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EVALUATION OF AVAILABLE
HERBICIDES AND HERBICIDE
MIXTURES FOR CONTROL OF
BRUSH AND MILKWEED
ALONG ROADSIDES

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Interim Report

EVALUATION OF AVAILABLE HERBICIDES AND HERBICIDE MIXTURES FOR
CONTROL OF BRUSH AND MILKWEED ALONG ROADSIDES

TO: H. L. Michael, Director
Joint Highway Research Project

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FROM: D. James Morre

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Attached is the Interim Report on the HPR Part II Study titled "Chemical Mowing: A New Maintenance Concept for Indiana Roadsides" which covers the implementation phase of an HPR Part II Study of earlier years. This implementation phase is a part of the current study but was to be completed by December 31, 1979. This Report, hence, will complete that phase of this Study.

Details of the evaluation are included in the Report. The ISHC is using many of the recommendations of the earlier study and these evaluations of implementation by them have been of value to the research, to ISHC and to further implementation of the findings.

Respectfully submitted,

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16. Abstract A mixture of Tordon (picloram) herbicide plus 2,4-D amine at recommended rates applied in the fall of 1978 in the fall-spring spraying rotation in an experimental contract gave excellent full season control of common milkweed and brush. Other materials were as effective as 2,4-D amine on 2,4-D susceptible species but offered little improvement for control of the milkweed. A 3-WAY HERBICIDE MIXTURE for control of brush on unmowed portions of the Interstate System was evaluated on the basis of use by contractors as "spot" applications. In some areas, kill of brush was good. However, there appeared to have been many "skips" especially with small, scattered brush. In other areas, there was no evidence of kill or even injury suggesting that perhaps these areas were not sprayed. Based on brush/mile estimates, the treatment was found to have been about 30% effective. Needless to say the spot application of herbicide to control brush in the 1978 schedule was not cost effective and probably should not be repeated in future years. A problem of increasing severity is that of brush (and trees) growing in the fences bordering the Interstate highways. We found an average of 52.5 brush or woody species per mile, overall, for the northern 2/3 of the State. This averages to nearly 1 every 100 feet. Eventually, this source of vegetation is likely to become a problem in the maintenance of Interstate fences.			
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HIGHLIGHT SUMMARY

A mixture of Tordon (picloram) herbicide plus 2,4-D amine at recommended rates applied in the fall of 1978 in the fall-spring spraying rotation in an experimental contract gave excellent full season control of common milkweed and brush. Other materials were as effective as 2,4-D amine on 2,4-D susceptible species but offered little improvement for control of the milkweed.

A 3-WAY HERBICIDE MIXTURE for control of brush on unmowed portions of the Interstate System was evaluated on the basis of use by contractors as "spot" applications. In some areas, kill of brush was good. However, there appeared to have been many "skips" especially with small, scattered brush. In other areas, there was no evidence of kill or even injury suggesting that perhaps these areas were not sprayed. Based on brush/mile estimates, the treatment was found to have been about 30% effective. Needless to say the spot application of herbicide to control brush in the 1978 schedule was not cost effective and probably should not be repeated in future years.

A problem of increasing severity is that of brush (and trees) growing in the fences bordering the Interstate highways. We found an average of 52.5 brush or woody species per mile, overall, for the northern 2/3 of the State. This averages to nearly 1 every 100 feet. Eventually, this source of vegetation is likely to become a problem in the maintenance of Interstate fences.

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INTRODUCTION

The Fall-Spring Spraying rotation for control of broad-leaf weeds along Indiana was instituted in 1971 when approximately 1,500 linear miles of highway received a fall application of 2,4-D between September 15 and October 15 under the Spraying Program by Contract. The fall application was followed by a second application in early spring. In 1972 the program was expanded to a 3-year spraying rotation so that each year approximately 1/3 of the state is sprayed. The rationale in this program is that the treatment is, on the average, 90% effective in the control of roadside vegetation. With a "weedy" road having a weed density of 100,000 weeds per acre, the reduction is down to 10,000 weeds per acre which is quite acceptable in terms of appearance and maintenance of a healthy turf. Approximately 3 years are required for the weed population to re-establish to the point where it again become worthwhile to spray.

