STIMULATING GERMINATION OF WILD OAT SEED WITH SODIUM AZIDE

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The area of dense plant growth was treated with sodium azide to stimulate germination of wild oat seed.

Farmers often ask if chemicals exist which overcome weed seed dormancy. Such chemicals would eliminate a major survival characteristic of many of our most important weed problems since seeds would no longer remain dormant but viable for extended periods of time. Tests were conducted to determine if sodium azide would stimulate wild oat germination. Three to fifteen-fold increases in wild oat seed germination were measured after sodium azide was broadcast and incorporated into soil, however, under field conditions no more than 50% of the wild oat seed reserve was stimulated to germinate.

Nearly the entire population of wild oat seed must be made to germinate before sodium azide will have potential for field usage. The results are promising since they indicate that other chemicals may exist which would be more effective than sodium azide.

OBJECTIVE OF RESEARCH

Wild oat infests more than 28 million acres in the U.S., causing annual losses between $300 and $500 million (2). North Dakota is the most heavily infested state with crop yield losses estimated at $150 to $250 million annually. Nalewaja (5) estimated 90 per cent of the small grain acreage in North Dakota is infested with wild oat seed — 57 per cent of this acreage was moderately to heavily infested in 1973.

Seed dormancy is a major survival characteristic of wild oat since seed can remain dormant but viable in cultivated soils for five to eight years (1). If wild oat seed dormancy could be broken artificially and the emerged seedlings killed, wild oat eradication would be possible.

Sodium azide increased weed seed germination when mixed with soil in greenhouse experiments (8).

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Fay (3) reported that broadcast-incorporated azide resulted in three- to fivefold increases in wild oat emergence in field tests in 1975. Since that time laboratory, greenhouse, and field tests have been conducted to determine the proper conditions for optimum stimulation of wild oat germination with sodium azide.

MATERIALS AND METHODS

Growth Chamber Experiment

Sodium azide granules (2% active ingredient) were mixed with air-dry "greenhouse soil" to give an equivalent sodium azide concentration of 0, 2, 4, or 8 pounds per acre when incorporated to a depth of 3 inches. Twenty freshly harvested wild oat seeds were planted 1.5 inches deep in 1 pound of soil in plastic pots 4.25 inches in diameter by 3 inches deep and given 100 ml water. The pots were placed in a growth chamber at 50°F with alternating 16 hours of light and and 8 hours of dark. Seedling emergence was recorded daily. The experiment was conducted three times with five replications each.

Field Experiments

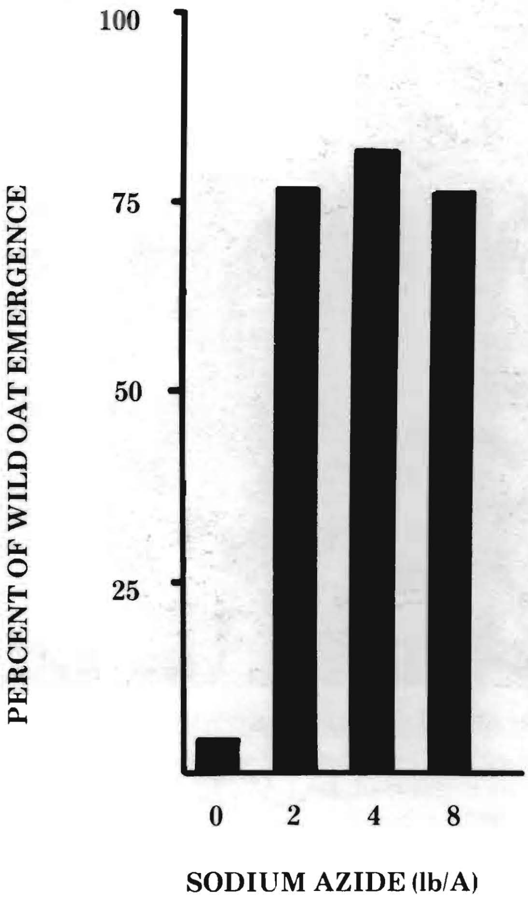
Experiments in the field were conducted to determine the influence of sodium azide on wild oat germination. The experiments were established on April 10, 1975; April 14, 1976; and April 25, 1977, at Penn, Williston, and Fargo, respectively.

