

Dormancy of Grasses

temperature, day-length, available moisture factors on rangelands

Horton M. Laude

On California rangelands, the perennial pine bluegrass—*Poa scabrella*—may enter complete dormancy in late spring when surrounding annual vegetation is still green and vigorous.

Summer dormancy—reduced or halted growth—of pine bluegrass and other perennial grasses limits the production of green forage on California pastures and range lands during the arid summer period.

The factors involved in summer dormancy of perennial grasses in California were investigated in a study of 20 species in field and greenhouse plantings at Davis.

Relatively high summer temperatures with meager rainfall for five to six months place most plants under moisture stress by late spring or early summer.

The field test plantings—made on a deep fine sandy loam in November of four years—were in replicated rows three feet apart and were kept free of weeds.

Water was supplied during the summer to determine whether vegetative growth would continue. Commencing in the spring following planting and before moisture deficiency was apparent, half the plots received thorough weekly waterings which continued until the first effective autumn rain.

Vegetative growth was continued by 13 of the 20 species when supplied with water. They were desert wheatgrass, California bromegrass, prairie bromegrass, Harlan bromegrass, orchardgrass, veldtgrass, blue wild-rye, tall fescue, perennial ryegrass, smilo, hardinggrass, big bluegrass, and Canada bluegrass. However, their growth differed considerably in vigor and in the time when the unwatered plants of the same species ceased growth.

Of the seven species which ceased growth, even though watered, four—California melicgrass, Nevada bluegrass, nodding stipa, and purple stipa—retained green tissue, but three—bulbous bluegrass, pine bluegrass, and Sandberg bluegrass—retained no green tissue. Evidently factors other than or in addition to soil moisture are involved in this dormancy behavior.

A fall planting of four replications of nine species—perennial ryegrass, blue wild-rye, orchardgrass, prairie brom-

grass, California bromegrass, Harlan bromegrass, nodding stipa, purple stipa, and pine bluegrass—was used the following summer to determine the effect on growth resumption of watering after several durations of dormancy. Nodding stipa, purple stipa and pine bluegrass represented the group failing to continue summer growth when supplied with supplemental water in previous tests. By July 20 the nine species had ceased growth, but some green tissue was still visible in all but perennial ryegrass and pine bluegrass.

One replication was thoroughly watered on July 20, the second on August 10, the third on September 7, and the fourth on September 29. In each instance decided growth was obtained seven to 10 days after a watering in all species except the stipas and the pine bluegrass. The stipas made appreciable growth only after the September waterings, while pine bluegrass did not break dormancy until cool weather prevailed coincident with the first fall rain. This suggests that those species in which summer growth may be prolonged by watering will also break dormancy when watered after being dormant a portion of the summer.

Nodding stipa, smilo, and hardinggrass made vigorous vegetative growth at Davis in September before autumn rains and after a period of dormancy or of greatly reduced growth during the summer. Such fall growth prior to precipitation was recorded in a stand of two-year-old spaced plants of hardinggrass in 1949. The plots were mowed at 3" height June 1 about two weeks after the last spring shower. By July 12 there was no new growth and the plant bases were nearly devoid of green tissue. Growth evidenced by green leaf 6" to 8" tall was noted on all plants September 13, although the first fall rain did not come until November 9. The source of moisture for this growth was obtained by roots at considerable depth.

Pine bluegrass exhibited such precision in its summer dormancy behavior that the species was selected for critical study of the factors involved. When dormant in the field, this plant is devoid of visible green tissue. The species when entering dormancy first shows a bronzing of the leaf tips and then loses all green coloration in a period of approximately

two weeks. In breaking dormancy in the field it produces green shoots about four days after suitable conditions prevail.

Observations obtained over a five-year period indicated this species entered complete dormancy—when all green coloration had disappeared—at approximately the same time regardless of the date of the last spring rain. This indicated that high temperatures and long day-lengths might be related to the initiation of dormancy in this plant.