In the nearly 10 years since this program has been operational general roadside weed problems have all but been eliminated. A reduction from 5-cycle to 3-cycle mowing resulted in substantial cost savings and as demonstrated in recent years further reductions in mowing are possible.

A major problem with a program involving spraying with 2,4-D amine is that a few species, especially milkweed and canadian thistle are resistant. Thistle occurs in localized patches and is ammenable to control by spot applications if this is desired. Milkweed, on the other hand, is a more general weed problem and because of the conspicuous nature of the plant (Figure 1) presents an unsightly aspect to an otherwise weed-free roadside.

Figure 1. Common milkweed infestation along I-74 in Montgomery County. This particular area shows milkweed in an unsprayed area planted to crown vetch. Not only is the plant large, attaining a height of 3-5 ft, and unsightly, it is a good competitor and is probably the only weed that can successfully compete with established crown vetch. The plant is a perennial growing from an underground system of rootstocks.

A second problem, especially with reduced mowing or elimination of mowing in certain areas, is the invasion of roadsides by brush, brambles briars and trees. This is especially a problem near the fence where most contractors do not spray or do not spray heavily enough with the 2,4-D mixtures to control brush. A THREE-WAY HERBICIDE MIXTURE was recommended for broadcast application by off-road equipment for the Interstate System. In 1978, this herbicide mixture was applied not as a broadcast application but as a "spot" treatment.

The purpose of this report is to present results on the efficacy of broadcast herbicide applications in relative control of milkweed and an evaluation of the efficacy of the THREE-WAY HERBICIDE MIXTURE as a "spot" treatment for control of brush in the contract spraying program. Additionally information is given on the incidence of brush growing in fences bordering the Interstate system.

METHODS OF PROCEDURE

General.--All herbicide treatments were applied in the fall of 1978 with a second application of standard 2,4-D in the spring of 1979. Applications were in the normal contract program and by contractors. Evaluations were during the spring and summer of 1979.

Tordon + 2,4-D for control of common milkweed.--This treatment was evaluated as a special Contract No. M-11639. The experimental section was on I-74N and I-74S in Montgomery County and extended from mile post 21 to mile post 27 as indicated in the north-bound lane. The rate of application was approximately 1.5 lb picloram + 0.5 lb 2,4-D amine per acre. The actual amount applied by the contractor was 50 gal per 60 acres. Picloram was 2 lb/gal material. 2,4-D amine was 4 lb/gal material.

Efficacy was evaluated in terms of general weed control in the fall of 1978 approximately 6 weeks after spraying. Efficacy for milkweed and general weed control was again evaluated in the spring of 1979. Final milkweed and weed counts were obtained June 29, 1979. At this time the plots were also photographed.

MCPP + MCPA for control of common milkweed.--The materials were mixed at the rate of 0.75 gal MCPA + 1.25 gal MCPP (4 lb/gal material) per 100 gal of water and applied at a rate of about 40 gal per acre. This is equivalent to about 1.2 lb MCPP + 2 lb MCPA per acre. Applications were in the Greenfield District.

3-WAY HERBICIDE MIXTURE for "spot" control of brush.--A mixture of equal parts of an amine salt formulation of 2,4-D + 2,4,5-TP (Silvex) + dicamba (Banvel) was used as a tank mix of formulated products each containing 4 pounds per gallon of active material in 100 gallons of water.

The application was made at the discretion of the contractor so that the evaluation is some combination of the efficacy of the herbicide material and the efficacy of the applicator in treating the brush.

Standard 2,4-D amine.--The material was 2,4-D, amine form, containing 4 lbs of acid equivalent per gallon. The material was recommended to be mixed at the rate of 2 gallons of 2,4-D concentrate to 100 gallons of water. The mixture was applied at the rate of 40 gallons per acre in the fall between September 1 to the first killing frost and again in the following spring between April 15 and approximately May 15.

