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An evaluation of the activity of selected plant growth regulators, herbicides and mixtures of plant growth regulators and herbicides on leafy spurge (*Euphorbia esula* L.)

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Introduction

Leafy spurge (*Euphorbia esula* L.) is a perennial herbaceous plant which produces an extensive underground root system. It is extremely difficult to control because it develops dense stands, produces vegetative root buds, its roots contain large carbohydrate reserves and it can tolerate a wide variety of habitats and environmental conditions (2).

Wyoming currently has over 48,000 acres infested with leafy spurge. It is mainly a problem on noncultivated land, however, its presence can be very costly. Wyoming has projected the overall cost of controlling 48,618 acres of leafy spurge to be $10,501,488 (3).

Herbicide research for controlling leafy spurge began around 1952 in Wyoming with 2,4-D being the most prominent chemical tested. Many other herbicides have been developed and released since then, however, picloram which became available in 1963 has proven to be the most reliable and effective herbicide for controlling leafy spurge (4).

Regeneration of leafy spurge from viable root buds is a major problem encountered in its control. While certain herbicides have been shown to be effective in controlling shoot growth they appear to not be as effective in destroying the root systems from which new shoots can develop. While there has been considerable research involving growth regulators and their effects on plant growth, research involving growth regulator-herbicide combinations on controlling problem weeds is limited. Research involving growth regulator-herbicide combinations on leafy spurge has not yet resulted in effective control (l).

The purpose of this study was to evaluate the activity of selected growth regulators, herbicides, and mixtures of plant growth regulators and herbicides on leafy spurge shoot and root growth.

Materials and methods

A field study was established to evaluate the following growth regulators; ABG-3034, a cytokinin, (6-benzylamino-purine), mixed cytokinins, mostly zeatin-like, extracted from marine algae tissue, 2,4-D (2,4-dichlorophenoxy=acetic acid), gibberellic acid (2,4a,7-trihydroxy-1-methyl-8-methylenegibb-3-ene-1,10-carboxylic acid-1,4-lactone), glyphosate (*N*-[phosphonomethyl] glycine, NAA (1-naphthaleneacetic acid), and PP333 an experimental antigibberellin compound ([2RS,3RS]-l-[4-chlorophenyl]-4,4-dimethyl-2-1,2,4-triazol-1-yl-]pentan-3-ol) and herbicides; dicamba (3,6-dichloro-o-anisic acid) and picloram (4-amino-3,5,6-trichloropicolinic acid) on leafy spurge shoot control.

The experimental site was located 5 miles south of Hulett, Wyoming on the Terry Peterson ranch, on the first alluvial bench of the Belle Fourche River. Plots were established June 29, 1982 on a uniform infestation of leafy spurge 8-24 inches tall. Plants were in the prebud to full bloom stage of growth with densities averaging 18 shoots/sq feet. A sparse understory of blue grass and western wheatgrass 4-12 inches in height was also present.

Growth regulators and herbicides were applied by hand with a 6-nozzle knapsack spray unit in 40 gal/A water carrier. Plots were 9 by 30 feet and arranged in a completely randomized design with three replications. Soil was a clay loam (39% sand, 31% silt, and 30% clay) with 2.1% organic matter and a pH of 7.8. Subsoil moisture was good and the leafy spurge was in excellent condition. The air temperature was 75F with a relative humidity of 45%. Winds were from the northeast at 0-10 mph and skies were partly cloudy. Soil temperatures ranged from 64F at the surface to 65F at 1 in., 75F at 2 in., and 80F at 4 in. Treatment applications began at 2:00 pm and were finished at 6:00 pm MDT.

Growth regulators and herbicides were applied singularly and in combination at the following rates: cytokinin (BAP) at 12 g ai/A, mixed cytokinins at 1 gal of formulation/A, 2,4-D amine at 0.25 lb ai/A, gibberellic acid at 12 g ai/A, glyphosate at 1/8 lb ai/A, NAA at 12 g ai/A, PP333 at 12 g ai/A, dicamba at 1.0 and 2.0 lb ai/A, and picloram at 0.25 and 0.5 lb ai/A.

