Conversion of Medusahead to Downy Brome Communities with Diuron[1]

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Highlight

Application of 2 lb./acre of the herbicide diuron changes rangeland communities from medusahead to downy brome dominance. This conversion lasted for at least 3 years and greatly increased utilizable forage.

The spread and increase in dominance of medusahead in plant communities of semi-arid rangelands has largely been at the expense of other annual grasses (McKell et al., 1962; Young and Evans, 1970). In the Intermountain area, medusahead (*Taeniatherum asperum* (Sim.) Nevski) has replaced downy brome (*Bromus tectorum* L.) (Hironaka and Tisdale, 1963; Turner et al., 1963). The short period of green feed, variability in yield among years, and flammability of downy brome make it much less desirable than perennial grasses. However, downy brome is one of the principal forage species for many livestock operations. Medusahead has all the undesirable characteristics of downy brome, and in addition its high silica content and barbed awns virtually eliminate utilization by livestock or chukar partridges (Sharp and Tisdale, 1952; Major et al., 1960; Savage et al., 1970).

Tillage and herbicide treatments have been developed and are being perfected to control medusahead and permit the establishment of perennial grasses (Torell and Erickson, 1967; Young et al., 1969a). Tillage treatments are restricted to the limited rangeland areas that can be cultivated. Herbicide treatments extend these practices to areas where a rangeland drill can be used to plant the perennial grasses. There are millions of acres of rangeland, where medusahead has replaced downy brome, that are too steep and rocky for application of current techniques. A possibility for temporary range improvement on these areas would be to shift

[1] Received November 7, 1970, accepted for publication February 24, 1971. Cooperative investigation of the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Agricultural Experiment Station, University of Nevada, Reno, Nevada. University of Nevada Journal Series No. 177. Appreciation is extended to Erin Forrest of the XL Ranch for furnishing and fencing the experimental area.

Table 1. Location, vegetation, and physical characteristics of experimental sites where diuron was applied in 1968.

Location	Soil	Vegetation	Elevation (feet)	Annual (ppt, inches)
Fisher Ranch	Deep—vertisol clay	Entirely medusahead	4200	11
Adin Mountain	Deep—vertisol clay	Medusahead and forbs	5000	17
Fly-Blown-Flat	Shallow—clay	Medusahead and downy brome	4100	14
Susanville	Deep—clay	Medusahead and forbs	4200	14

the ecologic balance of these sites to permit the return of downy brome.

Our purpose was to convert medusahead dominated sites to downy brome plant communities through the use of the herbicide 3-(3,4-dichlorophenyl)-l,l-dimethylurea (diuron).

Methods

Greenhouse Test

We planted 100 caryopses of downy brome and medusahead in separate sections of flats. Four replications in a randomized block design were employed. Treatments applied were diuron at 0.25, 0.5, 1.0, and 2.0 lb./acre and control. In one experiment, the herbicide was applied as soon as the caryopses were planted; and in another, applications were made when the seedlings reached the two-leaf stage. The herbicide was applied in 35 gal per acre of water by using a boom-type sprayer. Surviving seedlings were counted in the various treatments 4 weeks after application of the herbicide.

Field Experiments

The majority of the field trials were conducted at the XL Ranch near Alturas, California. A portion of a large block of native range infested with medusahead was fenced in 1966. The vegetation was mostly annual grass with a small amount of downy brome intermixed with the dominant medusahead. Remnant perennial grasses present were bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. and Smith), squirreltail (*Sitanion hystrix* (Nutt.) J. G. Smith), Sandberg bluegrass (*Poa secunda* Presl.) and Junegrass (*Koeleria cristata* (L.) Pers.).

The mean annual precipitation at Alturas is 12.97 inches. The north-northwest aspect of the experimental area traps drifting snow making the effective precipitation higher.

The soil at the XL Ranch experimental site has a clay-loam surface horizon grading into a heavy clay.

In 1966 we applied diuron logarithmically at rates ranging from 0.125 to 4.0 lb./acre. The herbicide was applied in 35 gal of water per acre. A four-replicate split plot with systematic arrangement of subplots (rates) was employed. The diuron was applied October 15 after initial germination of the annual grasses.

In 1967 2 lb./acre of diuron was sprayed on a 200 by 200 ft block in mid-October after initial annual grass germination. The diuron was applied in 10 gal of water per acre using whirl chamber nozzles (Klingman, 1964).

In mid-October, 1968, the 1967 treatments were repeated and also applied an additional 2 lb./acre of diuron to a 50 by 200-ft section of the block that was treated in 1967.

To obtain a pregermination treatment, a 50 by 100-ft block was disk-harrowed before applying 2 lb./acre of diuron. On a 50 by 50-ft portion of the disk-harrowed area, we seeded 1,000 downy brome caryopses per sq ft before applying the herbicide.

