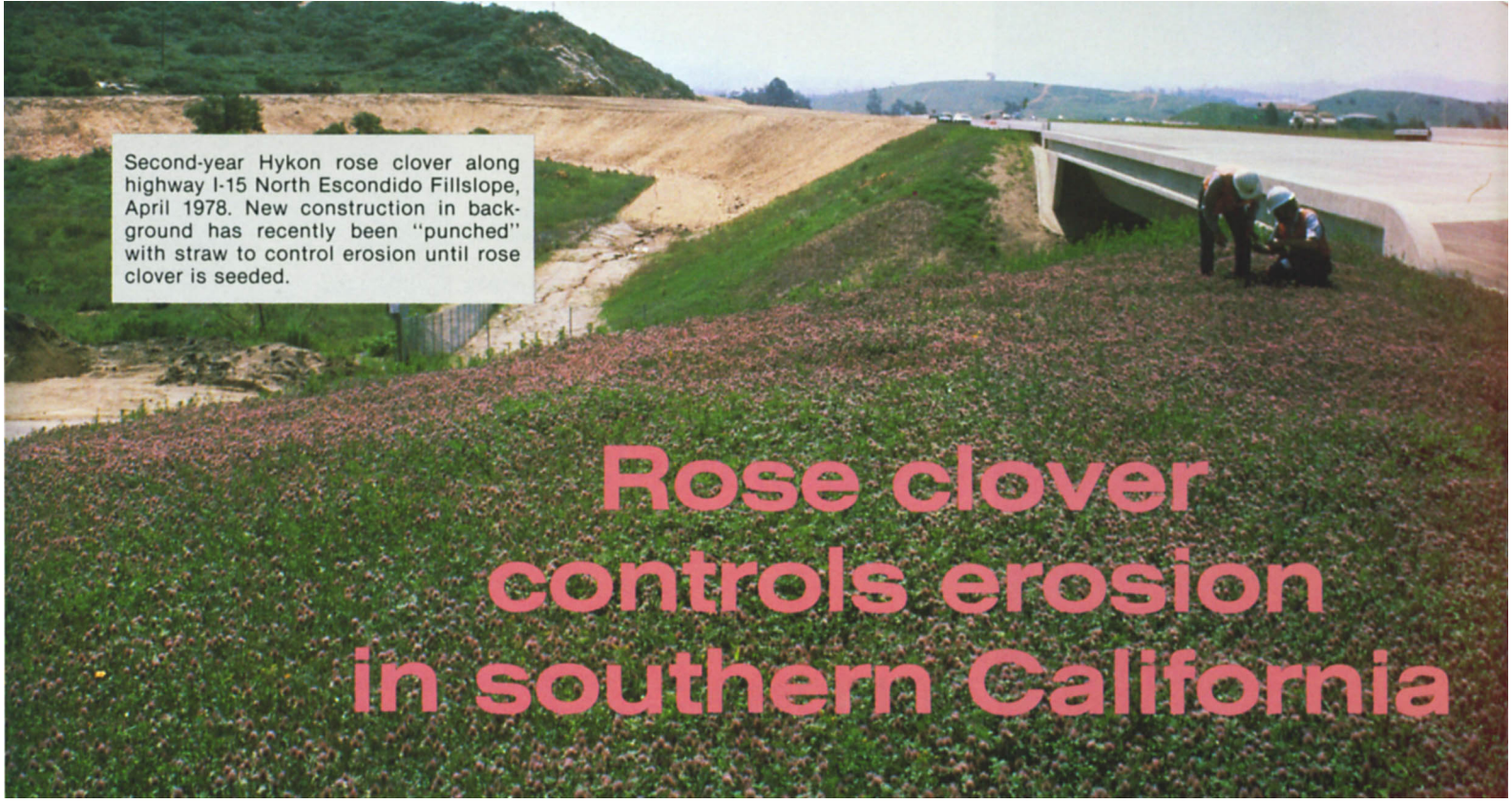

Second-year Hykon rose clover along highway I-15 North Escondido Fillslope, April 1978. New construction in background has recently been "punched" with straw to control erosion until rose clover is seeded.