The experiment was evaluated May 19, 1983, 324 days following treatment. Evaluations were based on percent shoot control as compared to the untreated check.

Data were analyzed using an analysis of variance procedure for a completely randomized design.

Data were analyzed for significance at the 95% confidence level. Means were separated on the basis of the least significant difference (LSD) test. Due to the large number of treatments involved in this study all treatment means are not reproduced on the same page. Treatment means within the same experiment, although on different pages, are comparable using the appropriate LSD value.

Results

Significant increases or decreases in shoots/sq feet were not observed for any of the GR treated plots. However, GA at 12 g ai/A had the largest increase in shoots/sq feet at 28.0. BAP at 12 g ai/A resulted in the lowest number of shoots/sq feet with 16.9. The untreated plots had an average of 24.3 live shoots/sq feet (Table 1).

Table 1. Effects of growth regulators on leafy spurge shoot counts.*

Treatment	Rate** ai/A	Percent shoot control	Shoots/ sq ft
BAP	12 g	30	16.9
Cytokinin	1 gal	20	19.4
2,4-DA	0.25 lb	0	26.0
Gibberellic acid	12 g	0	28.0
Glyphosate	0.125 lb	16	20.3
NAA	12 g	16	20.5
PP333	12 g	0	24.4
Check	---	0	24.3
LSD (.05)			10.3
CV%			41

* Values are the average of three replications.
**Cytokinin is reported as actual formulation/A.

No combination treatments of GR's + dicamba at 1.0 lb ai/A resulted in significant decreases in shoots/sq feet. However, the mixed cytokinins + dicamba resulted in the greatest reduction at 17.2 shoots/sq feet. Dicamba applied alone at 1.0 lb ai/A had no significant effect on the number of shoots/sq feet (Table 2).

Table 2. Effect of growth regulator-dicamba combinations on leafy spurge shoot counts, dicamba applied at 1.0 lb ai/A.*

GR + dicamba at 1.0 lb/A	Rate** ai/A	Percent shoot control	Shoots/sq ft
BAP	12 g	2	23.8
Cytokinin	1 gal	29	17.2
2,4-DA	0.25 lb	23	18.6
Gibberellic acid	12 g	24	18.4
Glyphosate	0.125 lb	28	17.4
NAA	12 g	12	21.3
PP333	12 g	5	23.2
dicamba	1.0 lb	0	24.7
Check	---	0	24.3
LSD (.05)			10.3
CV%			41

* Values are the average of three replications.
**Cytokinin is reported as actual formulation.

2,4-D at 0.25 lb ai/A + dicamba at 2.0 lb ai/A and PP333 at 12 g ai/A + dicamba at 2.0 lb ai/A both resulted in significant decreases in the number of shoots with 12.9 and 13.9 shoots/sq feet, respectively. Dicamba applied alone at 2.0 lb ai/A had no significant effect on the number of shoots/sq feet (Table 3).

Table 3. Effect of growth regulator-dicamba combinations on leafy spurge shoot counts, dicamba applied at 2.0 lb ai/A.*

GR + dicamba at 2.0 lb/A	Rate** ai/A	Percent shoot control	Shoots/sq ft
BAP	12 g	18	20.0
Cytokinin	1 gal	18	19.9
2,4-DA	0.25 lb	47	12.9
Gibberellic acid	12 g	23	18.7
Glyphosate	0.125 lb	40	14.6
NAA	12 g	36	15.6
PP333	12 g	43	13.9
dicamba	2.0 lb	23	18.8
Check	---	0	24.3
LSD (.05)			10.3
CV%			41

* Values are the average of three replications.
**Cytokinin is reported as actual formulation/A.

