AN ABSTRACT OF THE THESIS OF

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Title: Integrated Control of Tansy Ragwort (Senecio jacobaea L.)

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Abstract approved:

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Three components of an integrated control program for tansy ragwort (Senecio jacobaea L.) were studied: (a) the effects of fall and spring applications of 2,4-D [(2,4-dichlorophenoxy)acetic acid] on white clover (Trifolium repens L.); (b) the effect of fall application of 2,4-D on the regrowth of tansy ragwort which had been defoliated by cinnabar moth [Tyria jacobaeae (L.)]; and (c) the effect of direct application of 2,4-D to cinnabar pupae. A pilot study was also conducted to observe tansy ragwort growth and cinnabar moth activity during the summer following fall 2,4-D treatment.

None of the fall treatments of 2,4-D caused any significant reduction in dry matter of white clover, even at the relatively high rate of 4.5 kg/ha. All spring treatments reduced clover growth significantly when clover was harvested 4.5 weeks after treatment. The ester formulation caused the most severe injury, followed by amine plus wetting agent, then amine. By mid-summer, the clover had nearly

recovered. Fall treatment of tansy ragwort with 2,4-D ester, amine + wetting agent, or amine at 2.25 kg/ha controlled 99% of regrowing rosettes. Emergence of adult moths from pupae treated directly with 2,4-D amine at 2.25 kg/ha was not affected.

In the pilot study area, regrowing and first-year tansy ragwort was controlled. The cinnabar moth, although preferring large, second-year plants, also laid eggs on seedlings and first-year plants.

These results indicate that an integrated control program is practicable. Fall applications of 2,4-D avoid white clover injury, eliminate regrowing tansy ragwort, and speed up control of this noxious weed with the continuing assistance of cinnabar moth larvae which feed on the tansy ragwort seedlings and young rosettes that germinate following 2,4-D treatment.

INTEGRATED CONTROL OF TANSY RAGWORT

(*Senecio jacobaea* L.)

by

Claudia L. Powers Evans

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INTRODUCTION

Tansy ragwort (*Senecio jacobaea* L.) is a toxic member of the composite family found throughout the world in temperate to subtropical zones (Muth 1968). Native to Europe and the British Isles, it has spread to many other geographical areas, including North America, New Zealand, Tasmania, Australia, South Africa, and South America (Huffaker and Messenger 1976). Tansy ragwort was first introduced into Canada in the town of Pictou, Nova Scotia, circa 1852 in ship ballast from Scotland (Tilt 1969). The weed was recorded in western North America for the first time in 1913 near Nanaima, Vancouver Island, British Columbia. The first documented introduction into Oregon was in 1922 (Isaacson 1973).

Tansy ragwort is now a serious problem from northwestern California to British Columbia, particularly from the West Coast to the Cascade Mountains. Reports from the Oregon State Department of Agriculture indicate that 18 western Oregon counties have tansy ragwort infestations.

The toxic components found in tansy ragwort are from a group of pyrrolizidine alkaloids which are known to be hepatoxic. These alkaloids include senecionine, seneciphylline, jacoline, jaconine, jacobine, and jacozine and have been reported to be carcinogenic, mutagenic, and teratogenic (Deinzer et al. 1977). These alkaloids are relatively non-toxic until conversion by liver microsomal enzymes into the more toxic compounds, known as pyrroles. Pyrroles are highly reactive and are suspected to cause liver damage by acting as a mitotic inhibitor producing liver cell enlargement. Necrosis of liver cells and vascular damage are also seen (McLean 1974).

Cattle, horses, and swine have been poisoned by tansy ragwort. Estimates of losses due to livestock poisoning in Oregon range from $707,000 to $3.6 million (Isaacson 1975). Sheep appear to be more resistant to the toxic agents and have been suggested as a means of control (Mosher 1979).

Because of its unpalatability, tansy ragwort is not a preferred forage; however, on overgrazed or heavily infested pastures, it can be inadvertently consumed by grazing livestock. Another area of concern is contamination of hay and seed crops.

Toxicology

The question of public health hazard has been raised by two studies. Schoental (1959) found that young rats whose mothers were fed the plant, developed symptoms of poisoning. A recent study using goats (Goeger 1980) suggests that the toxic pyrrolizidine alkaloids can be transferred into the milk.

Tansy ragwort is a biennial plant. Seeds generally germinate in the fall with the first rains, although spring germination does occur (Cameron 1935). During the first years, plants remain as rosettes; in the spring of the second year each rosette produces a stem which grows to a height of 0.5 to 1.5 m. Near the top of the stem, branching occurs with the formation of numerous flower heads from a compact terminal corymb. If the plant is injured by grazing of phytophagous insects, mechanical injury from mowing, or grazing of animals during the second year, it may assume a perennial habit, producing a flower stalk the following spring.

Good management practices have long been recommended for control of tansy ragwort (Cameron 1935, Montgomery 1947, Oregon State University 1979). In areas where tansy ragwort has not been reported, the use of preventative measures including certified seed, maintaining a vigorous closed sward, using clean feed, and organizing a grazing rotation system will help prevent establishment.

Early chemical control recommendations included sodium chlorate applied as a solution (Deem 1930) or a mixture of three parts common salt and one part iron sulfate applied directly to the plants (Cameron 1935).