Rose clover controls erosion in southern California

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Early-maturing varieties of rose clover (*Trifolium hirtum* All.) could be useful in revegetating southern California roadside embankments and other critical areas to control erosion and improve soil. This annual legume, said to grow in soils where few other plants survive, seems adaptable to areas of San Diego County with low and highly variable rainfall, frequent dry winters, and poor soils. In its original habitat, the Mediterranean region of North Africa, Asia Minor, and southern Europe, it grows in dry, sterile fields, on slopes and sandy steppes, and along roadsides.

Rose clover has been around the California scene since it was introduced by Dr. R. M. Love in 1944. Hundreds of range trials have been conducted throughout the state to evaluate its adaptation, persistence, and ability to improve range forage production.

San Diego County rose clover range trials in the 1950s were encouraging, and in 1962 a range field planting of a late-maturing variety, Wilton, was established successfully at a site having 750 millimeters (mm) (30 inches) of average annual rainfall. This variety's late maturity was a disadvantage because of the variable rainfall and the usual lack of spring rain after March to early April. Still, rose clover seemed a prime candidate for San Diego County, because its large amount of hard seed would allow it to lie dormant during the low-rainfall years.

In 1974, equipped with a number of early- to late-maturing rose clover cultivars (all except Wilton developed by Australian researchers), plus improved strains of inoculating bacteria and inoculation techniques, we initiated a roadside-revegetion trial under unirrigated conditions. Our objectives were to evaluate the varieties for their ability to establish and persist and to compare them with grasses for soil building in critical areas. Grasses often give highly variable first-year establishment results and compete excessively with wildflowers and other native plants included in seed mixtures. During 1974 to 1978, rose clover varieties were seeded on 18 roadside sites and embankments.

Variety trial

An inland coastal climate embankment of interstate highway I-15, under construction north of Escondido, was chosen in the fall of 1977. Plots of 3 x 9 meters were planted on B and C horizon disturbed soil from a Cieneba rocky coarse sandy-loam series (typic xerorthents). Slopes varied from 10 to 20 percent, and elevation was 270 meters. Varieties Olympus, Sirint, Troodos, Hykon, Kondinin, and Wilton were hand-broadcast at 44 kilograms per hectare (kg/ha) and replicated twice in a randomized block on November 14, 1977.

All seed was coated with a commercial bacteria inoculum, Pelinoc. Plots were broadcast-fertilized with triple superphosphate at 110 kg/ha and mulched, after seeding, with barley straw at 2,200 kg/ha. The mulch was anchored with wood fiber at 880 kg/ha. Rains, beginning on December 16, greatly exceeded the 350-mm average for the site, approximating 625 mm for the season (July 1, 1977 to June 30, 1978), and ended in early April 1978. Plots were sampled June 1978 for dry-matter yield (table 1).

Hykon, an early-maturing cultivar, significantly outyielded all other varieties and also produced more winter growth. Hykon's winter growth could be a factor in its high productivity, allowing it to take full advantage of the short period of ideal growing temperature with available moisture during March and April.

Kondinin, the second-highest yielder, was similar to Hykon in adaptability to San Diego County but yielded less total dry matter. Both Troodos and Sirint, cultivars similar to Hykon or slightly earlier maturing, were considerably less productive.

Some mildew on Wilton influenced total production. This variety seems less adapted for use because of its later maturity. Olympus, the earliest-maturing variety, was the poorest yielding, apparently because it is unable to take advantage of the entire growing season.

Comparison with grasses

Because annual grasses have extensive, rapidly developing root systems, we normally consider them better than legumes for erosion control. That is true if the grass variety is initially fertilized and is well adapted to the conditions under which it is being used.

Annual ryegrass (*Lolium multiflorum*) has long been used elsewhere for erosion

control because of its fast growth and high foliage production. Nevertheless, all annual grasses tested, including ryegrass, have given erratic results for erosion-control seeding in San Diego County.

