Tolerance of Subclover, Rose clover, Hardinggrass, and Orchardgrass to 2,4-D

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Highlight

Species commonly used to seed California rangelands were sprayed with varying rates of the alkanolamine salt of 2,4-D at a number of vegetative growth stages in two different years. Subclover, hardinggrass, and orchardgrass were not permanently damaged by rates up to 2.0 lb/acre at any of the growth stages tested. Rose clover was tolerant of up to 0.5 lb/acre if sprayed at the proper growth stage but yields were frequently reduced by even low rates at other growth stages.

Much of the range improvement in the grasslands of cismontane California below 3,000 ft elevation involves the seeding of subclover (*Trifolium subterraneum* L.), rose clover (*T. hirtum* All.), and hardinggrass (*Phalaris tuberosa* L. var. *stenoptera* (Hack.) Hitchc.). These plants are sown alone or in mixtures to replace the well established, but less productive, annual vegetation. The resident annuals produce an abundance of seed and invariably result in an extremely weedy seedbed in spite of the best preparation. Although many of these annual weeds are grasses, the weeds in a new seeding on a seedbed prepared by cultivation are often predominantly broadleaves. Common among these are mustard (*Brassica* spp.), radish (*Raphanus* spp.), yellow star thistle (*Centaurea solstitialis* L.), filaree (*Erodium* spp.), and fiddleneck (*Amsinckia* spp.). There is a need for a selective herbicide to control these weeds.

The reaction of rose clover to 2,4-D (2,4-dichlorophenoxyacetic acid) was demonstrated by Williams and Leonard (1959). Both the propylene glycol butyl ether ester of 2,4-D and the alkanolamine salt of 2,4-D, applied at the rosette, early bud, and early bloom stages, caused significant reduc-

Table 1. Stage of growth at times of 2,4-D application.[1]

Experiment	Spraying date	Rose Clover	Subclover	Hardinggrass	Orchardgrass
First	1/29/65	1 trifoliate leaf	1 trifoliate leaf		
	2/26/65	5 to 6 leaves, 2–3 inch rosette	6 to 8 leaves, 1.5 inch rosette		
	3/9/65	10 to 20 leaves, 3 inch rosette	6 to 12 leaves, 3 inch rosette		
	4/1/65	vegetative—10 inch rosette	vegetative—10 inch rosette		
Second	12/8/65	unifoliate leaf	unifoliate leaf	2nd leaf just starting	1.5 leaves
	1/10/66	1.5 trifoliate leaves	1 to 2 trifoliate leaves, 1 inch rosette	1 inch, 3 leaves	1 inch, 3 leaves
	2/11/66	5 leaves, 2.5 inch rosette	5 leaves, 2.5 inch rosette	2 to 3 inches, 5 leaves, tillering	2 inches, 1 to 3 tillers
	3/2/66	3 to 4 inch rosette	3 to 4 inch rosette	4 to 6 inches, tillered	2 inches, tillered

[1] Linear measurements refer to diameter of rosettes in clovers and leaf lengths in grasses.

tions in forage and seed production of rose clover. Ormrod et al. (1960a, 1960b) found subclover was more tolerant to 2,4-D ester than were rose and crimson clovers (*T. incarnatum* L.). Treatment in the early flowering or bud stage produced significant reductions in both forage and seed yield of all three clovers.

The application of paraquat (1,1′-dimethyl-4,4′-bypyridinium) removed grassy weeds from rose and subclover (Kay, 1964), but cannot be used when hardinggrass occurs in the mixture. Fiddleneck can be killed with bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) without damage to the clovers or seeded grasses (Kay, 1967).

Two formulations and a number of rates of 2,4-DB (4-(2,4-dichlorophenoxy) butyric acid) were tested under cultivated conditions (Kay, 1963), on rose clover, subclover, and crimson clover at four to six growth stages varying from one trifoliate leaf to early ripe. Herbage yields, seed yields, and seed quality were for the most part unaffected by either formulation at the spraying dates which normally would be used for weed control. However, trials under range conditions showed 2,4-DB to be an ineffective weed killer. While some species were controlled, others seemed to be totally unaffected. These results have prompted another look at 2,4-D amine because of its broader weed-control spectrum. Hardinggrass was also included in one trial because of past reports (unpublished) that 2,4-D cannot be safely used with hardinggrass in the seedling stage. Palestine orchardgrass (*Dactylis glomerata* L.) was also included in one trial because of its popularity in range seeding.

