

was apparent on both Cal 7 and DSL by mid-season of 1960. But Cal 7 gave a higher lint yield than A4-42 and the DSL yield was below that of A4-42. The 1961 planting was made on a field where an observational block of DSL was grown in 1960. Following the wilted cotton of 1960, it was easy to detect wilt symptoms in mid-summer throughout the Cal 7 and DSL plots, and minor symptoms were evident even in A4-42 plots. Yields from this location were considerably lower for all varieties in 1961 than in 1960. Nevertheless, the grower allowed the test to remain on the same plots in 1962.

However, the grower did switch the planting scheme from "solid" cotton to "2-in, 2-out." Significant yield differences were obtained among the varieties in 1962. A4-42 was outstanding for its wilt tolerance even though the low summer temperatures in 1962 were ideal for the wilt organism to operate. Heavy wilt damage was evident in the Cal 7 plots and lint yield was 19% lower than A4-42, as shown in the graph. DSL was severely damaged by *Verticillium* wilt. In fact, the wilt attacks occurred so early in the summer that the "2-in, 2-out" planting scheme offered no advantage. With both the direct wilt damage and the indirect loss of growth advantage due to the earliness of the wilt attack, the yield of DSL was 57% lower than that of A4-42.

### Woodville

It was necessary to relocate the test plots at Woodville with a different grower each year since farm units are smaller and the growers cannot afford to absorb the loss from *Verticillium* wilt continuously.

*Verticillium* wilt was evident by mid-season on both Cal 7 and DSL in 1960 and 1961. The land used in 1962 gave less wilt damage. Data for the three years, as shown in the graph, shows higher yields were obtained from A4-42. The growth of both Cal 7 and DSL was visibly reduced on the 1960 and 1961 plots as a result of wilt attacks. The Woodville area plots showed a more drastic yield reduction for Cal 7 than at any of the three other areas.

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# Tarweed

... a nuisance plant on California ranges

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Tarweed seedling (*Holocarpha virgata*) as it appears in early annual range forage.

Tarweed is well adapted for survival as a nuisance plant on California ranges. While expensive control measures may not be justified, effective methods are needed for minimizing the use of soil moisture by tarweed seedlings in the spring. Clipping or heavy grazing and nitrogen fertilization offer possibilities for reduction in density of tarweed seedlings in favor of the more desirable forage species.

**T**ARWEED, *Holocarpha virgata* (A. Gray, Keck), is a nuisance plant that grows on California foothill rangelands and is generally distributed in the Sierra foothills, Central Valley and inner coast ranges. At times it dominates some of the better forage-producing sites. This annual forb germinates in the fall, but has its greatest growth in the late spring and summer. The tarweed stand is persistent but may be dominant one year and of only minor proportions in a following year. Grazing use of tarweed has been observed during winter and early spring. Tarweed growth is most rapid in the late spring when the plants compete with desirable forage species for the diminishing soil moisture. Tarweed becomes most noticeable and particularly objectionable in the summer season when its bushy-stemmed, ill-scented growth

forms dense patches among and above the dry annual forage species—obscuring and limiting use of desirable species as dry feed by livestock.

Some observations of tarweed seed production, germination, and hard seed percentage were made to help show how tarweed persists even though a seed crop might fail to mature. Clipping and fall application of nitrogen were studied as possible means of minimizing tarweed stands during the seedling stage.

Three tarweed-infested rangeland areas located in the Sierra Nevada foothills in Sacramento, Tuolumne, and Madera counties were chosen in the fall of 1956 as study sites. An additional study of nitrogen fertilization was initiated in the fall of 1958 and carried on through 1960 at the Shaubach Ranch, Madera County. Old tarweed plants from the previous growing season were used as a basis to choose specific sites for these studies.

Tarweed seeds were harvested by hand in the fall from mature plants growing on a foothill range area in Madera County. Seeds were germinated for 28 days with temperatures alternating from 5, 15, 20, and 20–30°C.

### Treatments

A series of 10×20 ft. plots were clipped at three-week intervals through the spring months. A different set of plots was clipped at a height of 1½ inches with a scythette mower at each location each time. Tarweed density estimates were made on June 27, 1957. Soil moisture percentage was determined at 5 to 7-inch and 18 to 20-inch depths.

Fertilized plots, .2 acre in size, were established at each county location in 1957. Treatments consisted of 60, 120, and 180 pounds of nitrogen applied as 16-20-0 for comparison with an unfertilized check plot. A strip through each plot was harvested June 27, 1958, with a scythette mower. The percentage of tarweed was obtained by hand separation.

