Wheatgrass Establishment with Tillage and Herbicides in a Mesic Medusahead Community[1]

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Highlight

Intermediate wheatgrass seedlings were successfully established in a medusahead community in 1965, 1966, and 1967 with mechanical or chemical-fallow treatments. Summer fallowing by disk harrowing was the most successful treatment. The most productive wheatgrass stands suppressed but did not eliminate medusahead.

Medusahead (*Taeniatherum asperum* (Sim.) Nevski) poses a difficult problem for ranchers and resource managers in California, Idaho, Nevada, Oregon and Washington. When this winter annual grass becomes established on depleted ranges, forage productivity is drastically reduced (Torell et al., 1961; Turner et al., 1963). Grazing capacity on some ranches has been decreased as much as 75% (Major et al., 1960).

The ultimate control of medusahead over the millions of acres of rangeland that it now occupies is basically a matter of suppression by well-managed perennial grasses (Torell, 1967). By the time medusahead becomes established and occupies extensive areas in a rangeland community, the perennial grass component of the community is too depleted to respond to management. In these situations the need for range seeding is imperative.

The extreme competition offered by dense medusahead stands makes weed control essential for establishment of perennial grass seedlings. Kay and McKell (1963) used several preemergence herbicides to aid in establishment of rose clover (*Trifolium hirtum* All.) and hardinggrass (*Phalaris tuberosa* L. var. *stenoptera* (Hack.) in medusahead stands. The most widely tested herbicide for medusahead control is 2,4-dichloropropionic acid (dalapon). This herbicide has successfully controlled medusahead in California, Idaho, and Oregon (Kay, 1963; Turner et al., 1963; Torell, 1967). On the California annual range, control of medusahead with low rates of 1,1′-dimethyl-4,4′-bipyridinium salts (paraquat) has been extremely effective in the establishment of hardinggrass and annual clovers (Kay, 1966).

Our objectives in this study were: (1) to evaluate tillage and herbicide treatments for control of medusahead; (2) to determine the most effective method for establishment of perennial grasses in conjunction with medusahead control; and (3) to ascertain the best adapted perennial grass species for seeding on the medusahead site being investigated.

Methods

We conducted this investigation at Verdi, Nevada (11 miles west of Reno at the base of the Sierra Nevada Mountains). The medusahead infestation is found on a formerly cultivated, unimproved pasture. The experimental plots were established on a long 5% slope facing east-to-southeast. Soil moisture increases along a gradient beginning with dry rangeland at the upper end and ending in a wet meadow at the lower. The upper portion of the slope is occupied almost entirely by medusahead. Small areas disturbed by rodents or grazing animals supported sparse stands of downy brome (*Bromus tectorum* L.) and hairy chess (*B. commutatus* Schrad.). Growing intermixed with, but suppressed by the medusahead population, were scattered plants of field bindweed (*Convolvulus arvensis* L.) and poverty weed (*Iva axillaris* Pursh.). The only remaining perennial grasses on the upper portion of the site were scattered bunches of squirreltail (*Sitanion hystrix* (Nutt.) J. G. Smith) and isolated rhizomatous clumps of streambank wheatgrass (*Agropyron riparium* Scribn. and Smith). The more mesic lower slope supported a thick stand of medusahead around dense clumps of Baltic rush (*Juncus balticus* Willd.). A thin remnant stand of pine bluegrass (*Poa scabrella* (Thurb.) Benth.) and meadow barley (*Hordeum brachyantherum* Nevski) was interspersed in the medusahead.

Precipitation amounts and distribution were extremely variable during the investigation. In 1963–64 (July–June) 13.4 inches of precipitation were received. The 1964–65 precipitation was 12.8 inches. In 1965–66 virtually no precipitation fell after January and the total was 7.3 inches. The winter and spring of 1966–67 were extremely wet with 33 inches of precipitation recorded. Reno, Nevada has a long-time average annual precipitation of 7.73 inches, while at Truckee, California, 25 miles west of Verdi and higher in the mountains, the annual precipitation averages over 30 inches (U.S.D.A., 1941).