Discovery of the herbicidal properties of plant growth regulators opened the "Chemical Age" of weed control (Peterson 1967). Ward (1946) reported promising results in preliminary tests using 2,4-D to control tansy ragwort but cautioned that clovers (Trifolium spp.) were quite susceptible. Further research confirmed the effectiveness of 2,4-D against tansy ragwort (Bird 1977, Forbes 1978, Halliday and Templeman 1951); however, the effect on clover remained disputed. Slaats and Stryckers (1951) reported that white clover was injured by 2,4-D applications and suggested that applications be made between October and March to allow recovery. Brewster et al. (1978) showed that fall applications of 2,4-D caused less white clover injury than spring applications. Seedling white clover is very sensitive and may be eliminated by several 2,4-D formulations (Scragg 1952). Many other research workers reported that timing

clover damage

and growth stage of the clover are important considerations in treatment of pastures with growth regulator-type herbicides (Matthews 1965; Slaats and Strycker 1953, 1960; Willis 1950).

The cinnabar moth [*Tyria jacobaeae* (L)[1]] is an arctiid moth whose larval stages feed primarily on tansy ragwort and other members of the genus *Senecio*. Cameron (1935) conducted extensive studies on the cinnabar moth and recommended its introduction into New Zealand as a potential biological control agent. After extensive starvation tests (Parker 1960), the moth was introduced into the western United States for the same purpose. Releases were made in northwestern California in 1959 and in western Oregon and Washington in 1960 (Frick and Holloway 1964).

A detailed account of the cinnabar moth life history is given by Cameron (1935). In Oregon, the adult moths usually emerge from May through July. After mating, the females lay bright yellow eggs on the underside of tansy ragwort leaves in batches ranging from 1 to 150 or more eggs per batch. Large plants, on the average, receive more eggs than small ones with the majority of small plants never being chosen for oviposition (van der Meijden 1976a). Before hatching, the eggs turn a silver gray color. Newly-hatched larvae are gregarious and feed on the leaves on which they hatch. Second through fifth instar larvae may move to other plants even before they completely defoliate the host plant (van der Meijden 1976b). They prefer to feed

[1]Also reported under the generic names *Callimorpha*, *Euchelia*, and *Hypocrita*.

on the floral parts. This preference is of selective advantage as larvae reared on a diet of floral parts generally become larger, more fecund adults than those reared on vegetative plant parts (Rose 1978). Pupation occurs in well-protected sites under moss, bark, stones, or litter on the ground. The univoltine life cycle of the moth is completed by September.

Following pupation of the cinnabar moth in late summer, tansy ragwort plants that have been defoliated by the insect often regrow from the crown. They may produce seed that same fall or overwinter and produce seed the following season.

The above factors have led to a proposed system for integrating chemical and biological methods of controlling tansy ragwort. Fall applications of 2,4-D have resulted in less clover injury than spring treatments and resprouting of the tansy ragwort following cinnabar feeding in the summer allows only slow progress in control. It was, therefore, of interest to learn more about the possibility of using fall 2,4-D applications in areas already colonized by cinnabar moth as a means of more quickly reducing the tansy ragwort to acceptable levels, while maintaining a viable population of cinnabar moths.

No information has been published on the direct toxicity of 2,4-D to <u>Tyria</u> spp. or pupae of any species of Lepidoptera. Studies showing the effect of 2,4-D on other insect populations report results as varied as the species tested. Prairie grain wireworm (<u>Ctenicera destructor</u> Brown) is unaffected by plant growth regulators (Davis 1968) while coccinellid larvae mortality increased four times for all age groups treated with 2,4-D at 0.56 kg/ha (Adams 1960).

The general goal of this thesis was to investigate three components of the proposed integrated system for a white clover-grass pasture situation. The objectives were: (a) to measure the effect of fall and spring applications of 2,4-D formulations on white clover growth, (b) to determine the effect of fall applications of 2,4-D on tansy ragwort which had regrown following defoliation by cinnabar larvae, and (c) to obtain information on the direct toxicity of 2,4-D to *Tyria* pupae. A pilot study also was conducted to observe the effects of 2,4-D on tansy ragwort growth and cinnabar moth activity during the summer following fall treatment.

WHITE CLOVER (*Trifolium repens*) TOLERANCE TO 2,4-D

The purpose of this experiment was to compare the effect of fall and spring applications of three formulations and two rates of 2,4-D on white clover.

Materials and Methods

Two field experiments were conducted at the Oregon State University Hyslop and Schmidt Farms in 2-year-old stands of 'Grassland Huia' white clover. Soil type at both locations is a Woodburn silt loam, a fine silty, mixed mesic, Aquultic Argixeroll.

Treatments of 2,4-D amine, 2,4-D amine with wetting agent[2], and 2,4-D butoxyethanol ester were applied at 2.25 and 4.5 kg/ha in 230 L/ha water carrier on November 9, 1978 and April 14, 1979. A bicycle-wheel, compressed-air plot sprayer fitted with 8002 flat fan nozzle tips arranged in a double overlap pattern was used to make the applications.

Each experiment was conducted using a randomized complete block design with six replications. Plots were 2.5 by 6.7 m.

Visual estimates of percent reduction in biomass were made 4 weeks after spring treatments were applied.

On May 16, 4.5 weeks after the last treatment, a strip of forage 0.9 m wide was cut the length of each plot using a small-plot swather. Fresh weights were measured in the field and a subsample was taken.

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[2]X-77 spreader, a mixture of alkylarylpolyoxyethylene, glycols, free fatty acids, and isopropanol, used at 0.50% (v/v).

Dry matter yields were determined by weighing subsamples before and after air drying, calculating dry matter percentage, and multiplying by harvest weight. Following harvest, the plot area was mowed to a uniform height. Thirteen weeks after spring treatments, on July 13, 1980, the harvest procedure was repeated.