Evaluation of efficacy against common milkweed.--Due to the scattered nature of the milkweed plants, all plants were counted between the edge of the pavement and the fence in a 0.1 mile segment as one count. On the average for a road segment, one such 0.1 mile count was taken every 1.8 miles. It actually varied from one per mile to one per every 2 miles depending upon the uniformity and density of the milkweed population.

Brush counts.--All brush were counted between the edge of the pavement and the fence (up to but not including that in the fence). Brush was scored as "dead" if it showed definite evidence of being sprayed. Brush was scored as healthy if there was no evidence of being sprayed or if so little damage had been done so as not to be sure. Brush in the fence was counted as a separate category. Brush included briars, vines, brambles, small trees, large trees, evergreens and any form of woody vegetation but did not include species introduced as roadside planting.

All wood species were counted in 1 mile segments approximately 1 such segment every 3 miles. A total of 625 miles of Interstate in the northern 2/3 of the State were sampled.

General weed counts.--All surviving broad-leaved weeds exclusive of milkweed and canadian thistle were counted in an area of 10 square feet.

Three different portions of the right-of-way were sampled:

- a) Adjacent to the pavement
- b) Midway between the pavement edge and the fence or fence line
- c) Approximately 1 foot back from the fence or fence line

The first set of counts was taken on the right side of the road facing the direction of travel. The sample zones for this series were taken every 25 feet (about 5 paces) to give a total of 10 counts for each of the three sample zones in a linear distance of about 250 feet. When the last of the 10 counts was completed, an identical procedure was followed for the left side of the road.

RESULTS

Control of Common Milkweed

A serious milkweed infestation based on evaluation of unsprayed and unmowed check areas was estimated to be approximately 1,200 plants per mile (Table I). In a direct comparison, road segments sprayed with the standard 2,4-D amine fall-spring application schedule had 650 milkweed plants per mile confirming previous results that the 2,4-D mixture is only about 50% effective in control of milkweed. As in past years, the 2,4-D treatment in 1978 was judged to be about 90% effective reducing the overall weed population to less than 10,000 weeds per acre (Table I).

As a statewide average, the milkweed population on the Interstate System was 150 plants per mile and ranged from about 30 to 300 per mile (Tables III-IV). On this basis, an experimental mixture of MCPA and MCPP (Table II) appeared to offer no substantial improvement in terms of milkweed control over the standard 2,4-D amine formulation.

Satisfactory control of milkweed was given by picloram + 2,4-D mixture applied in the experimental contract (Table I). The population was reduced to approximately 20 plants per acre indicative of 98% control. Other 2,4-D susceptible weeds were eliminated by the treatment (Table I). The treated roadsides appeared to be in excellent condition (Figures 3 and 5) compared to untreated sections (Figures 2 and 4). These evaluations were made in late June and it is doubtful if any of the controlled milkweed plants will return. Those few plants that escaped were weakened and stunted as illustrated in Figure 3. A treatment of 0.5 lb/A picloram plus 2,4-D applied by Clyde Mason in the Greenfield in the spring was also effective especially with carrot (Table V).

TABLE I

Evaluation of Contract No. M-11639. Experimental Section. I-74. Montgomery County. Mile post 21 to mile post 27. The rate of application was approximately 1.5 lb picloram + 0.5 lb 2,4-D per acre.

<u>Treatment</u>	Common milkweed <u>(plants/0.1 mile)</u>	All other weeds <u>(weeds/10 square ft)</u>
None (unsprayed and unmowed check)	120 $\pm$ 40	200 $\pm$ 25
Standard 2,4-D amine (unmowed)	65 $\pm$ 35	19 $\pm$ 6
Picloram + 2,4-D (unmowed)	2 $\pm$ 2	0

Treatments were applied in the fall of 1978. Final evaluations were on June 29, 1979.

TABLE II

Evaluation of the effectiveness of a mixture of MCPP + MCPA for control of common milkweed and other weed species. The materials were mixed at the rate of 0.75 gal MCPA + 1.25 gal MCPP (4 lb/gal material) per 100 gal of water and applied at a rate of about 40 gal per acre.