The soils of the Verdi plots are members of a loamy-skeletal, mixed, mesic family of Typic Hap-

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laquolls. They have developed in gravelly alluvium from andesite, tuffs, and tuff breccias.

Design of all field trials involving logarithmic spraying of herbicides was a four-replicated split plot with systematic arrangement of subplots (rates) (Cochran & Cox, 1950).

We visually evaluated weed control through the growing season on all plots. Oven-dry yields of the mature weeds were used to evaluate season-long control.

We evaluated stand establishment of perennial grasses by 1st-year seedling counts and height measurements made in late July after annual plants had died. In 1964, perennial grass seedlings were counted several times during the growing season, to study time of stress and mortality of seedlings.

To further evaluate stand establishment, vigor, and productivity, we clipped perennial grasses for yield in successive years after establishment.

1964 Experiments.—We applied paraquat and 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (atrazine) logarithmically at rates ranging from 2.0 to 0.25 lb/acre and dalapon ranging from 6.0 to 0.75 lb/acre on plots 8 × 100 ft on April 24, 1964. Herbicides were applied in water at 58 gpa and 30 psi. The surfactant X-77[2] at 0.1% v/v was used with all spray solutions.

Other treatments were disk-harrowing, furrowing, and control. The disk-harrowing was done with an offset-disk harrow. Furrows, 4 to 6 inches deep and 4 inches across at the bottom and 10 to 12 inches at the top, were made with shovels attached to a toolbar.

We seeded two rows of intermediate wheatgrass (*Agropyron intermedium* (Host) Beauv.) and one row each of standard crested wheatgrass (*Agropyron desertorum* (Fisch.) Schult.) and Russian wildrye (*Elymus junceus* Fisch.) immediately after treatment except for the plots treated with dalapon and atrazine. Plots treated with dalapon were seeded two weeks later using the same species; plots treated with atrazine were left unseeded. The perennial grass seedlings failed to become established in any of the treatments. On November 24, 1964, all treatments that had been seeded in the spring of 1964 were reseeded with two rows of Amur intermediate wheatgrass and one row each of standard crested wheatgrass and fairway crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.). A dense stand of field bindweed developed in 1965 on all plots where medusahead was controlled. To reduce the field bindweed competition, we applied 1 lb/acre acid equivalent of propylene glycol butyl ether esters of 2,4-dichlorophenoxyacetic acid (2,4-D) on May 21 and July 3, 1965.

1965 Experiments.—We disk-harrowed a 50 × 100 ft block on May 5, 1965. The disk-harrowing provided a summer-fallow free of medusahead plants although we had to spray the area on May 24 and June 16 with 2 lb/acre of 2,4-D to reduce the bindweed population. We seeded the fallow on October 1, 1965, with Amur intermediate wheatgrass.

1966 Experiments.—We repeated the most successful 1964 treatments—disk-harrowing, furrowing, and dalapon—in 1966. The very low precipitation during the winter of 1965–66 permitted earlier application of treatments in 1966 than in 1964. Using the same experimental design as the one employed in 1964, we seeded disk-harrowed and furrowed plots to Amur intermediate wheatgrass on March 15, 1966. Because of incomplete emergence of the medusahead population, the 3 lb/acre dalapon treatment was delayed until April 19. Plots treated with dalapon were seeded on May 3, 1966 to intermediate wheatgrass. The disk-harrow and furrow treatments were repeated on April 19, a date comparable to the 1964 treatments. Field bindweed was again a serious problem. We sprayed all treatments with 1.5 lb/acre of 2,4-D on May 4 and June 15, 1966. Perennial grass stands on both the March and April plots were unsatisfactory; we therefore reseeded all plots with Amur intermediate wheatgrass on October 11, 1966.

Results

1964 Experiments.—Paraquat caused considerable discoloration of medusahead leaves soon after application. After a few weeks the medusahead plants completely recovered and no weed control was obtained. Atrazine at rates ranging from 1 to 2 lb/acre controlled medusahead on the drier, upper slope portion of the plots. The treatments located on the moist lower slope required 2 lb/acre of atrazine to control medusahead. Dalapon at rates ranging from 2 to 6 lb/acre resulted in excellent control. The disk-harrowed and furrowed plots were essentially free of medusahead. All treatments that reduced medusahead were followed by a heavy infestation of field bindweed.