The breaking of dormancy followed the first fall rains by a few days suggesting that moisture coupled with the cooler temperatures then prevailing might be instrumental in this response. Efforts to break summer dormancy of pine bluegrass in the field by watering failed until temperatures moderated toward autumn.

To determine whether dormancy could be broken in midsummer with water, if cooler temperatures prevailed, plants in the field approaching their third summer were potted in late February. The pots were sunk to the rim in soil among undisturbed plants.

Growth of the potted plants was similar to that of the undisturbed until early April. The potted plants, with greatly restricted root systems, entered dormancy four weeks earlier than those undisturbed. On August 4, 10 potted plants were moved to a laboratory where maximum temperatures averaged 76° F, while daily maximum field temperatures averaged 87° F. Plants in both the laboratory and field were watered to maintain available soil moisture. On the fourth day after the initial watering, plants in the laboratory commenced to break dormancy, and by the sixth day all were growing. There was no growth resumption in the field.

Cooler temperatures in the field without rain or applied water were ineffective in breaking the dormancy.

In view of the behavior of pine bluegrass in the field, studies to determine the factors involved in the induction of dormancy were conducted during the winter in a greenhouse where particular attention could be given to the effects of day-length and of temperature. A controlled environment chamber was used to provide exposures to high temperature. Responses due to deficient soil moisture were eliminated by daily watering of the plants.

It was found that plants grown under short-day—photoperiod—at greenhouse temperature—80° F day and 65° F night—continued vegetative growth, as did those plants under short-day subjected to the high temperature stresses in the controlled environment chamber. These stresses consisted of three 4-hour exposures on alternate days to air at 130° F and 50% relative humidity. With long-

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AVOCADO

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heim, Dickinson, Itzamna, Nabal, Hass, Challenge, and Taft—and 45 on six Mexican varieties—Ganter, Topa Topa, Duke, Northrop, Mexicola, and Blake. Two trees are on Waldin, a West Indian variety from Florida. As in the first plot, all Guatemalan seeds were of mixed origin, but seeds of the Mexican, except Ganter, came from single trees. The trees were propagated in the Subtropical Horticulture Nursery at the University of California, Los Angeles. This nursery also furnished trees for three additional plots.

In June, 1950, one year after planting, 78%—43 trees—of the trees on Guatemalan stocks showed chlorosis in varying degrees. Only one tree on Mexican stock was affected, but it soon recovered. The two trees on West Indian stock remained normal. As of September, 1951, a little over a year after the disease appeared, 56%—24 trees—of the chlorotic trees were recovered or nearly so and 44%—19 trees—were either dead or worthless. The loss on the basis of the 55 trees on Guatemalan planted was 35%, as compared to a 40% loss in the other plot. As in the other plot, chlorotic trees are scattered throughout the area and in some cases affected and normal trees on the same rootstock variety are side by side.

Five commercial trees—presumably on Mexican stock—which were planted in place of severely chlorotic ones, so far have shown no symptoms of the disease. Also, of several hundred commercial Fuerte trees on Mexican stock—planted by the grower in 1948 and 1949 in the same orchard in which the experimental plot is located—only three show chlorosis. Neither the old nor the young orange trees are chlorotic.

Three additional plots were planted in 1949 with trees from the same nursery which furnished the Fuerte trees for the plot in Orange County. Two of them are located in Ventura County and one in Los Angeles County. Only three trees—all in one plot in Ventura County—of about 200 on Guatemalan stocks planted have shown chlorosis. None of a similar number on Mexican stock and three on West Indian are affected.

In the same orchard in which the three chlorotic Fuerte trees are located, 96 Hass and 54 Anaheim on Guatemalan as well as a similar number on Mexican and 11 on West Indian stocks were planted in 1950. A year later 5% of the Hass and 10% of the Anaheim on Guatemalan stocks showed chlorosis. However, practically all seem to be recovering. None of the trees on Mexican or West Indian are affected. Paradoxically, in the same orchard eight of about 40 Mexican seedlings planted by the grower showed the disorder a few months, then recovered.