<u>Location</u>	Common milkweed (plants /0.1 mile)	All other weeds (weeds/10 square ft)
U.S. 40 east of Greenfield	37 $\pm$ 3	0
U.S. 40 west of Greenfield	6 $\pm$ 4	0
I-70 west of Greenfield	7 $\pm$ 7	0
I-465 N	24 $\pm$ 11	0
Average	18 $\pm$ 6	0

Treatments were applied in the fall of 1978. Final evaluations were in June of 1979.

TABLE III

Evaluation of the effectiveness of the standard fall-spring application of 2,4-D amine for control of common milkweed and other weed species. Treatments were applied in the fall of 1978 and spring of 1979. Evaluations were in June and July 1979.

<u>Location</u>	Common milkweed (<u>plants/0.1 mile</u>)	All other weeds (<u>weeds/10 square ft</u>)
I-65 N of Indianapolis	28 $\pm$ 12	16 $\pm$ 5
US 52 W of Indianapolis	22 $\pm$ 8	3 $\pm$ 3
I-74 N of Crawfordsville	65 $\pm$ 35	19 $\pm$ 6
I 69 N of Fort Wayne	3 $\pm$ 3	1 $\pm$ 1
I-70 N of Lebanon	3 $\pm$ 8	
US 52 E of Lafayette	7 $\pm$ 7	
US 24 W of Fort Wayne	less than 1	
I-65 S of Indianapolis	15 $\pm$ 5	
US 31 S (U.S. 24 to Kokomo)	6 $\pm$ 4	
Average	18 $\pm$ 18	10 $\pm$ 9

TABLE IV

Further evaluation of the effectiveness of the standard fall-spring application of 2,4-D amine for control of common milkweed and other weed species. Treatments were applied in the fall of 1978 and spring of 1979. Evaluations were in June and July 1979.

<u>Location</u>	<u>Miles</u>	<u>Miles surveyed</u>	<u>Common milkweed (plants/0.1 mile)</u>
I-65 N Lafayette to White-Tippecanoe Co line	5	0.4	20 $\pm$ 10
I-65 N White-Tippecanoe Co line to Remington exit	16	1.4	2 $\pm$ 2
I-65 S Remington exit to White-Tippecanoe Co line	16	2.0	3 $\pm$ 3
I-65 S White-Tippecanoe Co line to Lafayette	5	1.8	11 $\pm$ 7
I-70 W Terre Haute to Illinois/Ind state line	6	0.5	7 $\pm$ 3
I-70 E Illinois/Ind state line to Terre Haute	6	0.5	29 $\pm$ 15
I-65 S Hammond to Remington	60	1.5	3 $\pm$ 3
I-65 N Remington to Hammond	60	2.1	7 $\pm$ 7
Average			10 $\pm$ 9

Figure 2. Unsprayed portion of I-74 adjacent to picloram-2,4-D test area in the background. Northbound lane photographed June 29, 1979.

Figure 3. Sprayed portion of I-74 in the picloram-2,4-D test area. Northbound lane photographed June 29, 1979. The few remaining plants (one shown in the foreground) are weakened and stunted.

Figure 4. Unsprayed portion of I-74 in the vicinity of the picloram-2,4-D test area. This is the southbound lane looking north photographed June 29, 1979.

Figure 5. Sprayed portion of I-74 in the picloram-2,4-D test area. This is the southbound lane looking north photographed June 29, 1979.

TABLE V

Evaluation of a mixture of 0.5 lb picloram + 1.5 lb 2,4-D amine per acre applied in the fall of 1978 on SR 9 north of Greenfield. Evaluations were on May 10, 1979.

