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Diflufenzopyr increases perennial weed control with auxin herbicides

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Introduction

BAS-662 (formally known as SAN-1269) is a combination of dicamba plus diflufenzopyr (SAN-836) in a ratio of 2.5:1 dicamba:diflufenzopyr. Diflufenzopyr is an auxin transport inhibitor (ATI), which suppresses the transport of naturally occurring IAA and synthetic auxin-like compounds in plants. In general, diflufenzopyr interferes with the auxin balance needed for plant growth. The purpose of this research was to evaluate diflufenzopyr alone and in combination with dicamba and other auxin herbicides for perennial weed control in a series of greenhouse and field studies.

Materials and methods

Greenhouse

Initially diflufenzopyr was only available for research as a tank-mix with dicamba (BAS-662) and was evaluated in two greenhouse studies. BAS-662 was applied to 12-week-old leafy spurge plants to achieve dicamba rates of 0.5 to 4 oz/A. The treatments were compared to dicamba applied alone. The plants were evaluated for top growth injury 1 and 2 WAT (weeks after treatment) Then all top growth was removed and the plants were allowed to regrow for 4 weeks (6 WAT), at which time the leafy spurge regrowth was harvested, oven dried, and weighed.

In a second greenhouse study, BAS-662 was applied in combination with other auxin and non-auxin herbicides. The ratio of the new auxin herbicide to ATI was 2.5:1. Since BAS-662 also contained dicamba, the treatments were in effect 3-way tankmixes.

Field

Diflufenzopyr in combination with auxin herbicides was evaluated in a series of field trials following the promising results observed in the greenhouse trials. Diflufenzopyr

alone was available when these trials began. Auxin herbicides were applied with diflufenzopyr at a ratio of 2.5:1 to Canada thistle, leafy spurge, and spotted knapweed on June 12, 1997. The air temperature and dew point were in the mid-80s and mid-60s, respectively. Treatments were applied using a hand-held sprayer delivering 8.5 gpa. Each species was a separate trial. Treatments were visually evaluated for foliage injury 1.5 MAT (months after treatment) and control 3 MAT.

BAS-662 will likely be marketed for cropland use in 1998 and would be the first herbicide with diflufenzopyr available for pasture and rangeland use. Thus, a second leafy spurge experiment to compare dicamba alone and applied with the ATI was established near Fargo on July 22, 1997. The air temperature was 73 and the dew point was 66. The experimental area had been flooded in April 1997 which delayed the leafy spurge maturity. Leafy spurge was beginning seed-set (25%) but 50 to 75% were still flowering.

Results and discussion

Greenhouse

There were no visible differences in injury symptoms on plants where dicamba was applied alone or with diflufenzopyr. However, leafy spurge regrowth was much less when dicamba was applied with diflufenzopyr compared to dicamba applied alone at the same dicamba rate (Table 1). For example, leafy spurge regrowth 6 WAT averaged 385 mg/plant with dicamba at 4 oz/A and with BAS-662 that included dicamba at only 0.5 oz/A plus diflufenzopyr. Leafy spurge did not regrow when dicamba at 4 oz/A plus diflufenzopyr was applied.

Table 1. Leafy spurge regrowth 6 weeks after treatment with dicamba applied alone or with diflufenzopyr in the greenhouse.

Treatment	Rate	Dry weight
	—— oz/A ——	—— mg ——
Dicamba + diflufenzopyr[a]	0.5+0.2	385
Dicamba + diflufenzopyr[a]	1+0.4	73
Dicamba + diflufenzopyr[a]	2+0.8	43
Dicamba + diflufenzopyr[a]	4+1.6	0
Dicamba	4	385
Control		729
LSD (0.05)		210

[a]Commercial formulation, BAS-662.

Leafy spurge control also increased when BAS-662 was applied with picloram, 2,4-D, and picloram plus 2,4-D (Table 2). In general, leafy spurge regrowth was reduced nearly 50% more when picloram or 2,4-D was applied with BAS-662 compared to either herbicide alone and by 98% when picloram plus 2,4-D was appliedwith BAS-662 compared to the herbicide combination alone. No increase in control was observed when

diflufenzopyr was applied with the non-auxin type herbicides glyphosate or AC 263,222 (data not shown). The combination of quinclorac plus BAS-662 resulted in precipitate formation, which probably reduced leafy spurge control. This problem was later overcome when quinclorac was applied with diflufenzopyr alone in the field studies. It is not known what amount, if any, the dicamba portion was contributing to the increase in control when BAS-662 was applied with these herbicides. However, dicamba at 4 oz/A caused less than 50% weight reduction (Table 1), so dicamba at 2 oz/A (as occurred with diflufenzopyr at 0.8 oz/A) probably had only a small additive effect on total control observed in this experiment.

Table 2. Leafy spurge regrowth 6 weeks after treatment with various auxin herbicides applied alone or with diflufenzopyr in the greenhouse.

Treatment	Rate	Dry weight
	— oz/A —	— mg —
Picloram	2	313
Picloram + diflufenzopyr[a]	2+0.8	137
2,4-D	2	1045
2,4-D + diflufenzopyr[a]	2+0.8	513
Picloram + 2,4-D	2+4	212
Picloram + 2,4-D + diflufenzopyr[a]	2+4+0.8	6
Control		595
LSD (0.05)		286

[a]Commercial formulation, BAS-662, which includes dicamba.