Results

Visual evaluations (Table 1) indicated that white clover is tolerant to all tested formulations of 2,4-D when applied in the fall, even at the relatively high rate of 4.5 kg/ha. Split fall/spring treatments at 1.12 kg/ha likewise did not differ from the untreated check plots.

All spring-only treatments significantly reduced white clover foliage growth. The ester formulation caused the most severe injury, followed by the amine plus wetting agent, then amine. white clover injury

Fresh weight yields from the May harvest (Table 1) substantiated the visual evaluations. None of the fall treatments caused significant yield reductions. Yields from the split fall/spring treated plots also did not differ from those of the untreated check plots. All spring-only treatments reduced clover yields significantly. The highest yields in spring-treated plots were from those treated with 2.25 kg/ha of amine.

By July 13, 1980, clover damaged from spring treatments had nearly recovered. Analysis of July fresh and dry matter yields showed no signficant f-value at 0.1 for treatment differences (Appendix Tables 3 and 4).

Table 1. Effect of three formulations of 2,4-D on solid-seeded, established white clover when applied in the fall and spring.[a]

Treatment	Rate	Hyslop Injury[b]	Hyslop Fresh wt.	Schmidt Injury[b]	Schmidt Fresh wt.
	kg/ha	%	kg/ha	%	kg/ha
November 1978					
2,4-D amine	2.25	0.0a	15,300ab	3.3a	16,900a
2,4-D amine	4.5	0.0a	15,500ab	1.7a	17,400a
2,4-D amine + WA[c]	2.25	0.0a	17,400a	0.8a	15,000a
2,4-D amine + WA	4.5	0.0a	16,000ab	0.8a	14,800a
2,4-D ester	2.25	0.8a	14,400ab	1.7a	15,600a
2,4-D ester	4.5	0.0a	16,600ab	0.8a	15,400a
April 1979					
2,4-D amine	2.25	32.5b	8,200c	14.2b	11,200b
2,4-D amine	4.5	66.6cd	2,600d	48.3c	4,800cd
2,4-D amine + WA[c]	2.25	58.3c	4,900cd	46.7c	6,400c
2,4-D amine + WA	4.5	74.2de	2,100d	66.7de	1.800de
2,4-D ester	2.25	69.2de	2,800d	55.0ed	3,100de
2,4-D ester	4.5	78.3e	1,500d	72.5e	1,400e
November/April					
2,4-D amine/ 2,4-D amine	1.12/ 1.12	3.3a	12,900b	2.5a	14,900a
Check		0.0a	15,600ab	0.0	17,900a

[a]Means followed by the same letter are not significantly different at the 1% level according to Duncan's multiple range test.

[b]Visual evaluations made on May 10, 1979, based on 0 = no injury and 100 = complete kill. Statistical analysis conducted on transformed data using an angular transformation.

[c]Wetting agent used was X-77 at 0.50% (v/v).

Grazing limitations 2,4D on white clover

Current 2,4-D registration prohibits grazing by dairy cows on treated pastures for 7 days. Although white clover eventually recovers from spring applications of 2,4-D, the amount of forage available during an important part of the grazing season is severely reduced. Further, in a white clover-grass mixture, recovery of the white clover might be even slower than observed in these pure-stand studies because of competition from the grass. Fall treatment caused no reduction in forage available for spring grazing.

TANSY RAGWORT CONTROL FROM FALL APPLICATIONS OF 2,4-D

A brief study was done to substantiate work by Brewster et al. (1978) who found that fall applications of 2,4-D satisfactorily controlled tansy ragwort when evaluated during the following grazing period.

Materials and Methods

A field experiment was located in a grass-clover pasture in Linn County, Oregon. The pasture was heavily colonized by cinnabar moth and was grazed by dairy cattle. Treatments of 2,4-D amine, amine plus wetting agent, and ester applied at 2.25 kg/ha in 230 L/ha water carrier were made on November 12, 1979. A bicycle-wheel, compressed-air plot sprayer fitted with 8002 flat fan nozzle tips arranged in a double overlap pattern was used.

Plots were 2.4 by 7.6 m arranged in a randomized block design with five replications.

Visual evaluations were made in March to determine percent control of tansy ragwort.

Results

All treatments provided 99% control of tansy ragwort when evaluated in March, 1980 (Appendix Table 5). No first-year rosettes had survived and no seedlings had germinated.

EFFECT OF 2,4-D ON VIABILITY OF *TYRIA* PUPAE

A study was designed to detect effects of direct application of 2,4-D to cinnabar moth pupae. Since the larvae pupate during late summer in protected places, pupae are not likely to come in direct contact with fall applied herbicides. However, to assure an adequate safety margin, data from the worst possible case, i.e., direct exposure of pupae and surrounding litter, were collected.

Materials and Methods

Collections of pupae were made during the winter of 1979 from two locations in the Willamette Valley. Obviously diseased or damaged pupal cases were discarded. Water flotation was suggested[3] to identify viable pupae; those which do not float probably contain viable insects. As only 10% of the pupae did not float, too few to conduct the study, all the pupae were used. After towel drying, pupae were randomly segregated into eight groups, each containing 25 pupae. Each group was placed on a 7.6 cm layer of maple and alder mulch in 28 by 28 by 20 cm wood frame cages enclosed with hardware cloth. The pupae in four of the cages were sprayed with 2,4-D amine at the rate of 2.25 kg/ha in 322 L/ha of water using a single-nozzle track sprayer.

An additional 2.5 cm layer of mulch was distributed over the pupae, the cage tops were secured by tacks and tape, and the cages were set outside.

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[3]Personal communication, Robert Brown, Oregon Department of Agriculture.