No seedlings of any perennial grass species survived after August 1. More seedlings of intermediate wheatgrass emerged and lived longer than the other three grass species tested. Also, more seedlings emerged and lived longer in the disked and furrowed treatments than in the dalapon-treated areas (Fig. 1). The dalapon treatment had the disadvantage of a 2-week delay of seeding. Residual herbicidal activity of dalapon in the soil made this delay necessary (Holstun and Loomis, 1956).

Excellent intermediate wheatgrass stands were obtained on the plots seeded in the fall of 1964 that had been treated with dalapon, disk-harrowed or furrowed the previous spring (Table 1). Standard and fairway crested wheatgrass stands were considered failures on all treatments. Plots treated

[2] X-77 is a trade-mark surfactant containing alkylarylpolyoxyethylene glycols, free fatty acids, and isopropanol.

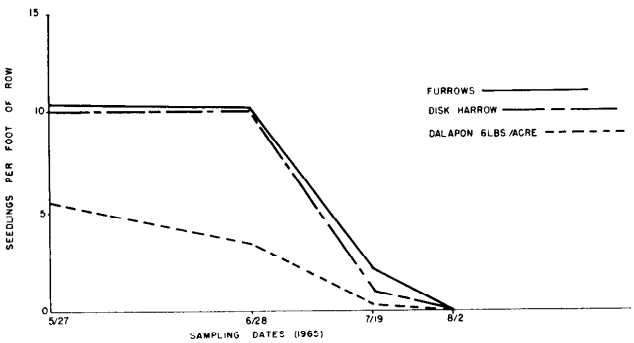

FIG. 1. Intermediate wheatgrass seedling survival in relation to weed control treatments. All treatments were applied and seeded in the spring of 1964.

with atrazine had unsatisfactory wheatgrass stands, except at the 2 lb/acre rate which had a fair stand. Two lb/acre of atrazine and disk-harrowing markedly reduced medusahead yield below the control population. The 0.5 lb/acre atrazine treatment increased medusahead production.

An important factor in the successful establishment of the wheatgrass seedlings was the suppression of field bindweed with application of 2,4-D.

Plots that were disk-harrowed or which had been sprayed with higher rates of dalapon in 1964 produced more intermediate wheatgrass and less medusahead in 1966 than the other 1964 treatments (Table 2). In 1967, the plots sprayed with 6 lb/acre of dalapon or disk-harrowed in 1964 produced significantly more intermediate wheatgrass than the other treatments. The plots treated with atrazine in 1964 supported vigorous wheatgrass plants, but stands were too sparse for satisfactory yields. In the very wet season of 1967, medusahead growth

Table 1. Medusahead yield and wheatgrass seedlings per ft of row 1964 fall seeded treatments.[a]

Treatment	Medusahead Yield lb/A[b]	Wheatgrass seedlings/ft of row: Intermediate Whtg	Standard Crested Whtg	Fairway Crested Whtg
Dalapon (lb/A)				
6	280b	6.2	0.4	0.1
3	200bc	6.0	0.1	0.2
1.5	150c	6.0	0.0	0.0
0.75	270b	5.5	0.1	0.1
Atrazine (lb/A)				
2	120dc	1.2	0.1	0
1	230b	0.9	0.1	0.1
0.5	440a	0.2	0.0	0
Disk harrow	140c	6.2	0.7	0.1
Furrows	200bc	5.4	0.3	0.6
Control	280b	0.4	0.0	0.0

[a] Medusahead yield was taken the fallow year (1964) and seedling counts were made the seedling year (1965).

[b] Means followed by the same letter are not significantly different at 0.5 probability level as determined by Duncan's Range Test.