Field

Diflufenzopyr applied with auxin herbicides increased both foliage injury and season-long control of Canada thistle, especially when applied with 2,4-D and quinclorac (Table 3). Foliage injury averaged 47% 1.5 MAT when the auxin herbicides were applied alone compared to 80% when applied with diflufenzopyr. Quinclorac has very little activity on Canada thistle; but when applied with diflufenzopyr, foliage injury increased from 19 to 76% and control 3 MAT increased from 6 to 67%. Control also dramatically increased when diflufenzopyr was applied with dicamba and 2,4-D, but control only tended to increase when applied with picloram or clopyralid. The increase in control was attributed to root kill to a lower depth and less bud regrowth on the remaining root tissue when the treatment contained diflufenzopyr compared to the corresponding herbicide applied alone.

Table 3. Evaluation of diflufenzopyr applied with various auxin herbicides for Canada thistle control in the field.

Treatment[a]	Rate	Foliage inj. 1.5 MAT[b]	Control 3 MAT[b]
	oz/A	%	
Dicamba	4	54	37
Dicamba + diflufenzopyr[c]	5.6+2.2	76	70
Picloram	2	46	94
Picloram + diflufenzopyr[c]	2+0.8	89	88
2,4-D	4	36	44
2,4-D + diflufenzopyr[c]	4+ 1.6	65	83
Picloram + 2,4-D	2+4	63	93
Picloram + 2,4-D + diflufenzopyr[c]	2+4+0.8	84	94
Quinclorac	8	19	6
Quinclorac + diflufenzopyr[c]	8+3.2	76	67
Clopyralid	1.6	65	83
Clopyralid + diflufenzopyr[c]	1.6+0.6	88	97
LSD (0.05)		13	21

[a]All treatments were applied with X-77 at 1.25% + 28%N at 1.25% v/v.
[b]Months after treatment.
[c]Commercial formulation BAS-662.

Leafy spurge foliage injury and season-long control were also increased when diflufenzopyr was applied with auxin herbicides compared to the herbicides applied alone (Table 4). However, the increase in injury and control was less dramatic compared to the Canada thistle study. Foliage injury 1.5 MAT averaged 66% when auxin herbicides were applied alone compared to 97% when applied with diflufenzopyr. The largest increase in foliage injury occurred when diflufenzopyr was added to picloram, quinclorac, and fluroxypyr. Leafy spurge control 3 MAT was increased or tended to be increased when diflufenzopyr was applied with an auxin herbicide. The largest increase was from 28% with fluroxypyr alone to 76% when with diflufenzopyr, and from 10% with picloram alone to 47% when with diflufenzopyr. No grass injury was observed with any treatment.

Leafy spurge foliage injury 1 MAT was much higher when dicamba was applied with diflufenzopyr compared to dicamba alone (Table 5). Dicamba at 4 and 8 oz/A caused 10 and 66% foliage injury, respectively, compared to 36 and 80%, respectively, when applied with diflufenzopyr.

Spotted knapweed control was similar regardless of herbicide or whether the herbicide was applied alone or with diflufenzopyr (data not shown). The evaluations 12 MAT may provide a better indication of whether or not the addition of diflufenzopyr to an auxin herbicide treatment will improve spotted knapweed control.

Table 4. Evaluation of diflufenzopyr applied with various auxin herbicides for leafy spurge control in the field.

Treatment[a]	Rate	Foliage inj. 1.5 MAT[b]	Control 3 MAT[b]
	oz/A	%	
Dicamba	4	76	5
Dicamba + diflufenzopyr[c]	5.2 + 2.2	93	43
Picloram	2	56	10
Picloram + diflufenzopyr[c]	2 + 0.8	99	47
2,4-D	4	81	40
2,4-D + diflufenzopyr[c]	4 + 1.6	98	45
Picloram + 2,4-D	2 + 4	68	64
Picloram + 2,4-D + diflufenzopyr	2 + 4 + 0.8	95	71
Quinclorac	8	38	88
Quinclorac + diflufenzopyr[c]	8 + 3.2	95	96
Fluroxypyr	4	78	28
Fluroxypyr + diflufenzopyrl	4 + 1.6	100	76
LSD (0.05)		9	34

[a]All treatments were applied with X-77 at 0.25% + 28%N at 1.25% v/v.
[b]Months after treatment.
[c]Commercial formulation BAS-662.

Table 5. Evaluation of dicamba applied alone and with diflufenzopyr for leafy spurge control in the field.

Treatment[a]	Rate	Foliage inj. 1 MAT[b]
	oz/A	%
Dicamba	4	10
Dicamba + diflufenzopyr[c]	4 + 1.6	36
Dicamba	8	66
Dicamba + diflufenzopyr[c]	8 + 3.2	80
Picloram + 2,4-D	4 + 16	97
LSD (0.05)		22

[a]All treatments were applied with X-77 at 0.25% + 28%N at 1.25%.
[b]Month after treatment, 0 = no injury and 100 = all topgrowth killed (brown).
[c]Commercial formulation BAS-662.

In summary, foliage injury and season-long control of Canada thistle and leafy spurge increased when diflufenzopyr was applied with an auxin herbicide compared to the herbicide applied alone. The addition of diflufenzopyr to the herbicide treatments appeared to cause both root kill to a lower depth and less regrowth from the remaining root tissue than when the herbicide was applied alone. ATIs such as diflufenzopyr may be a very important addition for perennial broadleaf weed control by increasing long-term weed control and/or enabling the use of reduced herbicide rates.