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Highlight

When aspen poplar trees were bulldozed and piled in the aspen parkland in Saskatchewan, and the area was seeded to bromegrass + alfalfa, the legume was unable to compete with tree regrowth from creeping roots. The preferred order of herbicide mixtures for control of aspen poplar was 2,4-D + picloram, 2,4-D + dicamba and 2,4-D + 2,4,5-T. Grass and alfalfa yields were statistically similar following all herbicide treatments but forb yields and number were greatly reduced following the application of the mixture containing picloram. The use of fertilizer with a herbicide mixture increased forage yields more than 5 times when compared to the untreated areas.

The aspen parkland vegetation zone in Saskatchewan extends from the northern edge of the mixed-grass prairie to the mixed wood vegetation type (Richards and Fung 1969). The dominant species in the aspen parkland is a tree, aspen poplar (*Populus tremuloides* Michx). At the southern edge of the aspen parkland, aspen poplar is confined to the moister depressional areas in the mixed-grass prairie whereas in the more northerly areas, it forms an almost complete canopy cover.

The forage produced under a complete canopy cover of aspen poplar seldom yields more than 336 kg/ha whereas in the nearby native grasslands, forage yields vary between 673 and 1121 kg/ha (Wiens and Lodge 1972). When trees are removed and a forage stand of bromegrass (*Bromus inermis* Leyss) and alfalfa (*Medicago sativa* L.) is established, yields between 1345 and 3363 kg/ha can be expected. Bulldozers are used to clear cut trees and pile them. Trees are burnt, the area is normally disked 2 or 3 times over several years, and tame forages are seeded. Forages are usually successfully established but at the same time, aspen poplar is able to survive the disk and forage seeding operations because the tree regenerates by creeping roots. Regrowth from root material presents a problem to ranchers as this is the start of a secondary succession that leads to the low forage yields expected in the aspen poplar vegetation type. Regrowth of aspen poplar is often controlled with herbicides but the rate needed for satisfactory tree control kills the alfalfa in the stand.

The objectives of the research were (1) to determine the ability of alfalfa to compete with aspen poplar regrowth, (2) to compare herbicides for aspen poplar control, (3) to increase forage yields with a combination of fertilizer and herbicides and (4) to characterize the vegetation components remaining following herbicide and fertilizer applications.

Methods

The experimental site was located 193 km northeast of Regina, Saskatchewan in the middle of the aspen parkland. During the winter of 1964-65, a solid stand of aspen poplar was bulldozed and piled. The area was disked twice during the summer of 1965 and seeded to a mixture of alfalfa and bromegrass. Forage establishment was satisfactory but aspen poplar quickly reestablished from small pieces of roots that were able to survive disk treatments.

In 1973 and 1974, four and six locations, respectively, were fenced to exclude grazing. Vegetation samples were clipped from sample areas which were 0.0625 m² in size and were located directly under and between plants of aspen poplar. All samples were hand separated into alfalfa, forbs and grasses to evaluate the change in the forage as the trees invaded.

In the herbicide evaluation experiment, the following herbicide mixtures and rates were applied: 2,4-D (2,4-dichlorophenoxyacetic acid) + picloram (4-amino-3,5,6-trichloropicolinic acid) at 2.2 + 0.56 kg/ha; 2,4-D + dicamba (3,6-dichloro-*o*-anisic acid) at 2.2 + 1.1 kg/ha; and 2,4-D + 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) at 1.5 + 0.7 kg/ha. All herbicides were applied on June 25, 1974, and one half of each plot was fertilized with 45 kg/ha of actual nitrogen and phosphorus on May 14-15, 1974; May 7-8, 1975; and April 28-29, 1976. Forage samples were clipped from four one-half m² quadrats per plot and were separated into grasses + alfalfa and forbs. All samples were oven dried. A species list of the forbs was made for each plot.

The degree of aspen poplar control following herbicide application was estimated from the amount of tree canopy cover, which was measured by placing two line transects through each plot. Canopy cover values are expressed as a percent of the total length of the line.

Results

The dry weight of alfalfa was greater in the openings between aspen poplar than directly under the woody plants (Table 1). However, the dry weights of forbs and grasses were similar directly under and between the woody plants.

Table 1. Yield of grass, forbs and alfalfa located under and in the opening between aspen poplar trees.