GR's + picloram at 0.25 lb ai/A combination treatments resulting in significant reductions in the number of shoots/sq feet were glyphosate at 0.125 lb ai/A + picloram and PP333 at 12 g ai/A + picloram. The reduction to 10.2 shoots/sq feet by PP333 was highly significant, compared to the untreated check. Picloram applied by itself at 0.25 lb ai/A did not significantly reduce the number of shoots/sq feet (Table 4).

Table 4. Effects of growth regulator-picloram combinations on leafy spurge shoot counts, picloram applied at 0.25 lb ai/A.*

GR + picloram at 0.25 lb/A	Rate** ai/A	Percent shoot control	Shoots/sq ft
BAP	12 g	35	15.8
Cytokinin	1 gal	40	14.6
2,4-DA	0.25 lb	40	14.7
Gibberellic acid	12 g	38	15.1
Glyphosate	0.125 lb	53	11.5
NAA	12 g	40	14.7
PP333	12 g	58	10.2
picloram	0.25 lb	38	15.1
Check	---	0	24.3
LSD (.05)			10.3
CV%			41

* Values are the average of three replications.
**Cytokinin is reported as actual formulation/A.

All GR + picloram at 0.5 lb ai/A combination treatments resulted in highly significant reductions in the number of shoots/sq feet with the exception of BAP + picloram whose reduction to 11.3 shoots/sq feet was significant at the 95% confidence interval. Picloram applied by itself also had at highly significant reduction of 3.1 shoots/sq feet (Table 5).

Table 5. Effect of growth regulator-picloram combinations on leafy spurge shoot counts, picloram applied at 0.5 lb ai/A.*

GR + picloram at 0.5 lb/A	Rate** ai/A	Percent shoot control	Shoots/sq ft
BAP	12 g	53	11.3
Cytokinin	1 gal	89	2.7
2,4-DA	0.25 lb	82	4.3
Gibberellic acid	12 g	88	2.8
Glyphosate	0.125 lb	91	2.3
NAA	12 g	94	1.4
PP333	12 g	87	3.2
picloram	0.5 lb	87	3.1
Check	---	0	24.3
LSD (.05)			10.2
CV%			41

*Values are the average of three replications.
**Cytokinin is reported as actual formulation/A.

Discussion and summary

Growth regulators were applied to leafy spurge with hopes of enhancing the activity of the herbicides dicamba and picloram. Growth regulator screening studies were conducted both in the greenhouse and field to observe the effects of growth regulators, herbicides, and growth regulator-herbicide combinations on various parameters of leafy spurge growth.

None of the GR treatments had a significant effect on the number of shoots/sq feet. Combination treatments of GR's and dicamba at 1.0 lb ai/A also had no significant effect on the number of shoots/sq feet. However, combination treatments of GR's with dicamba at 2.0 lb ai/A did result in a significant reduction in the number of shoots/sq feet, although the best GR-dicamba combination only produced 47% shoot control which was not significantly better than dicamba applied alone at 2.0 lb ai/A.

Treatments containing GR + picloram at 0.25 lb ai/A also demonstrated significant shoot reductions. However, the largest reduction only resulted in 58% shoot control, and was not significantly better than the control obtained with picloram applied alone at 0.25 lb ai/A.

The greatest shoot/sq feet reductions were attained with GR's + picloram at 0.5 lb

ai/A treatments, with the largest reduction resulting in 94% shoot control. However, this reduction was not significantly better than where picloram was applied alone at 0.5 lb ai/A, which resulted in 87% shoot control.

The results of this field study tend to support the data of the greenhouse study indicating that the GR's evaluated in these studies seemed to have no significant effect on increasing the activity of dicamba and picloram in controlling the regeneration of leafy spurge from viable root buds.

Although none of the GR's evaluated in this study seemed to hold promise for increasing the activity of dicamba and picloram in controlling leafy spurge, there are many GR's yet to be evaluated. Continued research is necessary in this field of study if an effective GR-herbicide combination is to be found. If such a combination were to be found it would greatly aid in the effort of eliminating this persistent and expensive pest from our rangelands.

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