Sodium azide granules (2% active ingredient) were broadcast with a granular applicator at rates of 0 and 10 lb active ingredient/A at Penn and 0, 5, and 10 lb a.i./A at Fargo and incorporated twice with a garden tractor rototiller set to till 5 inches deep. Each plot was firmed with a 6 foot wide seedbed packer. The experiment at Williston was with technical (98%) sodium azide applied at 0, 5, and 10 lb a.i./A in 15 gal/A of water from a backpack sprayer with CO_2 as the pressure source. Incorporation was once with a tandem disk working the soil approximately 3.5 inches deep. The experiments were a randomized complete block design with four replications, and individual plots were 6 by 15 ft. Wild oat plants per square foot were counted in six randomly selected locations in each plot to determine the effect of azide on wild oat emergence, May 19 to June 6 depending on the location.

Soil samples were taken from the experimental plot area prior to establishment of the experiment to determine the wild oat seed content. Plots were sampled by randomly taking eight 2.5-inch diameter by 6-inch deep soil cores. The soil samples were composited and placed in a mesh bag constructed from nylon window screen. The soil was weighed, washed from the bags and the residue air dried. The wild oat seeds were separated by hand from the stones and plant residues and counted. Seed viability was determined by germinating the recovered seeds in petri dishes with 3.0 ml of 1000 ppm gibberellic acid (GA_3), a treatment which stimulates germination of dormant wild oat seed (7).

Analyzing Soil Profiles for Wild Oat Seed

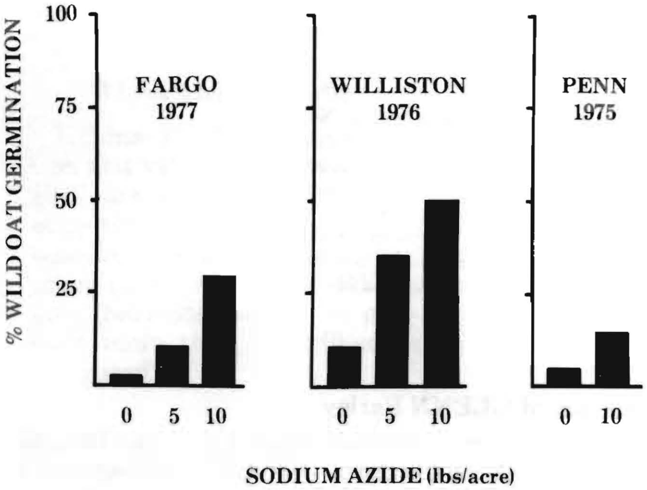
Thirty soil cores 3 inches in diameter by 8 to 10 inches deep were taken with a hydraulic probe mounted on a tractor hitch to determine the wild oat seed distribution in the soil profile at Penn, Jamestown, and Fargo. Soil cores were cut into seven 1-inch sections and wild oat seed number and viability determined by washing and germination as described above. Soil profiles were analyzed at Fargo, Penn, and Jamestown on July 15, 1976; June 28, 1977; and July 29, 1977, respectively.



RESULTS AND DISCUSSION

Mature wild oat seed usually is dormant at harvest. Sodium azide caused 75 to 80 per cent germination of freshly harvested seeds planted in soil in a growth chamber at 50 F as compared to 5 per cent germination of seed in untreated soil (Figure 1).

Wild oat seedling emergence increased tenfold, fivefold, and threefold at Fargo, Williston, and Penn, respectively, following a broadcast incorporated application of 10 lb/A sodium azide (Figure 2). Wild oat seeds were hand separated from soil samples taken from the experimental areas to determine the portion of the wild oat seed population which responded to sodium azide. Approximately 29, 50, and 14 per cent of the seeds in the soil at Fargo, Williston, and Penn, respectively, emerged after sodium azide (10 lb/A) was applied compared to 3, 11, and 4 per cent, respectively, in the untreated areas (Figure 2).



Sodium azide stimulated wild oat germination in the field but a lower percentage of the total seed reserve germinated in the field as compared to in the growth chamber experiment (Figure 1). Precise control of the environment was maintained in the growth chamber since sodium azide was uniformly incorporated, pots were watered daily, and the temperature was a constant 50 F.

