

## ABSTRACT

In a study in the Southern High Plains of the USA designed for other purposes, a cowpea aphid (*Aphis craccivora*) infestation in April 2001 provided information that might be of value to alfalfa breeders and managers and Cooperative Extension Service personnel, as this species can inflict severe damage to alfalfa (*Medicago sativa* L.), causing significant stand loss. Cowpea aphid damage ratings of furrow-irrigated alfalfa of fall dormancy (FD) categories 2 through 9, each represented by one to three varieties at Tucumcari, NM, were compared in a split plot with eight randomized complete blocks. Fall dormancy category was a significant ( $P < 0.05$ ) factor in the level of cowpea aphid damage, with FD 2 to 7 not significantly different and an increase in damage from FD 7 to 9. There also were significant differences ( $P < 0.05$ ) for cowpea aphid damage between varieties within FD 7 (14 and 40% for 'Doña Ana' and 'Helena 7000', respectively) and within FD 9 (64 and 35% for 'Salado' and 'WL612', respectively). Using more dormant alfalfa varieties in the Southern High Plains and Southern Great Plains may provide protection from cowpea aphid infestations by allowing an increase in beneficial predator populations before the initiation of alfalfa growth. 'Doña Ana' and 'WL612' alfalfa may have a degree of resistance to cowpea aphid.

## INTRODUCTION

In 2001, cowpea aphid (*Aphis craccivora*) began inflicting severe damage by attacking alfalfa (*Medicago sativa* L.) fields upon spring green-up, causing significant stand loss in the Southwest, including the Southern High Plains and Southern Great Plains (Ford, 2001; Palumbo and Tickes, 2001; Summers et al., 2004; personal observation). Cowpea aphid had been commonly found in alfalfa fields during summer, but was never considered an economic pest until a strain developed in California that spread eastward, eventually infecting fields in western Kentucky in 2006 (Ford, 2001; Robinson-Avila, 2005; Townsend, 2006). Consequently, little information is available about its activity in relation to alfalfa (Palumbo and Tickes, 2001).

Cowpea aphid normally feeds on cowpeas during the summer. Recent infestations damaging alfalfa in winter and early spring are thought to be a biotype that prefers warm, wet winter and spring periods (NMSU, 2005). Control by predatory insects very early in the growing season is unlikely because of low predator populations at that time; thus, insecticide treatment is often necessary (Palumbo and Tickes, 2001). Palumbo and Tickes (2001) found that, while several insecticides provide adequate control, pyrethroids and carbofuran had more residual activity on cowpea aphid than did dimethoate. Currently, no alfalfa varieties have known resistance to cowpea aphid (Summers et al., 2004), and standardized testing procedures for this pest are not in place (NAAIC, 2004).

Alfalfa varieties are grouped into fall dormancy (FD) categories based on their autumn height. While fall dormancy is often estimated fairly accurately, values are rounded to the nearest whole number for marketing purposes. Very dormant varieties (those ceasing to grow earliest and, therefore, being shortest) have low numbers, and very nondormant varieties (those not ceasing to grow, thus being the tallest) have high numbers (Teuber et al., 1998). This has been associated with reduced fall yields, winter survival, and drought tolerance for dormant varieties and earlier initiation of spring growth, more rapid regrowth after harvest, and heat tolerance for less dormant varieties (Brummer et al., 2002).

In a study conducted to determine which FD categories would be best suited to the region of the Southern High Plains of the USA proximal to the 35th N latitude (Lauriault et al., 2009), a cowpea aphid infestation during the last year of the trial provided information that might be of value to alfalfa breeders and managers and Cooperative Extension Service personnel.

## MATERIALS AND METHODS

The main study (Lauriault et al., 2009) was conducted from 1998 to 2001 at the New Mexico State University Agricultural Science Center at Tucumcari, NM, USA (35.20°N, 103.68°W; elevation 1247 m). The alfalfa was planted into a Canez fine sandy loam soil (fine-loamy, mixed, thermic Ustollic Hap-

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largid) having a pH of 8.4 within the surface 30 cm. The seed-bed was conventionally tilled and formed into beds on 0.9-m centers for furrow irrigation. Plots, sized 7.0 m × 1.8 m, were sown April 30, 1997, using a disk drill (20-cm drill spacing) fitted with a seed-metering cone. The seeding rate was 22.4 kg ha<sup>-1</sup> of inoculated commercial seed product.