Table 2. Yield in lb/acre dry matter of medusahead and intermediate wheatgrass for two and three years after establishment of perennial grass seedlings.[a]

Treatment	Rate (lb/A)	1966 Intermediate Whtg	1966 Medusahead	1967 Intermediate Whtg	1967 Medusahead
Dalapon	6	940a	390c	1600a	770b
	3	860b	590b	1110b	750bc
	1.5	920ab	510bc	1100b	710c
	0.75	380d	460c	560c	830b
Atrazine	2	540c	740a	640c	760b
	1	360d	640a	460c	740bc
Disk-harrow		1100a	280d	1540a	770b
Furrows		600c	450c	980b	820b
Control		0e	650a	0d	1300a

[a] Weed control treatments applied in spring, 1964; intermediate wheatgrass seeded in fall, 1964.

[b] Means followed by the same letter are not significantly different at the 0.5 probability level as determined by Duncan's Range Test. All comparisons are made vertically.

was significantly suppressed by all treatments; but yield of medusahead in successful wheatgrass stands exceeded that of control plots in 1966. The most productive wheatgrass stands suppressed, but did not eliminate medusahead.

A few scattered plants of standard and fairway crested wheatgrass were established in the dalapon, disk-harrowed and furrowed treatments, but stands were too sparse for yield measurements. The control plots were devoid of all wheatgrass plants by the 1966 sampling.

1965 Experiments.—The 50 × 100 ft block that was summer fallowed by disk-harrowing in 1965, and seeded in October, 1965, produced an excellent stand of intermediate wheatgrass in 1966. More than five perennial grass seedlings/ft of row became established in spite of the extremely dry spring and summer of 1966. Because the block was used for other experiments, 2nd year wheatgrass yields were not taken.

1966 Experiments.—Plots furrowed and ones disk-harrowed in March, 1966 produced marginal stands of intermediate wheatgrass seedlings in 1966 (Table 3). Treatments applied in April 1966 were complete failures. When intermediate wheatgrass

Table 3. Intermediate wheatgrass seedlings per ft of row 1966 treatments (All seedings made in 1966).

Treatment	Seeded March	Reseeded October	Seeded April	Reseeded October
Furrowed	1.8	9.0	0	4.3
Disk-harrow	1.1	7.0	0	6.2
Dalapon, 3 lb/A	0[b]	2.0	0[b]	1.9
Control	0	0.4	0	0

[a] Seedling counts made in late July 1966 and 1967.

[b] Seeded two weeks later than other treatments to avoid residual soil activity of herbicide.

was reseeded in October, 1966, plots treated in March produced more seedlings than those treated in late April.

Discussion

Intermediate wheatgrass seedlings were successfully established in a medusahead community in 1965, 1966, and 1967 with mechanical or chemical-fallow treatments. With the exception of the 1965 summer fallow by disk-harrowing, treatments were not exclusively designed to create a fallow. However, the summer fallow option was always much more successful than spring seeding and summer fallowing by disk-harrowing was the most successful treatment. The advantages of summer fallowing for seeding perennial wheatgrass on downy brome-infested rangelands have been demonstrated by Eckert and Evans (1967). During years of average or above average precipitation, the Verdi site is too wet and muddy to permit weed control and seeding treatments until late in the spring. This severely limits the chances of success with spring seeding. During the very dry spring of 1966, it was possible to apply treatments and seed in March, but resulting wheatgrass stands were marginal. Using similar weed control techniques on sites in Nevada where early spring treatment is possible, Evans et al. (1967) have been successful in establishing wheatgrass in downy brome communities with spring seedings.

Any reduction in medusahead density at Verdi resulted in an increase in field bindweed. The suppression of the field bindweed by spraying 2,4-D during the summer fallow and the seedling years aided establishment of wheatgrass seedlings. Torell (1967) reported similar problems with other broadleaf species in Idaho.

Downy brome did not significantly increase on plots treated with dalapon at Verdi. This species has significantly increased on other medusahead sites and caused severe competition to wheatgrass seedlings following dalapon fallow treatments (Torell, 1967).