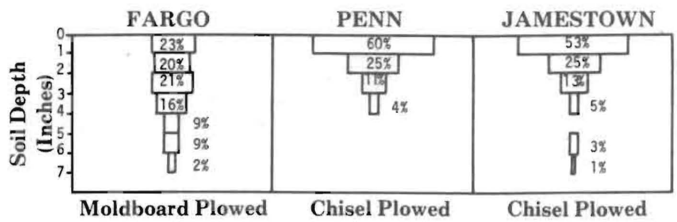
Only 14 per cent of the wild oat seed reserve germinated in response to sodium azide (10 lb/A) at Penn where dry soil conditions occurred during the experiment (Figure 2). In a number of other field experiments where sodium azide caused a large increase in wild oat emergence, rain occurred soon after sodium azide application. The optimum soil moisture concentration for sodium azide activity has not been determined. However, azide apparently has little activity under dry conditions.

Field applications of azide must be incorporated thoroughly to place the chemical as close as possible to each seed for maximum germination stimulation (3,4). Laboratory experiments indicated that a threshold quantity of azide must enter a seed before dormancy is affected (4). Seed location is influenced by previous tillage practices and the distribution of wild oat seed in a profile appears to be important for stimulating wild oat seed germination by sodium azide.

The wild oat seed distribution in fields which were moldboard plowed or chisel plowed is presented in Figure 3. Approximately 80 per cent of the wild oat seeds were located in the top 2 inches of soil at the Penn and Jamestown sites where the primary tillage was chisel plowing in the fall for 10 consecutive years.

Azide could be uniformly incorporated into the surface 3 inches with a tandem disc, giving good contact with most of the wild oat seed in fields which were chisel-plowed. Moldboard plowing shortly after harvest for a 10-year period resulted in a fairly uniform distribution of seeds throughout the working depth of the plow (Figure 3).

Percentage of Total Viable Wild Oat Seeds Recovered Per Inch



Primary Tillage Practice Used For More Than 10 Years

Uniform contact of sodium azide with wild oat seed to plow depth would be difficult and might require special procedures.

SUMMARY

Three field experiments conducted at three locations have shown soil-incorporated sodium azide can stimulate wild oat seedling emergence. While the results are promising, no more than 50 per cent of the wild oat seed reserve in the soil germinated and, at one location, little response to azide occurred. An effective germination stimulating chemical could nearly eliminate wild oat in a treated field if a large portion of the wild oat seed reserve was stimulated to germinate and the emerged seedlings controlled.

Sodium azide would need to stimulate germination of nearly the entire wild oat seed reserve to have potential for field use for wild oat eradication. A chemical which stimulates germination in half of a seed reserve is of little use since the remaining seeds can lay dormant and germinate in the future. Research is needed to determine the exact field conditions required for best germination stimulation activity to determine if sodium azide can cause the entire wild oat seed population to germinate.

LITERATURE CITED

1. Banting, J.D. 1962. The dormancy behavior of *Avena fatua* L. in cultivated soil. Canada J. Plant Sci. 42:22-39.
2. Ennis, W.G. 1974. Wild Oat Workshop. Weed Science Society of America. Las Vegas, Nevada. Feb. 14-15. p. 1.
3. Fay, P.K. 1975. The effect of germination stimulators on wild oat (*Avena fatua* L.) emergence in the field. Proc. North Cent. Weed Control Conf. 30:110-111.
4. Fay, P.K., and R.S. Gorecki. 1978. Stimulating germination of dormant wild oat (*Avena fatua* L.) seed with sodium azide. Weed Sci. In press.
5. Nalewaja, J.D. 1973. Wild oat infestations of field crops in 1973. North Dakota Farm Res. 31(2):3-5.
6. Parochetti, J.V., and G.F. Warren. 1970. Behavior of potassium azide in the soil. Weed Sci. 18:555-560.
7. Swedan, A.H. 1970. Germination studies with seed on various weed species under laboratory conditions. Diss. Lehrstuhl. PflSchutz. Univ. Hohenheim. p. 57.
8. Taylorson, R.B. 1975. Personal communication.