Methods and Materials

Two separate trials were conducted on successive years (1964–65 and 1965–66). Both studies were on the Agronomy Farm at Davis (50 ft elevation). Rose clover and subclover were seeded in separate rows 36 inches apart before the first fall rain. The alkanolamine salt of 2,4-D (2,4-D amine—Dow Formula 40) was applied at four growth stages in each experiment (Table 1) at rates from ⅛ to 2.0 lb/acre. No surfactant was added; however, there may have been some present in the 2,4-D formulation. Spray treatments were applied to one row of each species at the same time, using a logarithmic sprayer (Yates and Ashton, 1960) with a half distance of 28 ft, spraying 43 gpa in the first experiment and 49 gpa in the second. Rows of hardinggrass and Palestine orchardgrass were also included in the second trial. Each treatment was replicated four times in a split plot design. Weeds were controlled by tillage and hand hoeing when soil moisture conditions permitted.

Clover yields were measured by clipping to ground level 8 ft of row centered over the half distance for the treatments listed. Samples were air dried before weighing. Seedling heights of hardinggrass and orchardgrass were measured on March 10, and on May 11 plants were rated on a 1 to 10 scale for damage from spraying. Clover seed yields were measured from selected treatments in the first experiment only.

Results and Discussion

Rainfall during the two experiments was very different. The 1964–65 growing season was very close to "normal" for the area. Total annual rainfall was 18.56 inches (slightly above normal) and well distributed throughout the growing season. Forage yields were typical for the area. By contrast the 1965–66 season received only 11.41 inches with a very dry spring. The last effective rainfall occurred on February 23, 1966. Forage yields were about 25% of the previous year (Fig. 1 and 2).

Both rose clover and subclover reacted to spraying with varying degrees of epinasty and strapped and cupped leaves. However, in many cases the

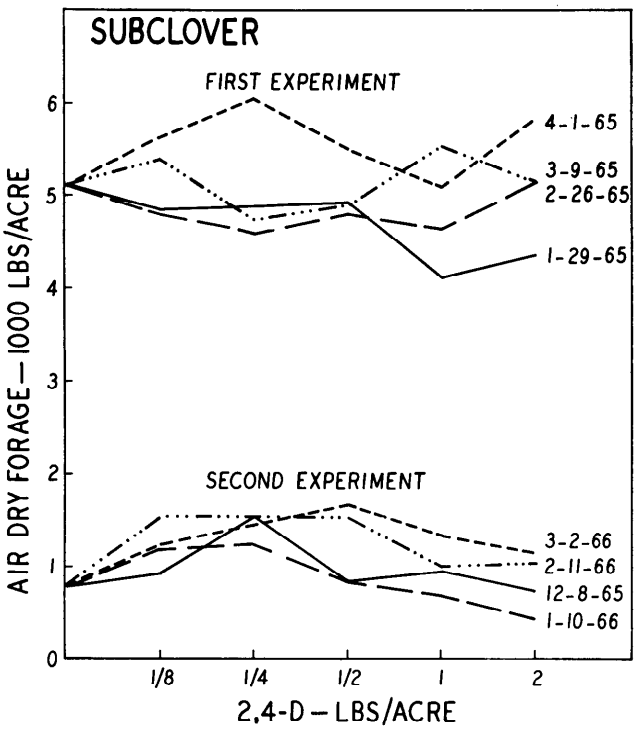

FIG. 1. Effects of varying rates of 2,4-D at four growth stages on forage production of subclover.