The test area was irrigated through gated pipe to attain field capacity at the initiation of the growth cycle for each of six harvests every year. From 1999 to 2001, before the initiation of growth, 25 and 117 kg ha<sup>-1</sup> N and P, respectively, were uniformly broadcast over the area. Grassy weeds, mostly field sandbur (*Cenchrus incertus* Curtis), were controlled each year using clethodim or sethoxydim at labeled rates. Alfalfa weevil (*Hypera postica* Gyll.) was not a problem in the area during the test years, and stands were still uniform prior to the cowpea aphid infestation. In early 2001, cowpea aphid did infest, and all plots were subsequently treated with 584 mL ha<sup>-1</sup> permethrin (38.4% a.i.) on April 3. Re-infestation did not occur. When symptoms of the infestation were observable as dead stems, each whole plot was rated for the percentage of plants exhibiting damage. No yield data were collected that could be related to insect damage—the aphids had equal access to all plots.

For comparisons related to the cowpea aphid infestation in 2001, main plot treatments were FD categories 2 to 9, and subplots were alfalfa varieties within each fall dormancy category. Novartis Seeds 'Viking I' represented FD 2; Monsanto 'DK127', Garst Seed 'Garst 645', and Novartis Seeds 'Rainier' represented FD 3; NC+ 'Jade II' and Geertson Seed Farms 'Landmark' represented FD 4; America's Alfalfa 'Archer' and Barenbrug USA 'Baralfa54' represented FD 5; Novartis Seeds 'Tahoe' and NMSU 'Wilson' represented FD 6; NMSU 'Doña Ana' and Helena Chemical 'Helena 7000' represented FD 7; America's Alfalfa '13R Supreme' and WL Research 'WL525HQ' represented FD 8; and America's Alfalfa 'Salado' and WL Research 'WL612' represented FD 9 (Alfalfa Council, 1999). There were eight randomized complete blocks. Data were analyzed as a split plot using SAS PROC MIXED to test the effects of FD as the main plot and VAR(FD) as the subplot (SAS Inst., 2007). Rep, Rep × FD, and residual mean squares were considered random and appropriately used by PROC MIXED as denominators for tests of significance (Littell et al., 1996). All differences reported were significant at  $P \leq 0.05$ . Least significant difference values were generated using the LSMEANS statement, with the PDIF option to determine where differences occurred among FD and VAR(FD).

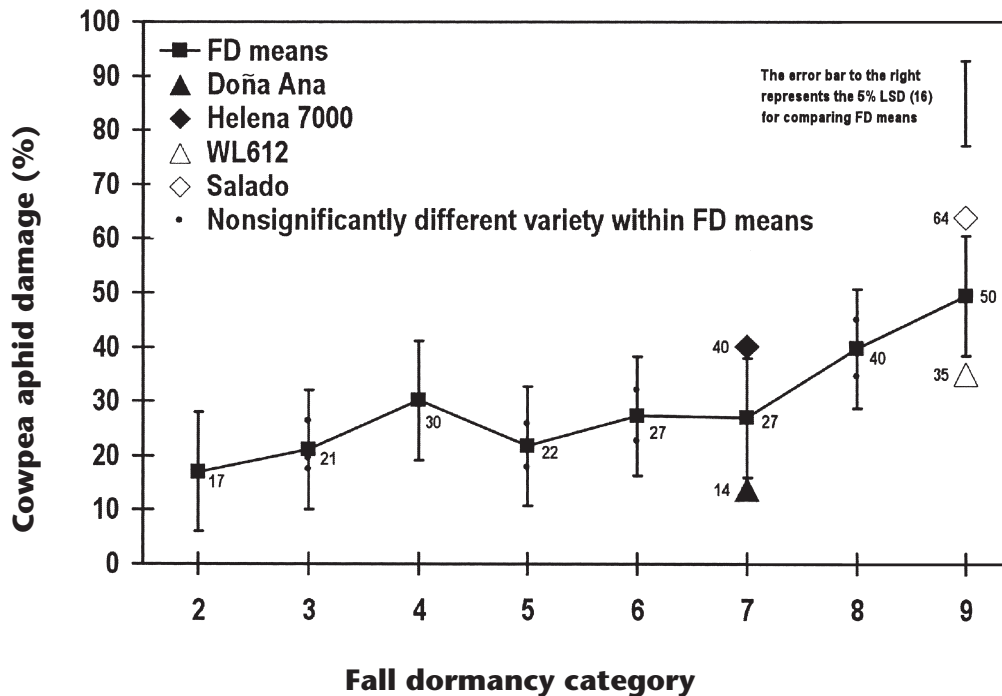
## RESULTS AND DISCUSSION

There was a difference among FD categories in the level of cowpea aphid damage. While some damage by cowpea aphids was observed for all FD categories, no differences existed among FD 2 to 7, and increase in damage was observed from FD 7 to 9 (Figure 1). The difference between FD categories

may have been caused by earlier initiation of spring growth by the most nondormant varieties compared to the other varieties, rather than by a difference in resistance or tolerance (Summers et al., 2004). Conditions associated with cowpea aphid infestations in alfalfa elsewhere did not occur during winter 2000–2001, which at this location was not exceptionally warm and wet (NMSU, 2005; Palumbo and Tickles, 2001; Summers et al., 2004). Still, in 2001, populations rapidly rose within 2 weeks from being undetected in mid-March to damaging levels in early April (NMSU, 2001). While cowpea aphid populations in 2001 in the present study were not determined, they were high enough on the nondormant varieties that, from over 7.5 m away, alfalfa stems were visibly black due to the aphids themselves (as opposed to sooty mold) (Palumbo and Tickles, 2001; Townsend, 2006; personal observation).

