Hardseeded Spanish subclover finds a place in southern California

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The impressive showing of Spanish subclovers may lead to wider use here for range and pasture in areas with low and variable rainfall.

Seeding of annual legumes can be more cost-effective than fertilization as a means of adding nitrogen to rangelands. Biological fixation of nitrogen by annual legumes is of increasing interest in California as well as in Australia, North Africa, the Middle East, Baja California, and the southeastern United States.

Subclover (*Trifolium subterraneum*), rose clover (*T. hirtum*), and the annual medics (*Medicago* sp.) are important range improvement legumes that have been introduced, screened, tested, and placed in regular use over the last four decades. Subclover is most successful in the higher, more dependable rainfall zones of northern California, but less successful in southern California, where amounts and within-season distribution of annual rainfall are less dependable (fig. 1). Rose clover and the annual medics are more persistent on drier range sites, partly because of their hardseededness, which is an important adaptation and survival mechanism in highly variable climatic conditions. Currently available subterranean clover varieties lack this desirable trait. Subclover germination is usually complete after the first fall rains, and if subsequent rains do not keep the plants alive, the clover stand may be lost. In contrast, rose clover commonly has about two-thirds hard seed and can regenerate following extended dry periods.

In the late 1970s, contact with Spanish researchers led to the importation of hardseeded subclover strains, which were increased and tested in field trials beginning in 1980. This report describes the field persistence of these Spanish subclovers in San Diego and San Luis Obispo counties.

UC researcher discusses with cooperators the performance of Spanish strains of hardseeded subclover. After six years of grazing at a San Diego County site, Spanish subclover showed significantly greater persistence than the best of the commercial cultivars now grown in the area. The hardseeded characteristic permits the subclover to regenerate after long dry periods.

Variety trials

The San Diego trial location is 6 miles north of the town of Lakeside in an inland foothill zone at a 1,560-foot elevation with a 15-inch average annual rainfall. The soil is a Greenfield sandy loam.

The San Luis Obispo County test site is 4 miles south of San Luis Obispo at a 200-foot elevation in a 22-inch average rainfall zone. The soil is Diablo clay.

Five Spanish subclover strains and three standard Australian commercial varieties (Daliak, Geraldton, and Nungarin) were seeded at both locations. The soil was lightly harrowed and fertilized with single superphosphate at 500 pounds per acre; 100 seeds of each entry were planted 1/4 inch deep in 4-foot row plots in a randomized block design. The block rows, spaced 4 feet apart, were replicated four times. All the subclover was freshly pellet-inoculated with a rose/sub inoculant at the rate of 5 pounds of inoculant per 100 pounds of seed (Pelinoc inoculating system). The San Luis Obispo seeding was December 11, 1980, and the San Diego County seeding January 30, 1981.

The plots received medium to heavy grazing by cattle during the six-year evaluation period. Plants were counted the first season to verify establishment.