The number of moths emerging was recorded from May 15 to July 5 with special notations made of any obvious deformities as a possible indicator of cellular damage from the treatment.

Results

2,4D effect on Cinnabar Larvae

Direct spray application of 2,4-D amine to pupae caused no reduction in the number of moths emerging. Emergence percentage was 43% from untreated pupae and 42% from treated ones (Appendix Table 6). Two moths were noted to have wing deformities, one from a treated pupae and one from an untreated one.

Factors affecting cinnabar mortality

Mortality of pupae has been related to several factors. Predation by moles may be important in the field, but does not apply under the conditions of this experiment. Excess moisture (Dempster 1971) may have been a factor. Limited parasitism has been reported in California (Hawkes 1973), but no adult parasitoids were trapped in the cages. It is possible that some parasitoids may have been present and escaped through small openings in the cages before detection.

PILOT STUDY OF INTEGRATED CONTROL PROGRAM

The purpose of this study was to determine the effect of removal of resprouting, newly-germinating, and first-year rosette tansy ragwort plants by fall application of 2,4-D on (a) the number of cinnabar moth eggs laid in the late spring on the remaining late fall- and spring-germinating tansy ragwort plants and (b) the change in ragwort biomass over the summer.

Materials and Methods

Permission was obtained from the Parks and Recreation Branch, Oregon State Department of Transportation, to conduct a field study on 6 hectares of ungrazed native prairie adjacent to Ellmaker State Park, 37 km west of Corvallis on Highway 20. The site is naturally divided by a creek into a section of 4 ha on the north side (Site I) and 2 ha on the south (Site II). The creek provided a natural barrier to larval migration between sites which might occur in response to limited food supply.

Three 30-m transects were located at each site with ten randomly selected sample sites permanently located along each transect. Because of insect migration, small replicated plots comparing sprayed and unsprayed plots could not be used. The compromise approach was to monitor the two areas carefully during the summer before and the summer after 2,4-D treatment. By comparing relative changes from 1979 to 1980 in the two sites, some estimate could be made of 2,4-D effects on tansy ragwort and cinnabar moth.

In June of 1979 a 0.25-m^2 section of each permanent plot (total of 30 plots in each Site) was searched for egg masses by examining all tansy ragwort leaves within the plot. All leaves with egg masses were tagged and recorded using a coordinate system. The number of eggs, or egg shells from already hatched eggs, was recorded or photographed using a 35mm camera and Macro-Takumar lens (1:4/50) to be counted later (Plate 1).

All above ground plant parts were hand collected from 0.1-m^2 subplots in June, July, August, and September. The plants were counted, grouping them as seedlings, rosettes, or bolted plants based on appearance of above-ground parts. No attempt was made to verify the classification of each plant, which would have required examination of the roots. Samples were air dried to obtain dry weight.

On November 6, 1979, Site I was sprayed with 2,4-D amine at 2.2 kg/ha in 159 L/ha water carrier using a tractor-mounted sprayer fitted with 8002 nozzle tips.

The process of counting eggs, taking stand counts, and collecting plant samples was repeated in 1980. To prevent resampling an area, collections were made to the immediate right of the transect in 1979 and to the immediate left in 1980 (Plate 2).

Results

The total number of cinnabar moth eggs decreased from 1979 to 1980 by 15.8% at Site I and 15% at Site II (Appendix Tables 8 and 9). This is believed to be due to cold, damp weather in the early spring which slowed the activity of adult moths, possibly preventing them from laying as many eggs. The number of eggs failing to hatch could

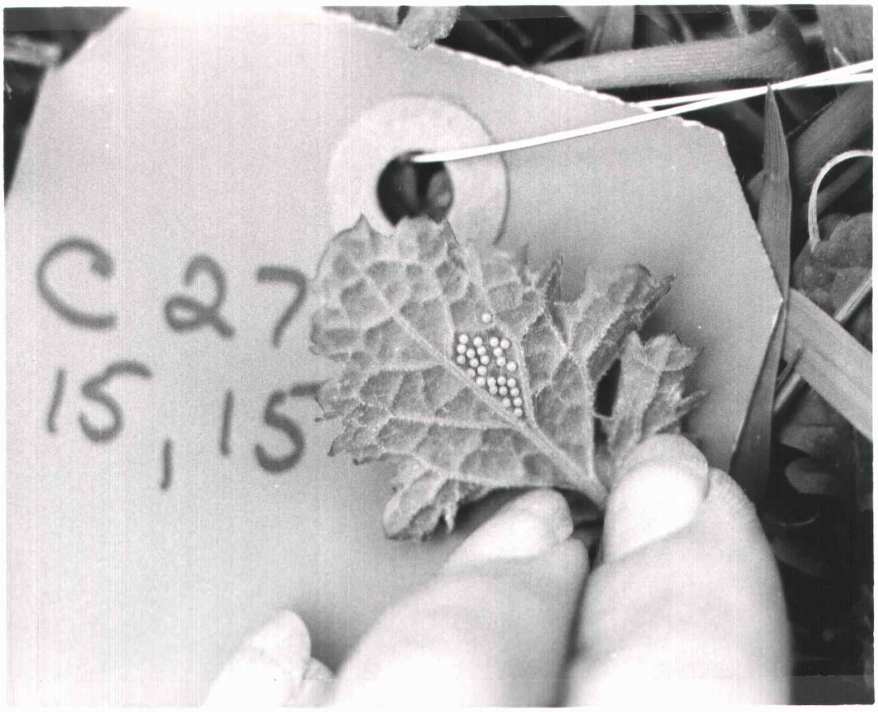

Plate 1. Tagged tansy ragwort leaf with cinnabar moth eggs.