Annual ryegrass and rose clover were compared at the south I-15 off-ramp entrance to Escondido. The embankment is a disturbed mixed granodiorite subsoil of the Fallbrook rocky sandy-loam series (typic haploxeralfs). The slope is about 30 percent, elevation 150 meters, and climate inland coastal. Plots of 2.25 x 12 meters were broadcast with Pelinoc inoculum-coated, Hykon rose clover seeds at 22 kg/ha on November 17, 1976, fertilized with 14-14-7 fertilizer at 300 kg/ha, and mulched with barley straw at 2,200 kg/ha. Adjacent slopes were seeded to annual ryegrass at 55 kg/ha, fertilized with 16-6-8 fertilizer at 550 kg/ha, and mulched with barley straw at 2,200 kg/ha.

U.C. soils specialist Roland Meyer, left, and author Walter Graves examine rose clover for nitrogen-producing nodules. The plant grows where other species can't survive.

Rains began in December 1976 and continued through April 1977. Total rainfall for the first and third growing seasons was 300 mm (1976/77) and 625 mm (1978/79). The twice-replicated Hykon plots and the annual ryegrass seedings were sampled in late May 1977 and June 1979 (table 2).

Visual estimates in the first growing season found both annual ryegrass and Hykon to be slow in covering the soil during the cool early part of the growing season (December-February). No real difference between them showed up until March, when moisture stress began to occur. During March and April, Hykon made maximum growth and attained more than 90 percent plant cover by the flowering period, in early April. Annual ryegrass (having a longer maturation season than Hykon) tapered off in early April as soil moisture was depleted, attaining only 40 percent cover by the end of the first growing season. Rainfall apparently was not adequate for annual ryegrass to mature, and no seed was produced. Thus, by the third year the clover plots had abundant seed and nitrogen, whereas the ryegrass plot had neither.

Dry-matter yields of Hykon and ryegrass were similar in the first growing season, but by the third season the Hykon yield was almost six times that of the ryegrass. By then the ryegrass samples were a mixture of volunteer red brome (*Bromus rubens*) and forbs, as well as barley from the straw, and some ryegrass, whereas the Hykon sample was predominantly Hykon. Thus the ryegrass planting was deteriorating while the Hykon stand was improving.

First-year evaluations of Blando brome (*Bromus mollis*), another annual grass, were also made during the 1977/78 season at the north Escondido rose clover variety trial site. This grass is often recommended as a replacement for annual ryegrass, because it is more likely to reseed and persist on poor soil sites. Blando brome was seeded at 44 kg/ha, and 14-14-7 fertilizer applied at 300 kg/ha. In that season of above average rainfall, Hykon rose clover outyielded Blando brome (5,200 kg/ha compared with 4,710 kg/ha).

Grasses on San Diego County roadsides need to be fertilized with nitrogen to maintain an adequate ground cover. Rose clover supplies nitrogen to the soil and thus maintains good ground cover without fertilization. The 5,200-kg/ha yield of Hykon had 13.8 percent protein. Assuming 90 percent of the nitrogen produced to be in the tops, 127 kg/ha nitrogen was left on the site to be cycled back to subsequent plant growth.

These results should encourage engineers and landscape architects to place early-maturing rose clovers in specifications for erosion control on many of the construction sites at lower elevations (below 900 meters). Over 100 hectares have been seeded successfully in the past 3 years, and plans are to expand these seedings to more than 400 hectares with the completion of highway I-15 in San Diego County.

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TABLE 1. Production of Rose Clover Varieties Planted at North Escondido I-15 Embankment Site*

Variety	Dry-matter yield† (kg/ha)
Hykon	5,200 a
Kondinin	2,940 bc
Troodos	2,860 bc
Sirint	1,980 cd
Wilton	1,840 d
Olympus	1,600 d

*Each plot sampled by four squares (30 x 30 cm) in June 1978.
†Means followed by the same letter are not significantly different at the 5 percent level by Duncan's multiple range test.

TABLE 2. First and Third Year Hykon Rose Clover and Annual Ryegrass Production on South Escondido I-15 Off-ramp.

Variety	Dry matter yield*	
	1st year	3rd year
Hykon rose clover	2,000	6,020
Annual ryegrass	1,420	1,060

*Average of two 30-cm-square samples from each plot in first year (late May 1977) and two 1-meter-square samples from each plot in third year (June 1979).