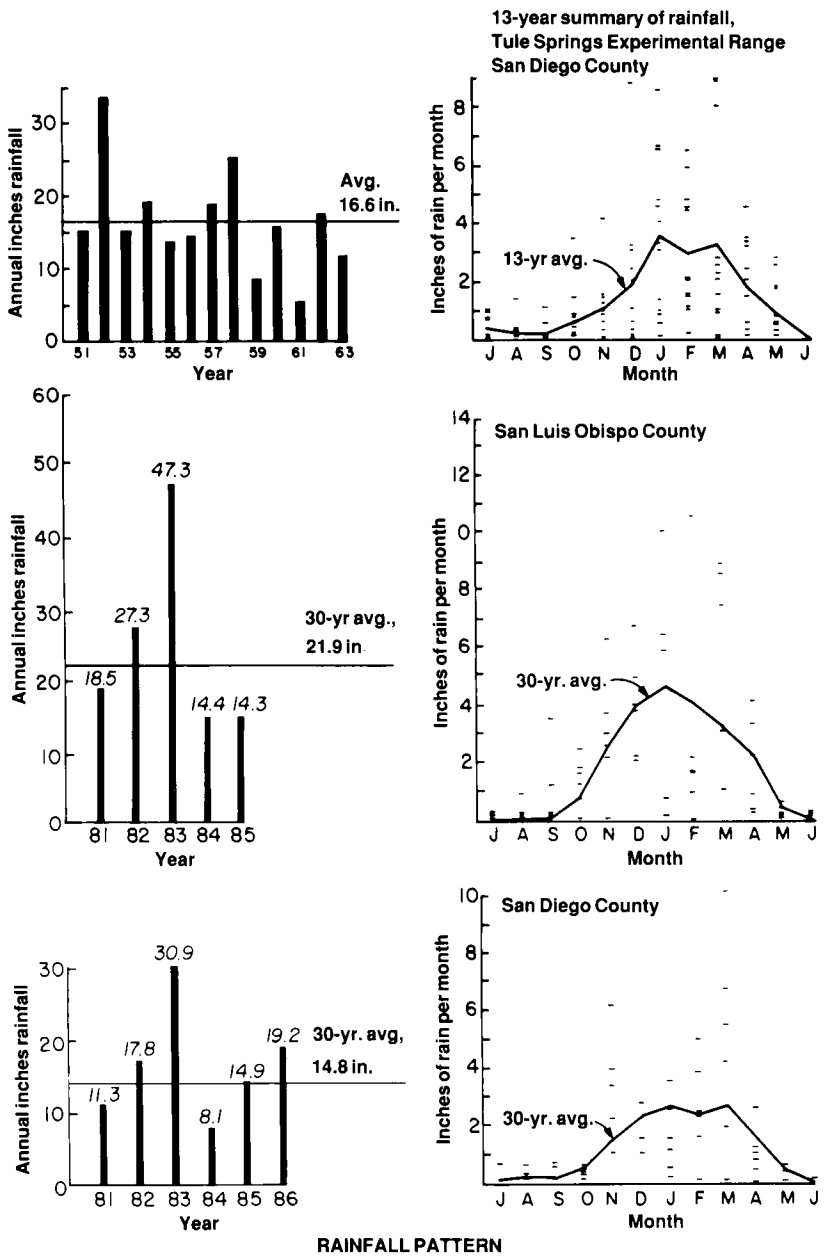

Fig. 1. Low amounts and variable seasonal distribution of rainfall during the study at the two sites (lower four graphs) were typical of the area over the long term (upper graphs).

Visual row-cover evaluations were made near the end of each spring growing season. The last stand persistence evaluation was made on April 10, 1985, at the San Luis Obispo site and on April 16, 1986, at the San Diego County site. Flowering dates were recorded in San Diego County during the 1985-86 season.

Results and discussion

Total seasonal rainfall was low in the establishment year (27 and 10 percent below normal in San Diego and San Luis Obispo, respectively). Rainfall was well distributed over the season, however, and first-year stand counts indicated establishment was adequate at both sites to permit all entries equal opportunities to grow and produce seed. This set the stage for observations of their long-term performance and adaptability.

Rainfall during the study was typical of each site, and sufficiently variable to test the subclover strains (fig. 1). Two of the six years of the San Diego study were considerably drier than normal, and 1983 was one of the three driest years in the 135-year recording period. San Luis Obispo rainfall was below normal in three of the five years and was also highly variable.

Persistence of the Spanish strains was better than that of the commercial Australian cultivars at the end of the six years in San Diego and five years in San Luis Obispo. At San Diego, four of the five Spanish strains were significantly better than Geraldton, the best of the Australian cultivars (table 1). Nungarin, the earliest maturing and most hardseeded commercial cultivar, was seventh in the ranking. Daliak, which disappeared from two of the four plots, was outperformed by all of the Spanish strains.

TABLE 1. Stand persistence and flowering date of eight subclover strains or varieties

Strain/ variety	Stand persistence* S.L.O. 4/10/85	Stand persistence* San Diego 4/16/86	Flowering (weeks after Nungarin)†
Spanish:			
312-A	8.5	10.0	+6
92	7.0	6.5	+3
59	8.5	6.5	+3
1142	8.2	6.5	+3
704	3.0	4.5	+2
Australian:			
Geraldton	6.5	4.2	+3
Nungarin	1.8	3.0	0
Daliak	4.5	1.8	+3
LSD (0.05)	2.0	1.7	

* Fifth year of stand in S.L.O. (San Luis Obispo County) and sixth year in San Diego County. Ratings on a scale 0 to 10; 0 = no plants, 10 = complete coverage of the plot.
† Earliness of maturity at San Diego County site. Nungarin is considered the earliest of trial entries.