We applied the basic 2 lb./acre of diuron treatment to 100 by 100-ft blocks in the fall of 1968 at 4 additional locations. These were the Fisher Ranch near Canby, California; Adin Mountain and Fly-Blown-Flat near Adin, California; and east of Susanville, California (Table 1). In the fall of 1969, the 2 lb./acre of diuron treatment was repeated at the XL Ranch for the third year.

During 1967, we visually evaluated shifts in species composition during the growing season on plots where diuron was applied logarithmically. In all other years, the large treatment blocks were divided into four subplots for sampling. Frequency sampling was employed using the step-point method of Evans and Love (1957). In addition, in each subplot, 4-square meter plots were clipped after determining the projected herbage of the species present.

In 1968 at the XL Ranch we sampled the density of the annual grass population weekly for 6 weeks following application of the diuron. Density was sampled with four 2 by 4-inch randomly located plots in each subplot by using the technique developed by Young et al. (1969b).

Results and Discussion

Greenhouse Trials

Diuron at 1 lb./acre completely controlled medusahead and downy brome when the herbicide was applied before the grasses had germinated (Table 2). In contrast, when the diuron was applied to seedlings the downy brome largely survived at

Table 2. Percentage survival (4 weeks after treatment) of downy brome and medusahead seedlings in relation to timing and rate (lb./acre) of diuron application in the greenhouse.

Time of application and species	Rate of diuron applied					
	Control (none)	0.25	0.5	1.0	1.5	2.0
Before germination						
Medusahead	88	34	11	0	0	0
Downy brome	100	30	3	0	0	0
After germination						
Medusahead	94	12	8	0	0	0
Downy brome	98	88	94	88	64	72

Table 3. Cover (%) by species in 1970 of medusahead communities treated with 2 lb./acre of diuron in 1967, 1968, and 1969 with an untreated control.[1]

Time of treatment	Percent cover					
	Downy brome	Medusahead	Poverty weed	Perennial grasses	Annual forbs	Perennial forbs
Control	15d	69a	6b	5bc	0	1
1967						
Diuron	48a	3b	13b	19a	3	6
1967–68						
Diuron	53a	1b	17b	17a	3	5
1968						
Diuron	36b	2b	26a	14ab	3	6
1969						
Diuron	25c	0b	33a	3c	8	1

[1] Means followed by the same letter are not significantly different at the 0.05 probability level as determined by Duncan's Multiple Range Test. All comparisons are made vertically.

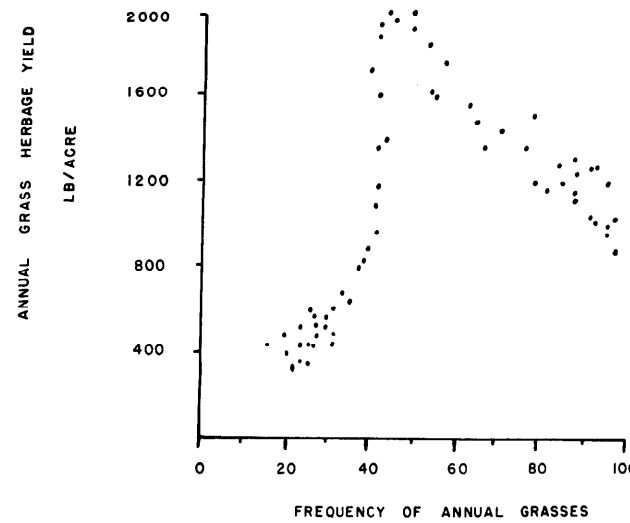

FIG. 1. Scatter diagram of the relation between the herbage yield and frequency of annual grasses.

the 1 lb./acre rate while the medusahead seedlings died.

Field Trials

The results of the 1966 trials where diuron was applied with a logarithmic sprayer indicated that medusahead was totally controlled at rates from 2 to 4 lb./acre. Above 2 lb./acre the downy brome was injured. Effective conversion from medusahead to downy brome dominance was accomplished only at, or very near, the rate of 2 lb./acre of diuron.

From 1967 through 1969, 2 lb./acre of diuron was very effective in converting medusahead communities to downy brome communities (Table 3). It was not necessary to repeat the treatment annually to maintain the shift in dominance. The first year following treatment there was a marked increase in poverty weed (*Iva axillaris* Pursh). The poverty weed was gradually suppressed in subsequent years by an increase in downy brome. Perennial grasses were apparently not injured by the initial treatment and by the third year following treatment there was a significant increase in cover of perennial grasses.