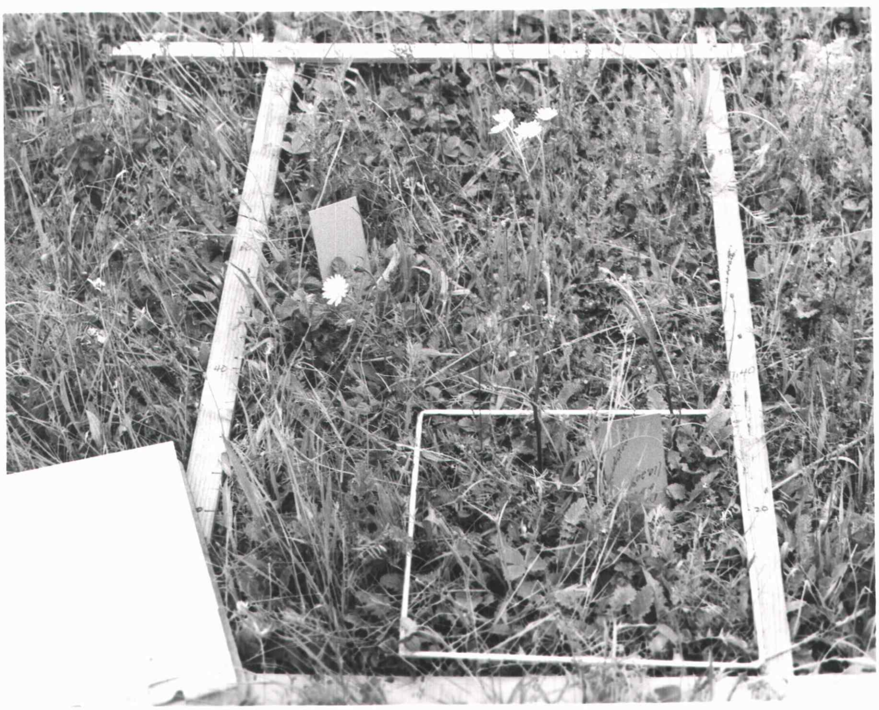

Plate 2. Equipment used to locate subplots along 30 m transects.

not be determined because the newly-hatched larvae destroyed the leaves.

Treatment with 2,4-D reduced the dry weight of tansy ragwort foliage harvested in June 1980 at Site I by 67.2% when compared to the amount present in 1979 (Appendix Tables 10 and 14). In 1979 all stages of plant development were present, seedlings, first-year rosettes, and bolted plants, whereas in 1980 the population consisted only of seedlings and first-year rosettes.

Through the summer, the number of plants and dry weight of the above-ground parts decreased steadily until August (Figures 1 and 2). Presumably, this was caused by the feeding of cinnabar larvae and by seedling mortality from drouth. The ragwort regrew rapidly between August and September 1979 following August rains and pupation of the cinnabar larvae. Tansy ragwort growth followed a similar pattern in both areas in 1980 as in 1979 although the ragwort population was at a lower level in the sprayed area.

Larvae of the cinnabar moth were present, actively feeding in both the treated and untreated areas in both years.

