on both cultivars were similar.

At 68°F, total progeny production was significantly higher ($P = 0.05$) in all four generations on Moapa 69 than on CUF 101 (fig. 2). At 59°F, however, total progeny production, except in the parental generation, was statistically identical on the two cultivars.

Discussion and conclusions

CUF 101, growing at 68°F, had an adverse effect on blue alfalfa aphid biology that was consistent with accepted definitions of antibiosis. Developmental times on CUF 101 were increased by as much as

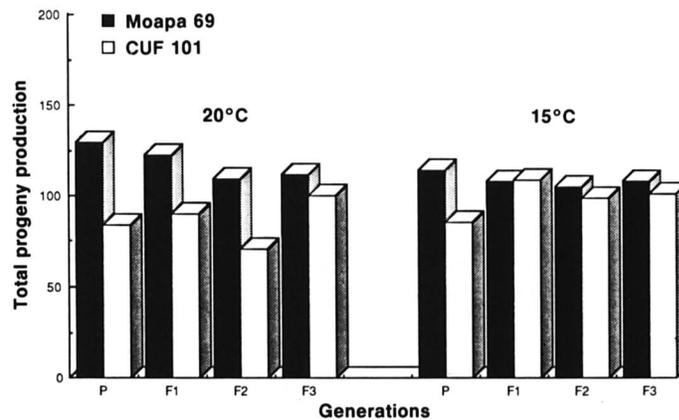


Fig. 2. Aphid reproduction was higher on Moapa 69 than on CUF 101 at 68°F, but was statistically identical, except in the parental generation, on the two cultivars at 59°F (15°C).

24 percent (third generation) with a protracted third or fourth nymphal stage as the principal contributor to this increase. At 59°F, only the first generation had a significantly increased time to adulthood when reared on CUF 101.

Reduced fecundity, another indication of antibiosis, was also apparent at 68°F. Rearing on CUF 101 significantly depressed reproductiveness in all four generations when compared with that on Moapa 69. Although reproduction varied somewhat between the various generations, it was relatively consistent within individual cultivars. Such results suggest a relatively stable relationship between aphid and host over an extended period. Longevity on CUF 101 was also markedly reduced at 68°F. Such depressions in fecundity and survival have been documented in relationships between other aphids and resistant cultivars.

At 59°F, cultivar-mediated differences in survival and fecundity were virtually eliminated in all but the parental generation. Such temperature-induced loss of resistance is consistent with the findings of other researchers working with the spotted alfalfa aphid.

CUF 101 appears to have moderate resistance to the blue alfalfa aphid when compared with a susceptible cultivar such as Moapa 69. While tolerance contributes somewhat to the success of CUF 101, antibiosis also plays a role. The loss of resistance at low temperatures could create some problems. Blue alfalfa aphid is an early-season, cool-weather pest and, in unusually cool springs, alfalfa resistance might be sufficiently suppressed to permit the development of economically injurious population levels. Frequent monitoring during such situations is advised.

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