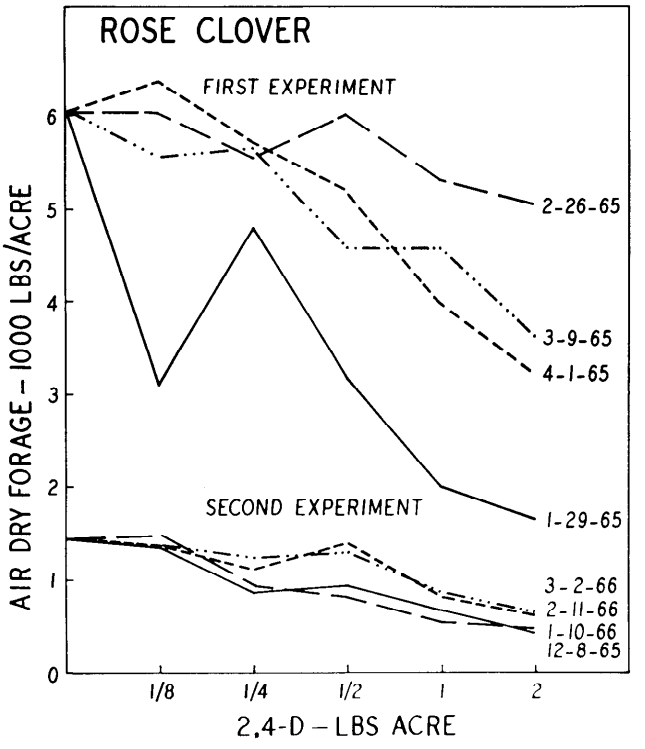

FIG. 2. Effects of varying rates of 2,4-D at four growth stages on forage production of rose clover.

plants completely recovered. There was no significant difference in forage or seed yields of subclover from any rates of 2,4-D at any of the growth stages in the first experiment (Fig. 1 and Table 2). In the second experiment forage yields were reduced at the .05 level of significance only by the 2-lb rate at the second growth stage. Yields were actually increased by many treatments because of the early weed control before tillage.

Rose clover was more severely damaged than subclover. In the first experiment, differences due to 2,4-D rates, growth stages, and the interaction of rates times growth stages were all significant at the .01 level. Forage yields were reduced by the 2-lb rate at all growth stages, and by the 1.0-lb rate at all but the second growth stage (Fig. 2). The first spraying date produced the greatest damage. Yields were reduced by all rates at this date.

Table 2. Effect of 2,4-D treatments on seed yields (lb/acre), first experiment.

Treatment date	2,4-D—lb/acre			
	Subclover		Rose clover	
	0.5	2.0	0.5	2.0
1/29/65	800	660	510	250
2/26/65	790	860	1080	880
3/9/65	800	810	820	640
4/1/65	780	870	642	460
Check	830		1050	

Results of the second experiment were very similar. Again, rose clover forage yields were reduced at all growth stages by the 2.0-lb rate, and by the 1.0-lb rate at the first two growth stages.

With the exception of the earliest growth stage 0.5 lb of 2,4-D was safely used on rose clover. Severe leaf deformations occurred at these rates, but the plants recovered to a degree that would be termed satisfactory under range conditions. Also, under range conditions weeds would intercept much of the 2,4-D and the clover would receive a much lower dosage. Seed production would be more than adequate to regenerate the species the following year.

However, 2,4-D cannot be safely used on rose clover grown for seed. Seed yields were significantly reduced by both the 0.5 and 2.0-lb rates at all but the second spraying date (Table 2). Seed yield was reduced 50–75% by some treatments. Yield reductions from the 2.0-lb rate were not significantly greater than at the 0.5-lb rate.

Spraying at the second growth stage of the first experiment (5 to 6 leaves) produced far less damage to either forage or seed yield of rose clover than spraying immediately before or after. However, this temporary immunity appears to be of little value in making a recommendation, as the following spraying, 11 days later, produced severe damage. The "safe" spraying occurred at the beginning of a period of very rapid growth. The tolerance may be correlated with this growth rate rather than

the size of the plant, because plants sprayed at a similar size the following year did not show this tolerance.

Hardinggrass and Palestine orchardgrass were not damaged at any of the combinations of rates and growth stages tested. There were no differences in seedling height or other damage symptoms. The first two applications were followed by a very wet fog the following night which probably resulted in some runoff from the sprayed plants to the root zone. Still, no mortality was noted.

The results of these trials indicate that 2,4-D may have a much more prominent place in controlling weeds in range seedings than had been supposed earlier. The experiments by Williams and Leonard (1959) showed severe damage to rose clover by rates of 2,4-D amine as low as 0.75 lb/acre. However, most of their applications were made at later growth stages to coincide with brush control practices rather than control of herbaceous weeds. Also the damage they measured using amine in the 2-inch rosette stage would not prohibit the use of 2,4-D. Ormrod et al. (1960a, 1960b) tested only the less selective ester formulation and again sprayed at later growth stages than would be used for herbaceous weeds.

In view of the results reported here it seems safe to use the alkanolamine salt of 2,4-D on subclover, hardinggrass, and orchardgrass at rates as high as 2 lb/acre to control herbaceous range weeds in new seedings. Normally spraying would be done at 0.5 to 1.0 lb/acre when the weeds are small. Up to 0.5 lb/acre could also be used on rose clover grown for forage recognizing that moderate damage will result to the clover. Moderate damage in the seeding year is preferable to a seeding failure due to weed competition.

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