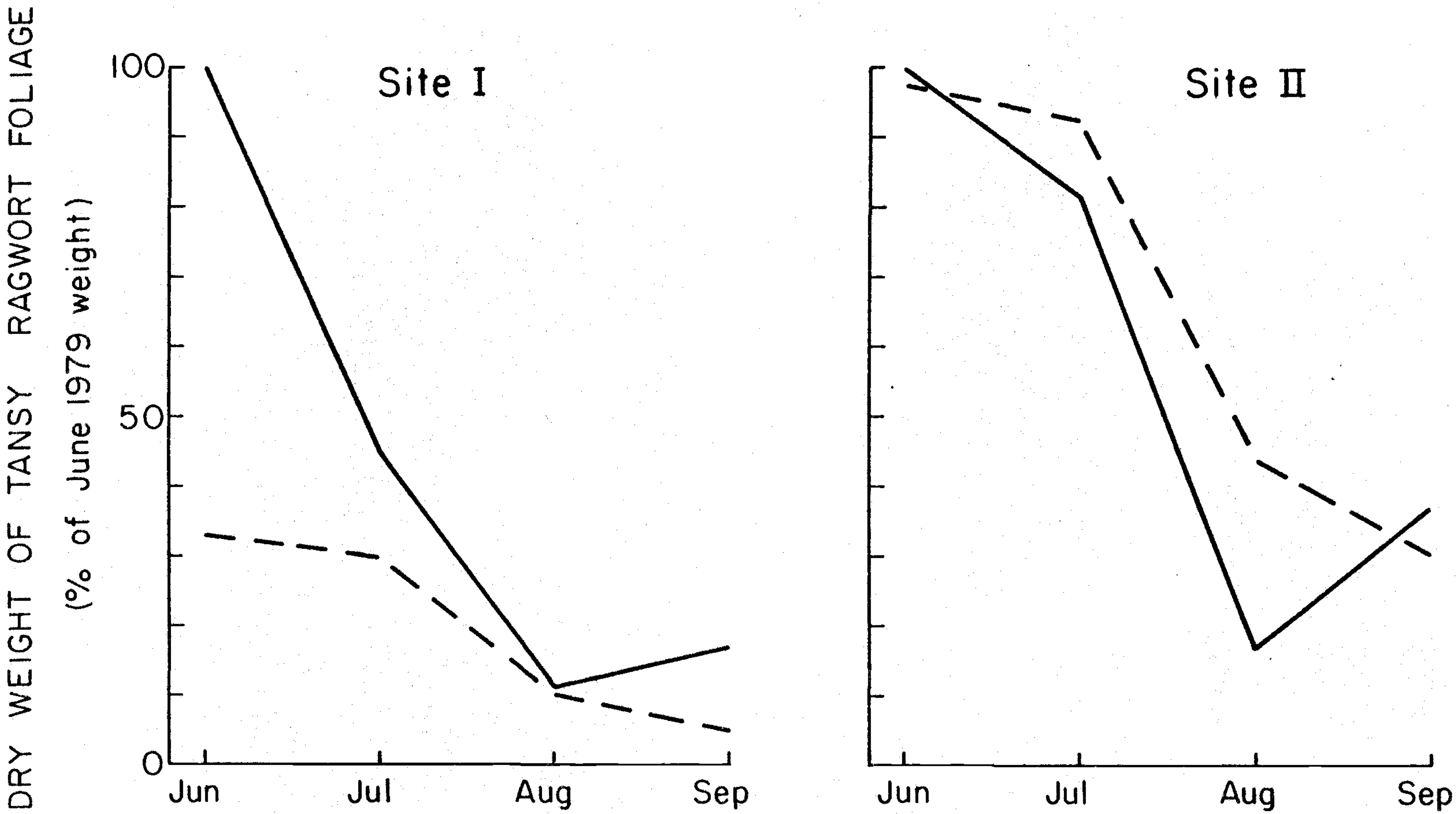

Figure 1. Dry weight of tansy ragwort foliage present at Ellmaker State Park expressed as a percent of June 1979 weight. ———— = 1979, — — — = 1980.

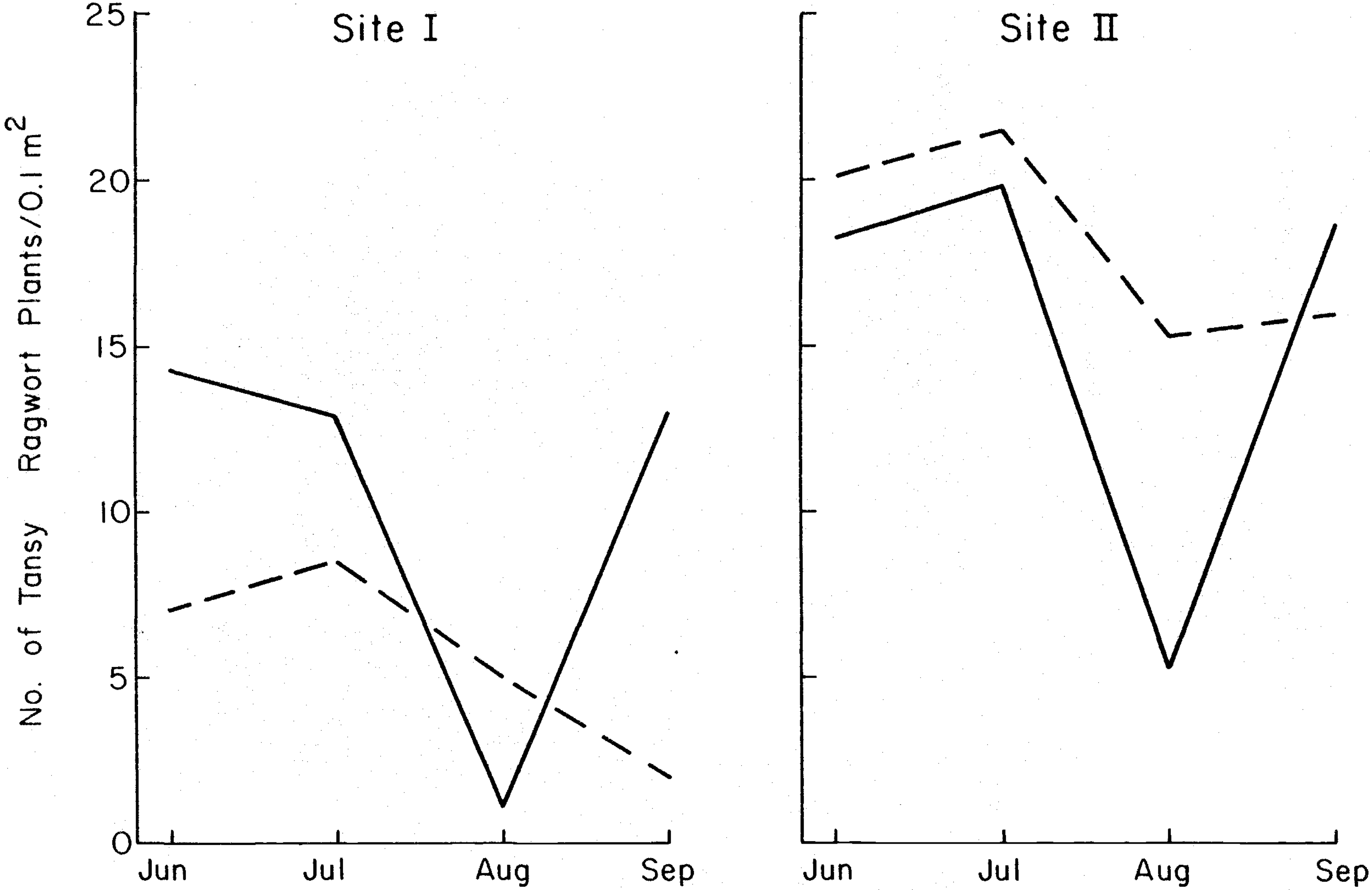

Figure 2. Number of tansy ragwort plants per 0.10 m^2. Values expressed as the mean of 30 subplots at each site. ———— = 1979, — — — = 1980.