The disk-harrowing, furrowing, and higher rates of dalapon treatments virtually eliminated the medusahead population for one year. Even though wheatgrass seedlings completely stocked plots so treated, medusahead reinvaded the plots during the seedling year. Wheatgrass stands, after the seedling year, suppressed growth of medusahead, but certainly did not eliminate it. Turner, et al. (1963) advocated weed control treatments to remove medusahead from established stands of wheatgrass.

On the Verdi medusahead site, Amur intermediate wheatgrass was superior to standard or fairway crested wheatgrass in seedling stand establishment.

The site at Verdi is representative of the margins of wet meadows in degraded condition found in the Great Basin. Medusahead is evidently well-adapted to these environmental conditions. The discontinuous distribution of meadows in the Great Basin should hinder the spread of medusahead. However, no matter how remote and disjunct these meadow sites may be, competitive species such as baltic rush are omnipresent. Given time, medusahead may become widely distributed on these restricted sites.

The generally steep and rocky terrain of much medusahead-infested rangeland imposes limitations on the feasibility of applying the tillage methods developed at Verdi to all medusahead infestations. The acreage of rangelands infested with medusahead where these tillage methods may be applied is small in comparison to the total acreage infested by the species, but the tillable sites are usually the most productive and offer the greatest return of investment. If weed control necessary to establish wheatgrass seedlings could be accomplished by a chemical fallow, thousands of acres ordinarily tilled only with difficulty, could be seeded with a heavy rangeland drill.

Conclusions

Intermediate wheatgrass seedlings were successfully established in a medusahead community in 1965, 1966, and 1967 with mechanical or chemical-fallow treatments. Summer fallowing with a disk harrow was the most successful treatment. However, chemical-fallowing with dalapon offers the possibility of extending the technique to areas not suitable for tillage.

The fallow treatments were much more successful for wheatgrass establishment than spring seeding following tillage or herbicide treatments.

Any reduction in medusahead density resulted in an increase in field bindweed. The suppression of field bindweed by spraying 2,4-D during the summer fallow and seedling years aided establishment of wheatgrass seedlings.

Intermediate wheatgrass produced the best stands among all grasses seeded regardless of weed control method. Established stands of intermediate wheatgrass greatly suppressed but did not eliminate medusahead.

LITERATURE CITED

COCHRAN, W. G., AND G. M. COX. 1950. Experimental designs. John Wiley & Sons, Inc., New York. 454 p.

ECKERT, R. E., AND R. A. EVANS. 1967. A chemical-fallow technique for control of downy brome and establishment of perennial grasses on rangeland. J. Range Manage. 29:35–41.

EVANS, R. A., R. E. ECKERT, JR., AND B. L. KAY. 1967. Wheatgrass establishment with paraquat and tillage on downy brome ranges. Weeds 15:50–55.

HOLSTUN, J. R., AND J. W. E. LOOMIS. 1956. Leaching and decomposition of sodium 2,2-dichloropropionate in several Iowa soils. Weeds 4:205–207.

KAY, B. L. 1963. Effects of dalapon on a medusahead community. Weeds 3:207–209.

KAY, B. L. 1966. Paraquat for range seeding without cultivation. California Agr. 20:2–4.

KAY, B. L., AND C. M. MCKELL. 1963. Preemergence herbicides as an aid in seeding annual rangelands. Weeds 11:260–264.

MAJOR, J., C. M. MCKELL, AND L. J. BERRY. 1960. Improvement of medusahead-infested rangeland. Calif. Expt. Sta. Ser. Leaf. 123. 3 p.

TORELL, P. J. 1967. Dowpon—an aid to reseeding medusahead-infested rangeland. Down to Earth 23:6–8.

TORELL, P. J., L. C. ERICKSEN, AND R. H. HAAS. 1961. The medusahead problem in Idaho. Weeds 9:124–131.

TURNER, R. B., C. E. POULTON, AND W. L. GOULD. 1963. Medusahead—A threat to Oregon rangeland. Special Rep. 149, State Univ. Corvallis, Oregon. 37 p.

U. S. DEPARTMENT AGRICULTURE. 1941. Climate and Man. Yearbook of Agriculture, U. S. Government Printing Office, Washington, D. C. 1248 p.