The observations obtained during these studies, to the effect that Guatemalan stocks are far more susceptible to whatever soil condition causes chlorosis, are limited in scope. Perhaps, as the root systems expand, trees now considered recovered may again become chlorotic or hitherto normal trees on both types of stocks may show the disease.

Whether the occurrence of chlorotic and normal trees in some cases only about 20' apart and on the same rootstock variety, is due to soil variation or genetic differences in the rootstock seedlings is an open question. All that can be said at present is that none of the 10 Guatemalan rootstock varieties used in the two severely affected rootstock plots is immune. The number of trees on these stocks varied from three to 18. This, and the fact that in one plot 14 trees on a certain variety showed 43% chlorosis and in the other, eight trees on the same variety showed 100%, stress the necessity for more extensive information for valid comparison.

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The late F. A. White was Farm Advisor, Santa Barbara County, University of California, at the time the study reported here was made.

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DORMANCY

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day and greenhouse temperatures plants continued active growth, but those grown under long-day and subjected to the high temperature stresses ceased growth and within one week after the last high temperature exposure lost all or virtually all visible green tissue. These plants were dormant as they could be induced to resume growth under favorable conditions two to three months later.

When pine bluegrass was permitted to grow in a warm greenhouse under natural day-length and without the high temperature exposures, the plant was dormant by early June even though watered daily. This is similar to the field behavior. Two weeks after such dormancy had set in, watering was stopped on a series of these plants. The pots then remained dry on greenhouse benches for 5, 7, 11, 17, and 20 months. At the end of each interval, six pots were removed to a section of greenhouse having daily maximum temperatures not exceeding 75° F, and daily watering was resumed. All plants of the groups dormant 5, 7, 11, and 17 months resumed growth by the fifth day after the resumption of watering. The majority of these plants developed vigorous new shoots $\frac{3}{8}$ " to $\frac{3}{4}$ " long on the fourth day.

In the group dormant 20 months, only two plants—out of 18—failed to grow.

New shoot growth was rapid. The average length of eight shoots of the group dormant 20 months measured $\frac{1}{2}$ " on the fourth day, $1\frac{1}{8}$ " on the fifth, $1\frac{5}{8}$ " on the sixth, and $2\frac{1}{8}$ " on the seventh day after watering was resumed. Seven days after the first watering, vigorous plants averaged 27 green shoots per plant.

The greenhouse studies demonstrate that the initiation of summer dormancy in pine bluegrass is associated with long day-length and high temperatures.

Growth resumption, after extended periods of dormancy, was obtained when the plants were subjected to relative coolness and were watered. These conditions parallel those which normally prevail in the field when the plant enters and breaks dormancy.

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KARA

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in bearing habit than most mandarins and mandarin hybrids. In off years it usually produces at least light and often medium crops. The combination of heavy yield and large size on the Riverside trees in 1952 is resulting in light crops for 1953 on most trees.

In the Riverside planting the Kara has made vigorous trees on sweet orange, sour orange, grapefruit, and Cleopatra mandarin rootstocks. On trifoliate and Rough lemon rootstocks the trees are smaller and on Cunningham citrange tree condition is poor. Fruit quality in 1952 was best on the sweet orange, grapefruit, and trifoliate stocks.

Some young plantings of Karas have been established recently in the Riverside area. One orchard of about 280 trees and another of some 170 trees are just coming into bearing. A group of Karas topworked on grapefruit in 1946 seem vigorous, and averaged moderate crops in 1952, with rather light crops set for 1953.

Near Fullerton, in Orange County, a Kara topworked on a large grapefruit tree gave fruit of good size and color in 1952. In the Piru area of Ventura County a block of 86 three-year-old Karas is just beginning to bear.

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