DISCUSSION AND CONCLUSIONS

Based on the limits and scope of this research, it appears feasible to integrate biological and chemical control of tansy ragwort in pastures which have white clover as an important forage component. Our data have shown that fall application of 2.2 kg/ha 2,4-D, amine or ester formulation, to white clover will not reduce forage available for spring grazing. When the same treatments are applied in the spring, significant reductions in dry matter result. If spring application of 2,4-D is required, the amine formulation should be used as it produces significantly higher yields than the ester.

Fall applications of 2,4-D amine to both improved, irrigated pasture and natural prairie provided control of first-year and regrowing tansy ragwort rosettes. Observations indicate that the closed sward of the improved pasture provided strong competition to germinating seedlings and weed control is maintained further into the spring than in the unimproved situation at Ellmaker State Park.

In spite of the oviposition preference of cinnabar moth for large rosettes, they will lay their eggs on smaller seedling plants. Fewer eggs were laid in 1980 than 1979; however, the same decrease was seen in both treated and untreated sites. This suggests that the increase was not related to herbicide treatment.

Direct contact of cinnabar moth pupae with 2,4-D amine did not 2,4,D on cinnabar affect their emergence. Further studies are needed to determine the fecundity of the emerging adults and their offspring before it can be stated with certainty that there was no negative effect from such exposure

By August, following treatment, the tansy ragwort dry matter in the sprayed site had declined over the summer to a low level, approximately equal to that present at the same time the previous year (Figure 1). At the untreated site, the tansy ragwort dry matter also declined over the summer, but by August, biomass was still 38% greater than August of the previous year. The amount of tansy ragwort available to the cinnabar larvae during 1980 feeding season was lower in the sprayed site than the unsprayed site. Perhaps the concentration of a large number of larvae on a limited amount of ragwort in the treated site explains the greater suppression of tansy ragwort in the herbicide treated site. Further research is needed in this area with data from a variety of situations to justify such a conclusion.

At many locations throughout Oregon, two additional biological control agents, the crown-feeding flea beetle, *Longitarsus jacobaeae* (Waterhouse), and a seed fly, *Hylemya seneciella* Meade, have been introduced to supplement the action of cinnabar moth (Frick 1969, Frick and Johnson 1973).

In these areas, before recommendations for fall applications of 2,4-D are made, cost/benefit analysis and toxicity studies should be carried out, particularly in the case of the flea beetle which feeds on the crown of the tansy ragwort plant and would have greater exposure to fall-applied chemical treatments.

Where the cinnabar moth is the sole biological control agent, the use of fall-applied 2,4-D appears to be beneficial in reducing tansy ragwort biomass and, at the same time, to be compatible with continued control by the cinnabar larvae.

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APPENDIX

Appendix Table 1. Fresh weight of white clover foliage harvested May 16, 1979.

Treatment	Rate	Hyslop Farm							Schmidt Farm						
		R1	R2	R3	R4	R5	R6	Mean[a]	R1	R2	R3	R4	R5	R6	Mean[a]
	kg/ha	pounds/harvest sample													
Fall 1978															
2,4-D amine	2.25	19.5	21.1	19.7	21.1	20.6	19.8	20.30 ab	22.8	24.0	21.5	22.9	21.0	22.9	22.52 a
2,4-D amine	4.5	17.6	20.0	30.1	19.7	19.2	17.2	20.63 ab	20.9	25.9	25.6	19.5	25.7	21.5	23.18 a
2,4-D amine + WA[b]	2.25	17.9	24.3	21.0	30.9	21.0	23.9	23.17 a	22.4	17.1	22.2	21.6	15.4	21.2	19.98 a
2,4-D amine + WA	4.5	22.5	25.0	21.1	17.3	19.6	22.5	21.33 ab	17.9	22.9	21.4	17.4	17.4	21.3	19.72 a
2,4-D ester	2.25	16.8	20.0	7.3	23.7	20.9	26.1	19.20 ab	26.8	14.6	22.4	18.7	22.3	19.9	20.78 a
2,4-D ester	4.5	20.8	24.1	20.5	20.1	23.0	23.7	22.03 ab	21.4	22.6	18.8	17.9	19.6	22.5	20.47 a
Spring 1979															
2,4-D amine	2.25	10.9	10.0	11.6	12.0	10.9	9.8	10.87 c	15.7	8.7	16.0	15.4	19.2	19.0	14.83 b
2,4-D amine	4.5	5.2	2.2	1.4	5.3	2.3	4.5	3.48 d	5.3	10.7	5.2	4.4	5.7	7.1	6.40 cd
2,4-D amine + WA[b]	2.25	6.5	5.5	9.0	3.1	9.1	5.7	6.48 cd	7.8	8.2	9.9	8.8	9.9	6.6	8.53 c
2,4-D amine + WA	4.5	2.9	1.6	4.5	1.4	3.5	3.0	2.82 d	0.9	2.4	2.3	2.6	2.8	3.2	2.37 de
2,4-D ester	2.25	2.8	2.5	6.5	2.7	1.6	6.6	3.78 d	5.1	3.7	3.9	2.7	4.4	4.7	4.08 de
2,4-D ester	4.5	2.1	1.7	0.7	0.1	2.1	5.3	2.00 d	1.5	2.7	2.3	2.5	2.1	0.4	1.92 e
Fall/Spring															
2,4-D amine/ 2,4-D amine	1.12 1.12	17.2	19.2	18.6	13.4	18.4	16.2	17.17 b	18.3	15.7	21.1	20.6	21.2	22.3	19.87 a
Check		27.9	18.8	16.6	20.2	14.4	26.2	20.68 ab	20.7	26.5	18.8	19.9	27.7	29.1	23.78 a

[a]Means followed by the same letter are not significantly different at the 1% level according to Duncan's multiple range test.