At the Shaubach Ranch the rates of nitrogen applied were 0, 40, 80, 120, and 160 pounds per acre using 16-20-0. Fertilizer treatments were replicated four times using 20×20-ft. plots. The total plot

TABLE 1. MEAN SEED GERMINATION AND HARD SEED PERCENTAGE OF TARWEED

Temperature (C)	Germination*		Hard Seed (%)
	14 days	28 days	
5°	1	1	89
15°	2	2	94
20°	2	3	84
20-30°	0	3	90

\*Germination tests by Seed Laboratory, State of California Department of Agriculture.

area was fenced during winter and spring, but dry feed was removed by grazing during the summer. The plot area was again fenced the second growing season following fertilization. Moisture depletion was recorded for 12-inch and 36-inch soil depths by using gypsum electrical-resistance blocks. Following fertilizer application in the second year, forage yield, tarweed density and tarweed height were recorded from all treatments near forage maturity. Three random square-foot samples were harvested and oven-dried from each plot. The number of tarweed plants per square foot was counted and measured for height. Plant material from one replication was hand-separated by forage class to determine species composition.

**Seed yield**

Tarweed seed yield per plant is high, but the seed germination percentage is low with a large proportion of hard seed remaining. Mature plants range in height from 6 inches to 3 feet, and are estimated

TABLE 2. RESULTS OF CLIPPING ON TARWEED DENSITY ON JUNE\* 27 AT THREE FIELD LOCATIONS

Time of forage removal	Sacramento plants per sq. ft.	Tuolumne plants per sq. ft.	Madera plants per sq. ft.
March 6	18.5	3.5	8.9
March 27	14.8	6.3	17.2
April 15	4.4	4.5	6.9
May 10	0.7	2.5	4.5
June 10	0.0	0.0	8.9
Non-clipped	14.2	4.4	12.6

\*Mean of three replications.

to produce fifty to several hundred yellow-flowered, composite-type heads. Four or five glistening black seeds, 1 mm in diameter, are usually produced in each seed head. Maximum seed germination was 1% to 3% for one-year-old seed, regardless of temperature (table 1). No differences resulted from an additional 14 days in the seed germinator. Hard seed content ranged from 84% to 94% under all temperature conditions.

Results from time of clipping varied from no reduction to almost complete reduction of the current stand of tarweed (table 2). Early clipping generally resulted in an increase in the number of tarweed plants present in June as compared to unclipped plots. In March, tarweed seedlings were small, averaging 11½ inches tall, and the two major forage species, soft chess and broadleaf filaree, averaged 4½ inches in height. Clipping in mid-April reduced tarweed density, and resulted in a 45% to 69% reduction of tarweed plants at two locations but

none at the other. In April all forage plants were growing rapidly and tarweed seedlings were from 4 to 6 inches in height. In contrast, soft chess was 8 to 14 inches tall, and in the early flowering stage. Clipping during the final weeks of the spring growing season substantially reduced the density of tarweed.

Plots clipped on May 10 when tarweed seedling height was from four to sixteen inches had 95% less tarweed than non-clipped plots at Sacramento, 43% less at Sonora, and 64% less at Madera. Tarweed density was reduced to zero at both Sacramento and Tuolumne locations when clipped in early June just after forage maturity. In the Madera plots, tarweed density increased after forage maturity, probably because of a late rain.

**Forage composition**

Species composition of forage one year later, in each location, appeared to be unaffected by the clipping treatments except on plots clipped late in the previous growing season. On these plots, bur clover appeared to replace soft chess in dominance.

The effectiveness of clipping tarweed in the late spring is attributed to the increased height of tarweed and limited availability of soil moisture. In March very few tarweed seedlings were clipped below any lateral growing points. Early clipping appeared to reduce competition from other plants and favor tarweed growth. In early April growing conditions were still favorable for the rapid recovery of winter annuals after clipping, thus providing plant competition and sufficient time for maximum use of remaining spring moisture. In late spring the height of tarweed plants results in clipping below lateral growing points.

Reduction of tarweed may also occur following nitrogen application, but fertilizer carry-over to a succeeding year appears to have little effect on the amount of tarweed. The volume of tarweed growth was reduced as forage production increased with each increment of applied nitrogen at each location (table 3). Tar-

A stand of maturing tarweed in mid-summer as it limits the production and use of dry annual range forage.



TABLE 3. TARWEED PERCENTAGE AND FORAGE YIELD FROM UNFERTILIZED AND FERTILIZED RANGE SITES\*

N fertilization rate	Sacramento		Tuolumne		Madera	
	Forage lbs/A	Tarweed %	Forage lbs/A	Tarweed %	Forage lbs/A	Tarweed %
Check	2,084	9.4	2,141	9.0	934	1.1
N <sub>60</sub>	2,709	5.1	2,253	1.5	1,427	0.4
N <sub>120</sub>	3,650	1.3	1,058	2.5	1,852	0.1
N <sub>180</sub>	3,251	0.7	2,586	4.3	1,747	0.0

\*Yields based on .001-acre strip harvested and oven dried. Tarweed percentage by hand separation from total yield.

weed on unfertilized check areas varied from 1% of the total forage produced at Madera to 9% at Sacramento and Tulumne.