		Dry weight/0.0625 m²		
Location	Year	Grass	Forbs	Alfalfa
Aspen	1973	4.9 ± 2.5	3.0 ± 0.3	1.0 ± 0.4
Openings	1973	5.7 ± 0.5	3.1 ± 0.3	5.3 ± 2.2
Aspen	1974	3.2 ± 0.2	2.3 ± 0.2	0.3 ± 0.2
Openings	1974	4.4 ± 0.5	2.2 ± 0.1	2.8 ± 1.0

The size of the canopy cover measured during June 1974 before the treatments were applied was similar for all treatments (Table 2). By August of the treatment year, the lowest canopy cover was recorded on the plots receiving a mixture of 2,4-D + picloram and no fertilizer. The size of the canopy cover on all of the other herbicide treated plots did not change greatly from that recorded during June. The canopy cover recorded on herbicide treated plots one (1975) and two (1976) years following chemical application was lowest on plots treated with a mixture of 2,4-D + picloram, intermediate on plots treated with a

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mixture of 2,4-D + dicamba and highest on 2,4-D + 2,4,5-T treated plots. Fertilizer did not appear to have any influence on the size of the canopy cover in a plot.

Table 2. Percent canopy cover of aspen poplar following the application of 2,4-D + picloram, 2,4-D + dicamba, and 2,4-D + 2,4,5-T on fertilized and non-fertilized plots.

			Time of canopy cover measurement			
Herbicide	Rate (kg/ha)	Fertilizer applied	June 1974	August 1974	August 1975	August 1976
Check		No	15	21	36	31
Check		Yes	17	24	33	28
2,4-D + picloram	2.2+0.56	No	12	4	2	7
2,4-D + picloram	2.2+0.56	Yes	15	16	5	10
2,4-D + dicamba	2.2+1.1	No	15	15	8	13
2,4-D + dicamba	2.2+1.1	Yes	15	10	7	11
2,4-D + 2,4,5-T	1.5+0.7	No	16	13	14	23
2,4-D + 2,4,5-T	1.5+0.7	Yes	14	10	11	15

Applying fertilizer in the spring of the year resulted in a significant increase in the yield of forage during 1974 (Table 3). However, during the year of application of herbicides, forage yields were similar on non-fertilized plots. The yield of forage recorded during the two years immediately following herbicide application exceeded the untreated plots. The highest forage yields were obtained when fertilizer was applied with any of the herbicide mixtures. Grass and alfalfa yields were statistically similar following the use of fertilizer with any of the herbicide mixtures.

Table 3. Yield of forage following the application of 2,4-D + picloram, 2,4-D + dicamba, and 2,4-D + 2,4,5-T on fertilized and non-fertilized plots.

			Yield of alfalfa and grasses (g/m²)[1]		
Herbicide	Rate (kg/ha)	Fertilizer applied	1974	1975	1976
Check		No	54be	70d	65d
Check		Yes	90ab	218b	224b
2,4-D + picloram	2.2+0.56	No	34e	207b	173bc
2,4-D + picloram	2.2+0.56	Yes	90ab	422a	435a
2,4-D + dicamba	2.2+1.1	No	37e	149bcd	154bc
2,4-D + dicamba	2.2+1.1	Yes	86ab	374a	402a
2,4-D + 2,4,5-T	1.5+0.7	No	39e	125cd	120c
2,4-D + 2,4,5-T	1.5+0.7	Yes	106a	357a	393a

[1]Means in the same column followed by the same letter are not significantly different at the 5% level of probability as calculated by Duncan's multiple range test.

The yield of forbs was more closely related to the type of herbicide mixture used than the use of fertilizer (Table 4). The dry weight of forbs following the use of mixture of 2,4-D + picloram was very low during both the first and second year following treatment. Comparing the three herbicide mixtures, forb yields were lowest when a mixture of 2,4-D + picloram was used, intermediate when a mixture of 2,4-D + dicamba was used and greatest when a mixture of 2,4-D + 2,4,5-T was used. Also, the number of species was lowest on 2,4-D + picloram treated plots, intermediate on 2,4-D + dicamba treated plots and greatest on 2,4-D + 2,4,5-T treated plots (Table 5).

Discussion

Alfalfa is an important component of our grasslands and its presence in a grass stand can increase yields by 50 to 100% over a grass mono-culture (Anonymous 1975). During the first 2 or 3 years following forage seeding when aspen poplar reestablishes itself from root fragments, alfalfa was unable to survive when closely associated with the tree, and was one of the first species to disappear from the forage stand (Table 1). It is during this time period that the application of herbicides for brush control is often delayed in Saskatchewan because alfalfa will not tolerate the rate of herbicide used. However, it is better to control aspen poplar to maintain a good stand containing grasses than to let the trees grow which will crowd out alfalfa and eventually the tame grasses.

Table 4. Yield of forbs following the application of 2,4-D + picloram, 2,4-D + dicamba, and 2,4-D + 2,4,5-T on fertilized and non-fertilized plots.