<u>Treatment</u>	<u>Weeds per 10 square feet</u>				
	<u>Wild carrot</u>	<u>Dandelion</u>	<u>Dock</u>	<u>Milkweed</u>	<u>Other species</u>
Check	1.2	7.0	0.6	0.4	7.0
Treated	0	0	0	0.4	0

Efficacy of the 3-WAY HERBICIDE MIXTURE as a spot application
for control of brush

Evaluations of the use of the 3-WAY HERBICIDE MIXTURE for control of brush on unmowed portions of the Interstate System were completed for the northern 2/3 of the State. Approximately 625 miles of the Interstate System were evaluated. All healthy and dead or dying brush beyond the fence line was counted on 210 miles of Interstate or about 33% of the total area evaluated.

Based on brush/mile estimates, the treatment was found to have been about 30% effective. That is to say only 30% of the brush found between the pavement and the fence showed evidence of having been successfully treated (Table VI).

On the average, we found 17.7 brush species/mile. Of these 12.4 were healthy and apparently had not been sprayed (most were susceptible species) while only 5.3 showed evidence of having been treated. The percent brush control varied from 100% on old US 40 between Greenfield and Indianapolis to 0% on I-74 East between Crawfordsville to the Henricks County line. Generally, where the brush was actually sprayed, the results were very good. In some areas definite overtreatment was indicated since enough spray material had been applied to kill the grass in the vicinity of the sprayed vegetation.

In the fence row, we found an average of 52.5 brush or wood species per mile, overall, for the northern 2/3 of the State. This averages out to 1 every 100 feet. Eventually this source of vegetation is likely to become a problem in maintaining Interstate fences.

TABLE VI

Evaluation of effectiveness of the 3-WAY HERBICIDE MIXTURE for control of brush as a "spot" application in the 1978 fall-spring contract application to the Interstate System. The final column gives the number of woody species present in or next to the fence.

<u>Road segment</u>	<u>Location</u>	<u>Miles</u>		<u>Brush/mile + Std. Dev.</u>		
		<u>Surveyed</u>	<u>Counted</u>	<u>Healthy</u>	<u>Dead</u>	<u>In Fence</u>
I-74E	Crawfordsville to Henricks Co ln	13	6	41 $\pm$ 26	0 $\pm$ 0	120 $\pm$ 20
I-74E	Henricks Co ln to Indianapolis	14	7	7 $\pm$ 7	2 $\pm$ 2	110 $\pm$ 10
I-70E	Indianapolis to Greenfield	14	8	6 $\pm$ 6	9 $\pm$ 9	55 $\pm$ 20
I-70 W	Greenfield to Indianapolis	14	9	1 $\pm$ 1	0	30 $\pm$ 10
US-40W	Greenfield to Indianapolis	14	6	0	10 $\pm$ 10	130 $\pm$ 70
I-465N	Indianapolis	26	10	8 $\pm$ 1	6 $\pm$ 3	76 $\pm$ 21
I-65N	Indianapolis to Lebanon	9	6	6 $\pm$ 2	1 $\pm$ 1	34 $\pm$ 10
I-65N	Lebanon to Lafayette	50	8	14 $\pm$ 7	4 $\pm$ 4	40 $\pm$ 4
I-65S	Lafayette to Indianapolis	60	8	20 $\pm$ 20	6 $\pm$ 6	33 $\pm$ 13
I-69N	Fort Wayne to Michigan line	40	20	8 $\pm$ 8	5 $\pm$ 5	41 $\pm$ 16
US-52W	Indianapolis to Lafayette	40	18	14 $\pm$ 14	7 $\pm$ 7	30 $\pm$ 11
US-52E	Lafayette to Indianapolis	40	15	12 $\pm$ 12	8 $\pm$ 8	36 $\pm$ 16
I-69S	Michigan line to Fort Wayne	44	20	11 $\pm$ 7	22 $\pm$ 16	55 $\pm$ 22
US-24W	Fort Wayne to US 31	40	4	10 $\pm$ 10	0 $\pm$ 0	33 $\pm$ 15
US-31S	US 24 to Kokomo	19	4	10 $\pm$ 10	0 $\pm$ 0	30 $\pm$ 10
I-65N	Lafayette to White-Tipp. Co ln	5	4	9 $\pm$ 4	3 $\pm$ 4	21 $\pm$ 6
I-65N	White-Tipp. Co ln to Remington exit	16	7	4 $\pm$ 4	1 $\pm$ 1	5 $\pm$ 5
I-65S	Remintgon exit to White-Tipp. Co ln	16	7	4 $\pm$ 4	0.3	4 $\pm$ 4
I-65S	White-Tipp. Co ln to Lafayette	5	5	11 $\pm$ 10	0 $\pm$ 0	20 $\pm$ 20
I-70W	Terre Haute to Ind/Ill line	6	6	8 $\pm$ 4	2 $\pm$ 2	38 $\pm$ 10