At the San Luis Obispo site, some of the selections persisted and spread into adjacent areas, and others disappeared. Two of the Spanish strains were more persistent than Geraldton, which was again the best Australian commercial variety, and four Spanish strains were better than Daliak.

The Spanish strain 312-A was clearly the best at San Diego and as good as any at San Luis Obispo. Strains 59, 92, and 1142 also were good at both sites, and seed of these as well as 312-A is being increased for further testing.

Flowering date is generally considered a limiting criterion for dry areas; earlier maturing varieties are chosen for drier sites. Later maturing varieties do not produce seed in dry years and would therefore not persist in the long run. It is therefore of concern that 312-A, the latest maturing strain, is the most persistent to date. Perhaps the higher hard seed content will ensure persistence through years when no seed is produced. Only a more extended trial period will provide the answer. Later maturity generally means higher forage and seed yield in years of adequate late-season moisture. Although 312-A was the latest maturing in this trial, it would rank mid-season in the range of varieties now used in California, and would have an appropriate maturity date for most of the range areas where subclover is now planted.

Tests are in progress with Texas A&M University cooperators to evaluate these Spanish introductions for estrogenic content, which in Australia has caused reproductive problems in sheep grazing some

strains of subclover. Additional field testing is continuing to confirm or reject the encouraging results of this study.

Conclusions

The evaluations of Spanish subclover and early-maturing Australian cultivars in both San Luis Obispo and San Diego counties in southern California indicate that subclover can be grown in this difficult region. The impressive showing of four of the five Spanish introductions over the best Australian performer, Geraldton, has encouraged us to look to the possible increase and release of the best-adapted germplasm. The poor showing by both the Daliak and Nungarin cultivars, which have largely replaced Geraldton commercially, should help to emphasize the need for more extensive testing of Australian introductions to determine their adaptation to the more variable California conditions.

Numerous Australian subclover cultivars have been introduced over the last several decades, but most have had low hard seed content and limited success outside the higher rainfall zones of northern California. The finding and testing of hardseeded subclover strains is believed to be the first step in extending this highly versatile range and pasture plant to parts of California with less favorable amounts and seasonal distribution of annual rainfall.

The encouraging results of these Spanish hardseeded strains justify the continued evaluation of subclover germplasm for hardseededness. The goal is to improve pasture and range animal productivity without using large inputs of high-energy nonrenewable fossil fuels.

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J. Kegg

Although the gypsy moth is primarily a pest of forest and shade trees, lab tests suggest the larvae will readily feed on foliage of numerous California fruit and nut trees.

The potential of gypsy moth as a pest of fruit and nut crops

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The gypsy moth is a well-known pest of deciduous forests and landscape trees in northeastern United States. Most of the studies and available information on the feeding habits of larvae are therefore based on the flora of that region. However, as the gypsy moth, *Lymantria dispar* (L.), is introduced into new areas such as California, different plants become available as potential hosts (*California Agriculture*, March 1977, July 1982, and March-April 1984).

The repeated recovery of gypsy moth males from pheromone-baited traps in many locations between Canada and southern California has created concern that larvae may be feeding not only on forest and urban landscape trees but also on some crops.

Laboratory studies on gypsy moth larvae and host plant suitability of western species have been under way in Oregon since 1983. One objective is to observe the feeding behavior, development, and survival of larvae on the foliage of select fruit and nut crops grown in California. Such information could help determine where best to place pheromone-baited traps and suggest which crops could be at risk to some degree of damage to the foliage. It could also indicate those crops in which management programs may need to include contingency plans for gypsy moth, should it become established.

One requirement for this study was that it be conducted in an out-of-state laboratory where other gypsy moth studies were in progress. Since the laboratory of the senior author satisfied this need, the study was conducted at Oregon State University.

The development of gypsy moth larvae was tested on the foliage of 24 varieties or species of fruit and nut crops obtained from commercial nurseries in California. The trees were kept in their original potted condition and grown in a greenhouse to maintain foliage similar to that which would be available to gypsy moth larvae during the spring. Cool temperatures (55° to 64°F) were maintained to minimize the occurrence of "greenhouse" foliage. The plants could not be grown outside because of unsuitable weather conditions for many of the species and because the ongoing gypsy moth eradication effort in Oregon could interfere with obtaining leaves free of insecticide.

Larvae were not placed on leaves while on the plant because of research protocol deemed appropriate in studying an organism that was under quarantine regulations. Instead, a sprig of foliage from a test plant was cut and its stem or