Damage to dormant varieties upon breaking dormancy has been observed in the California High Desert (Palumbo and Tickles, 2001). Alfalfa varieties FD 4 through 9 remained green throughout winter, and FD 2 and 3 had greened up prior to the cowpea aphid infestation (personal observation). Once the infestation was observed in the present study, it was effectively controlled using a pyrethroid, minimizing damage to the more dormant varieties. Using more dormant varieties may provide the opportunity for an increase in beneficial predator populations to effectively control the aphid. Noticeable populations of ladybird beetle (Family: Coccinellidae) were observed in early March 2008, feeding on pea aphid in alfalfa at this location (personal observation). Hence, the possibility exists for high predator populations early in the year, but in 2001, they were not sufficient in early April to control the cowpea aphids.

The VAR(FD) effect also was significant for cowpea aphid damage because of differences within FD 7 and within FD 9 (Figure 1). The difference between FD 9 varieties 'Salado' and 'WL612' could be related to the difference in unrounded fall dormancy rating between these two varieties selected to represent FD 9 in this study. Fall height measurements made by Salado's breeder estimated its fall dormancy rating to be 9.5 (Jim Moutray, personal communication), which would round to FD 10. The estimated fall dormancy for WL612 was 8.9 (Mike Peterson, personal communication), which rounds to FD 9. The greater cowpea aphid damage to 'Salado' compared to 'WL612' could have occurred if it had broken dormancy earlier than 'WL612' (Figure 1). The possibility also exists that 'WL612' has a degree of resistance to cowpea aphid, as it was numerically lower than the average for FD 8 (Figure 1). At the time of seeding the present study, both of these varieties were to be listed as FD 9 based on standardized testing (Alfalfa Council, 1999; Teuber et al., 1998). All other varieties with unrounded fall dormancy ratings obtainable from the breeder were 0.2 or less from the category to which they rounded (Alfalfa Council, 1999; personal communications with breeders), and there was much less variability in cowpea aphid damage ratings among these, except for FD 7 (Figure 1).



**Figure 1.** The difference in response to cowpea aphid infestation in spring 2001, by established furrow-irrigated alfalfa of different fall dormancy categories at Tucumcari, NM. Ratings represent the visually estimated percentage of plants with standing unclipped dead stems 21 days after insecticide application to control the infestation; whereas, prior to the cowpea aphid infestation and until shortly after the insecticide application, these unclipped dead stems had not been observed. Data are the LSMEANS of two irrigation treatments (irrigated once prior to each of six cuttings taken May through October or irrigated throughout the year), one to three cultivars within each fall dormancy category, and four reps. Bars (other than the isolated bar) indicate the LSD (22%,  $P < 0.05$ ) for variety within fall dormancy category comparisons.

The VAR(FD) difference in cowpea aphid damage for FD 7, and the fact that ‘Doña Ana’ had the lowest numerical damage of all varieties (even those representing the more dormant FD categories) suggests a degree of resistance in ‘Doña Ana’ (Figure 1). Known resistance levels to other species of aphids (*Acyrtosiphon kondio* [Shinj], *A. pisum* [Harris], and *Theerioaphis maculata* [Buckton]) were all in the moderate to high resistance categories for all varieties (Alfalfa Council, 1999), indicating that resistance to those species does not necessarily confer resistance to cowpea aphid. The difference may be related to toxins injected by cowpea aphids, which are not known to be injected by the other species of aphid (Manglitz and Ratcliffe, 1988; Townsend, 2006). Since 2001, there have been no significant outbreaks of cowpea aphids at this location.

### CONCLUSIONS

Bearing in mind that these findings are limited in scope due to the limited amount of data, alfalfa producers should scout fields frequently for the presence of cowpea aphids and beneficial predators before initiation of spring growth. If cowpea aphids are present but predator populations are low, the field should be treated with a long-residual-labeled insecticide such as a pyrethroid. Scouting should continue on all alfalfa fields on the farm until significant predator populations develop. ‘Doña Ana’ and ‘WL612’ alfalfa may have a degree of resistance to cowpea aphid. Other varieties not included in this study may also have natural resistance. Observations should be taken from established cultivar evaluations whenever a cowpea aphid or other insect infestation occurs as a means of evaluating potential varietal resistance, particularly for new pests.

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