Locations with the highest tarweed percentages were also highest in forage yield on the unfertilized treatments. Application of 60 pounds of nitrogen per acre generally reduced the tarweed at Sacramento and Madera by 50%. Further reductions of 87% were recorded with the application of 120 pounds of nitrogen per acre and 99% with 180 pounds. Results at Sonora were not as consistent as the other two locations; and the greatest reduction in tarweed, 82% of the check, was recorded for the treatment with 60 pounds of nitrogen per acre.

### Soil moisture

Soil moisture measurements on plots in Sacramento County show a pattern of decreasing moisture availability on unfertilized and fertilized range plots during the critical period of April to mid-May. By the middle of May, soil moisture on unfertilized plots decreased from 12% to 8% at the 6-inch depth and from 23% to 15% at the 20-inch depth. In comparison, moisture percentage on fertilized plots decreased from 9% to 5% at the 6-inch depth and at 20 inches remained at approximately 15%. It appears that less soil moisture is available for tarweed use on fertilized plots at its critical period in competition with the more desirable forage species. The greater forage yields indicate that soil moisture is more effectively utilized on the fertilized than on the unfertilized plots.

### Carry-over

At the Shaubach Ranch, the carry-over of fertilizer to the succeeding year slightly increased forage yield, but tarweed density and the proportion of tarweed to other plants remained nearly constant on both unfertilized and fertilized plots. Average forage yield on unfertilized plots was 2,230 pounds per acre, as compared with 2,888 pounds per acre on the fertilized carry-over treatments. Although forage production was 30% greater on carry-over fertilized treatments, tarweed seedling density was nearly equal with 5.3 plants per square foot on unfertilized and 6.0 plants on fertilized plots.

The proportion of tarweed to other plants, on a weight basis, averaged 3% on unfertilized check plots and 2% on fertilized treatments with other forage components differing more than tarweed. Broadleaf filaree averaged 71% and

## VARIETY IMPROVEMENT OF RICE

DURING THE PAST two years, rice variety improvement work at the Rice Experiment Station, Biggs, has been carried out on a larger scale with increased attention given to the development of non-lodging short, medium and long-grain varieties with desired cooking qualities.

Varieties developed here in former years and introductions from several countries were screened; some 24 were tested in large replicated yield trials. Four short-grain varieties yielded better than Caloro and lodged less. One long-grain variety originating from the South produced almost as much as Caloro; had a maturity period of from 110 to 125 days, depending on the method and date of seeding; and good cooking qualities.

In 1961, some 1,000 selections were made from two hybrid-populations received in the F<sub>2</sub> and F<sub>4</sub> generations from Beaumont, Texas. From these, 55 promising lines were retained in 1962 and, under drilled conditions, they did not lodge. Most of these 55 lines have a very good grain-type and a 1,000-grain weight ranging from 28 to 33 grams.

grass 25% on unfertilized treatments. In contrast, filaree averaged 90% and grass 3% on fertilized treatments. If increased yield differences are slight, tarweed seedlings may not be subject to the severe competition for space and moisture which limit growth in the initial year of fertilization.

### Well adapted

Tarweed appears to be well adapted to continue as a nuisance plant on California ranges. Habits of late spring and summer growth, apparent drought tolerance, high capacity for seed production, growth in dense stands, and a very high hard seed percentage help to explain tarweed persistence and pose problems in its control.

Expensive control measures may not be justified. However, effective ways to minimize use of soil moisture by tarweed seedlings in the spring growing period are needed, especially if spring forage is to be managed for use as dry summer feed. Clipping in the late spring or intensified grazing in mid-spring should bring about a reduction of tarweed seedlings and favor the more desirable species. Fertilization with nitrogen may also reduce the density of tarweed by increasing the vigor and moisture use by competing

To create a wider basis of long-grain hybrid-material—and to incorporate the good characteristics of Colusa with stiff straw—45 crosses were made in 1961. These involved 20 varieties from Surinam, most of which have stiff straw, very large grains and also good cooking quality. They were crossed with Calif. 405A and Belle Patna (both early glabrous long-grain types) and with Colusa (short-grain). By growing the F<sub>1</sub> in the greenhouse during the winter of 1961 the F<sub>2</sub> could be sown in the field during the summer of 1962.

Several crosses, including those with Colusa, showed considerable stiff straw in the F<sub>2</sub> plants. As expected, the crosses between the American and Surinam long-grain varieties produced seed of a very good type, and several combinations were as early as Colusa. Thousand-grain weights were estimated up to 38 grams. It is expected that a number of desirable lines can be obtained within three generations.—*Johan J. Mastenbroek, Associate in the Experiment Station, Agronomy Dept., Rice Experiment Station, Biggs.*

species which mature just as tarweed begins its rapid growth in late spring. In the year following fertilization there may or may not be any reduction of tarweed density depending on the amount of fertilizer carry-over.

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