			Forb yield (g/m²)[1]		
Herbicide	Rate (kg/ha)	Fertilizer applied	1974	1975	1976
Check		No	34a	45a	54a
Check		Yes	38a	42a	36b
2,4-D + picloram	2.2+0.56	No	9e	1c	3a
2,4-D + picloram	2.2+0.56	Yes	27ac	1c	1a
2,4-D + dicamba	2.2+1.1	No	15ce	11bc	14a
2,4-D + dicamba	2.2+1.1	Yes	23ace	8bc	17a
2,4-D + 2,4,5-T	1.5+0.7	No	15ce	28ab	38b
2,4-D + 2,4,5-T	1.5+0.7	Yes	33ac	37a	33b

[1]Means in the same column followed by the same letter are not significantly different at the 5% level of probability as calculated by Duncan's multiple range test.

Table 5. Number of species of forbs growing 1 and 2 years following the application of 2,4-D + picloram, 2,4-D + dicamba, and 2,4-D + 2,4,5-T.

			Time from application (years)[1]	
Herbicide	Rate (kg/ha)	Fertilizer applied	1	2
Check		No	17c	19c
Check		Yes	15bc	12b
2,4-D + picloram	2.2+0.56	No	3a	4a
2,4-D + picloram	2.2+0.56	Yes	2a	5a
2,4-D + dicamba	2.2+1.1	No	9ab	11b
2,4-D + dicamba	2.2+1.1	Yes	8ab	9ab
2,4-D + 2,4,5-T	1.5+0.7	No	16bc	15b
2,4-D + 2,4,5-T	1.5+0.7	Yes	14bc	11b

[1]Means in the same column followed by the same letter are not significantly different at the 5% level of probability as calculated by Duncan's multiple range test.

It is important to use as many disk operations as necessary, spaced over several seasons prior to forage seeding in order to reduce aspen poplar reestablishment. In an area of Saskatchewan where cultural methods failed to control aspen poplar, none of the herbicide mixtures tested completely controlled tree growth by reducing the canopy cover to a near zero value (Table 2). The most effective herbicide was a mixture of 2,4-D + picloram, which resulted in the lowest recorded canopy cover. Plots receiving mixtures containing picloram or dicamba had a lower aspen poplar canopy cover than the combination of 2,4-D + 2,4,5-T, which is often used in Saskatchewan. There was no consistent evidence that fertilizer changed the size of the canopy cover following application of any of the herbicide mixtures, which means the trees are not being fertilized.

Laboratory analysis for the nutrient content of the soil indicated both a nitrogen and phosphorus deficiency so forage yield increases were expected (Table 3). When the test was sprayed in 1974, the trees were growing rapidly and competing with the grasses. Herbicide injury was not apparent until the first part of July. Therefore, aspen poplar competition was not reduced until after the year's growth of forage, which explained why yields do not increase during the herbicide treatment year. Maximum yield increases occurred when herbicides were used in conjunction with fertilizer and this effect was independent of the herbicide mix. The magnitude of this increase indicates that it is more important to use one of the herbicide mixtures than the best one. Although 15% of the 2,4-D + 2,4,5-T treated plots were covered by a canopy of aspen poplar in 1976, the forage yield was 10% less than the plots treated with a mixture that contained picloram (Tables 2 and 3). This suggests that aspen poplar, which are treated with any of the herbicide mixtures and have a partial kill of the tree canopy, are much less competitive with grasses than are the unsprayed trees.

The main difference between the three herbicide mixtures used in the test was the reduction in the number and weight of forbs when mixtures containing picloram and dicamba were applied (Tables 4 and 5). Although no attempt was made to separate the forbs into desirable and undesirable components, the magnitude of the reduction that occurred when a mixture of 2,4-D + picloram was used means a loss of some desirable forage (Table 4). The reduction of forb number and weight on rangeland when picloram is used must be completely understood by ranchers before the chemical is widely used in Saskatchewan. Rangeland following picloram treatment will consist mainly of grasses rather than a mixture of grasses and forbs that are found following our presently used 2,4-D type herbicides.

The following was concluded: (1) When a mixture of alfalfa and bromegrass was seeded on rangeland following brush removal and cultural methods failed to control aspen poplar, the legume was unable to compete and disappeared from the stand. (2) Better control of aspen poplar was obtained following the application of a mixture of 2,4-D + picloram applied at 2.2 + 0.56 kg/ha than with a mixture of 2,4-D + 2,4,5-T applied at 1.5 + 0.7 kg/ha. (3) Grass + alfalfa yields were similar following the application of any of the three herbicide mixtures. (4) Maximum yields were obtained following the use of any of the herbicide mixtures and fertilizer. (5) Forb weight and number were greatly reduced following the use of the mixture containing picloram which resulted in a stand of mainly grasses.

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