Table 4. Herbage yields (lb./acre) from 1968 through 1970 in relation to diuron treatments (2 lb./acre) applied in October.[1]

Year of herbage yield	Control	Years of diuron application			
		1967	1968	1967-1968	1969
1968	1400a	520b	—	500b	—
1969	1160b	1670a	500c	480c	—
1970	1180c	1420bc	2200a	1560b	530d

[1] Means followed by the same letter are not significantly different at the 0.05 probability level as determined by Duncan's Multiple Range Test. All comparisons are made horizontally.

The first year following application of diuron herbage production was markedly depressed (Table 4). The second growing season after application of the herbicide herbage production significantly surpassed that obtained on the control plots. By the third year, production had dropped until it was not markedly higher than that obtained on the control area. However, in all 3 years the herbage was virtually free of the medusahead.

The increase in production the second year is apparently a function of the relation between annual grass density as interpreted from frequency sampling and production (Fig. 1), and possibly a fallow effect from the first year when there was a low density of vegetation (Young et al., 1969b). Maximum herbage production usually occurs at densities lower than those found in undisturbed stands. The first year after treatment the downy brome plants respond dynamically with a relatively few well spaced plants producing a great many tillers. The tremendous caryopses production of this type of downy brome population has been documented by Young et al. (1969b). These caryopses restock the stand for a great increase in production the second year. In the third year, the stand approaches pretreatment densities with intraspecific competition reducing production.

Application of 2 lb./acre of diuron controlled medusahead at all locations, but did not necessarily lead to an increase in downy brome. At the Fisher Ranch the medusahead formed a relatively pure stand and the diuron treatment produced a clean fallow which was invaded the second year by Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch.) and medusahead. At Adin Mountain and Susanville, there was an increase in forbs followed by a

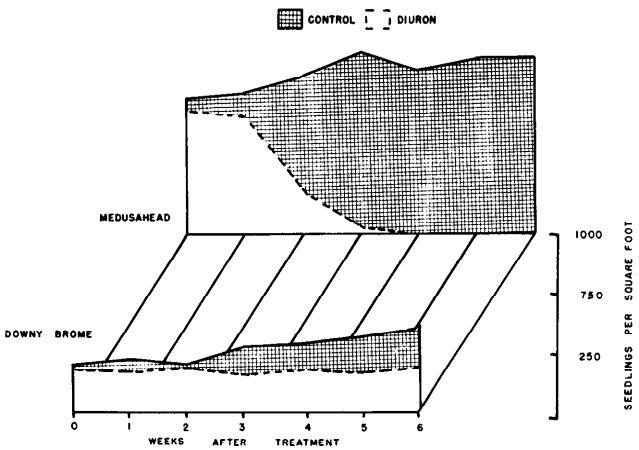

FIG. 2. Medusahead and downy brome seedling populations in relation to diuron treatment.

reinvasion of medusahead without a significant increase in downy brome. The diuron treatment at Fly-Blown-Flat initially gave very similar results to those obtained at the XL Ranch. Unfortunately, this plot was destroyed by road construction before a second year's data could be obtained. It seems that availability of downy brome caryopses on these sites makes the difference between replacement by this species or not.

Therefore, two conditions must exist in order for the diuron treatment to be effective: 1) there must be a residual stand of downy brome in the medusahead population, and 2) the grasses must germinate in the fall before the diuron is applied. The results of the greenhouse work showed there was no selectivity between medusahead and downy brome if the diuron was applied before the grasses germinate. Sampling in the field after application of the herbicide reinforced this relation.

On the control plots the density of medusahead continued to increase during the late fall. Medusahead rapidly dropped out of the diuron-treated communities, but the density of downy brome remained relatively stable (Fig. 2). When we disk-harrowed plots before applying the diuron a clean fallow was obtained the next year with no annual grasses. This was also the case where we seeded downy brome caryopses on the disk-harrowed area before applying the herbicide.

Diuron is not registered with the United States Department of Agriculture for this use on rangeland so an economic evaluation of the conversion of medusahead to downy brome is largely conjectural. The initial treatment would cost approximately $7.00/acre. There would be a loss of all grazing the first year to allow the downy brome to increase. The second and third years for the XL Ranch site herbage production averaged about 1600 lb./acre annually. With 80% utilization this production results in 1280 lb./acre harvestable forage. The 1280 lb./acre of forage @ $0.005/lb. (value of forage = $10/ton hay) results in a $6.40 value of the forage/acre. There is virtually no utilization of downy brome, forbs, or perennial grasses in medusahead-dominated communities in this area, so the increase in forage following the diuron treatment is almost entirely an economic benefit. Without discounting for interest it is apparent by the start of the third year the initial investment has been repayed. If the conversion from medusahead to downy brome lasts for four or more years under grazing, the cost can be prorated in terms of the additional return. The increase in perennial grasses may be an additional bonus.

All the material presented in this manuscript reflects results obtained with no grazing after the initial treatment. We are still investigating the dynamics of downy brome–medusahead communities under diuron and grazing treatments.

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