TABLE VI CONT'D

Evaluation of effectiveness of the 3-WAY HERBICIDE MIXTURE for control of brush as a "spot" application in the 1978 fall-spring contract application to the Interstate System. The final column gives the number of woody species present in or next to the fence

<u>Road segment</u>	<u>Location</u>	<u>Miles</u>		<u>Brush/mile + Std. Dev.</u>		
		<u>Surveyed</u>	<u>Counted</u>	<u>Healthy</u>	<u>Dead</u>	<u>In Fence</u>
I-70E	Ind/Ill line to Terre Haute	6	3	59 $\pm$ 12	15 $\pm$ 5	55 $\pm$ 5
80-94E	Ind/Ill line to I-64	14	3	25 $\pm$ 5	0 $\pm$ 0	25 $\pm$ 5
I-65S	Hammond to Remington	60	13	17 $\pm$ 17	1 $\pm$ 13	30 $\pm$ 60
I-65N	Remington to Hammond	60	14	7 $\pm$ 7	4 $\pm$ 4	20 $\pm$ 20
Total miles		625	210			
Average number of brush				12.4	5.3	52.5
% brush dead				30%		

DISCUSSION

The mixture of Tordon (picloram) + 2,4-D for control of brush and resistant weed species including common milkweed and a mixture of MCPP + MCPA for control of wild carrot, brush and resistant species, included in the fall portion of the 1978 fall-spring cycle of spraying by contract were evaluated and compared to standard 2,4-D amine. All treatments, including the standard 2,4-D, were greater than 90% effective in general weed control. All treatments were effective in control of wild carrot and wild parsnip. Standard 2,4-D, applied in the fall, was about 50% effective in control of common milkweed. MCP + MCPA offered no substantial improvement over standard 2,4-D for control of milkweed. Only with Tordon + 2,4-D was greater than 90% control of common milkweed achieved.

The poor performance of the spot application of the 3-WAY HERBICIDE MIXTURE for control of woody vegetation in the 1978 fall-spring cycle of spraying by contract was due largely to the following factors:

- a) Large segments of Interstate were never treated
- b) Isolated brush were skipped
- c) Large amounts of herbicide mixture were dumped in the centers of brush clumps (often enough to kill the grass) with no attention to uniformity of application.

The obvious conclusion is that the spot application of herbicide to control brush in the 1978 fall herbicide application was not cost effective and should not be repeated. A broadcast application, although more expensive, still seems to be the best approach due to the scattered nature of the brush and woody vegetation.

RECOMMENDATIONS

- 1) The mixture of Tordon + 2,4-D could be used in future years on Interstate segments where milkweed is a problem. The treatment is effective in control of general weeds, brush and problem weeds. One possibility would be to utilize milkweed count data available and schedule only those interstate segments where the milkweed population exceeds 100 per mile. If the milkweed population was less than 100 per mile, standard 2,4-D amine would be continued.
- 2) MCP + MCPA offers no advantage over standard 2,4-D amine in control of milkweed which gives about 50% control compared to 98% for the Tordon + 2,4-D mixture.
- 3) Tordon + 2,4-D mixtures where the amount of 2,4-D exceeds the amount of Tordon are not effective in control of milkweed at comparable rates of Tordon.
- 4) Spot applications for brush control in the contract program are not feasible largely due to skips and inconsistent application procedures.
- 5) In the fence row, the population of woody species averages 52.5 per mile for the northern 2/3 of the state or about 1 every 100 feet. This vegetation may become troublesome in future maintenance of Interstate fences.

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