[b]Wetting agent used was X-77 at 0.50% (v/v).

Appendix Table 2. Dry weight of white clover foliage harvested May 16, 1979

Treatment	Rate	Hyslop Farm							Schmidt Farm						
		R1	R2	R3	R4	R5	R6	Mean[a]	R1	R2	R3	R4	R5	R6	Mean[a]
	kg/ha	Pounds/harvest sample													
Fall 1978															
2,4-D amine	2.25	3.3	3.0	2.3	2.3	2.7	3.0	2.75 a	2.9	2.7	3.2	3.7	3.3	3.5	3.22 ab
2,4-D amine	4.5	2.5	2.6	4.1	2.6	2.5	2.3	2.77 a	3.3	3.6	4.1	3.0	2.8	3.1	3.30 ab
2,4-D amine + WA[b]	2.25	2.5	3.7	3.0	3.3	2.6	3.4	3.08 a	3.3	2.7	3.6	3.3	2.3	3.0	3.02 ab
2,4-D amine + WA	4.5	3.0	3.1	3.2	2.4	2.5	3.1	2.87 a	2.5	1.7	3.3	2.6	2.8	2.9	2.87 b
2,4-D ester	2.25	2.1	2.7	1.0	3.9	2.6	3.3	2.60 a	3.7	1.9	1.0	3.0	3.2	2.9	2.93 ab
2,4-D ester	4.5	2.9	3.4	2.7	2.4	2.9	3.0	2.88 a	2.6	3.3	2.9	2.7	2.9	3.1	2.92 ab
Spring 1979															
2,4-D amine	2.25	1.5	1.5	1.7	2.0	1.7	1.7	1.68 b	2.3	1.4	2.4	2.4	3.1	2.9	2.40 c
2,4-D amine	4.5	1.1	0.4	0.3	0.9	0.5	0.9	0.68 cd	1.1	3.1	3.0	0.7	1.1	1.2	1.13 de
2,4-D amine + WA[b]	2.25	1.7	0.9	1.4	0.6	1.5	1.0	1.18 bc	1.4	1.2	1.4	1.9	1.7	1.1	1.43 d
2,4-D amine + WA	4.5	0.6	0.4	0.9	0.3	0.6	0.6	0.57 cd	0.3	0.4	0.4	1.0	0.5	0.6	0.52 ef
2,4-D ester	2.25	0.5	0.5	0.8	0.6	0.3	1.2	0.65 cd	1.0	0.6	0.8	0.5	0.6	0.8	0.72 ef
2,4-D ester	4.5	0.2	0.4	0.2	0.1	0.4	0.7	0.32 d	0.3	0.6	0.6	0.5	0.3	0.7	0.39 f
Fall/Spring															
2,4-D amine/ 2,4-D amine	1.12 1.12	2.1	2.8	2.7	1.9	2.9	2.3	2.45 a	2.4	2.2	3.2	3.3	3.1	3.3	2.92 ab
Check		3.6	2.4	2.5	2.7	2.6	3.1	2.82 a	3.1	3.4	2.7	2.8	4.1	4.0	3.35 a

[a]Means followed by the same letter are not significantly different at the 1% level according to Duncan's multiple range test.

[b]Wetting agent used was X-77 at 0.50% (v/v).

Appendix Table 3. Fresh weight of white clover forage harvested July 13, 1979

Treatment	Rate	Hyslop Farm							Schmidt Farm						
		R1	R2	R3	R4	R5	R6	Mean	R1	R2	R3	R4	R5	R6	Mean
	kg/ha	pounds/harvest sample													
Fall 1978															
2,4-D amine	2.25	9.7	8.5	11.8	11.2	9.6	11.0	10.30	6.3	8.1	6.9	10.8	10.5	10.7	8.88
2,4-D amine	4.5	10.2	11.3	12.2	9.2	16.2	10.9	11.67	6.5	12.5	6.3	8.4	11.9	11.4	9.50
2,4-D amine + WA[a]	2.25	6.8	11.5	11.6	19.5	7.3	11.2	11.32	6.8	8.5	11.8	5.0	15.4	10.5	9.67
2,4-D amine + WA	4.5	10.5	12.0	8.0	12.1	15.9	5.1	10.60	7.2	9.5	9.9	9.5	14.8	12.3	10.60
2,4-D ester	2.25	8.2	6.9	11.7	13.2	18.6	10.3	11.48	5.3	19.5	8.8	8.5	11.0	5.7	9.80
2,4-D ester	4.5	12.0	12.1	11.0	13.4	13.1	13.8	12.57	7.2	6.7	9.2	5.1	7.9	14.1	8.37
Spring 1979															
2,4-D amine	2.25	13.7	10.2	10.8	7.9	7.8	13.4	10.63	8.0	6.5	7.6	9.9	11.0	14.8	9.63
2,4-D amine	4.5	9.1	9.1	8.5	14.5	20.4	7.9	11.58	6.8	11.6	8.6	9.0	13.4	13.9	10.55
2,4-D amine + WA[a]	2.25	7.0	8.1	7.2	7.6	14.4	10.7	9.17	13.0	11.8	11.8	8.3	8.7	14.2	11.30
2,4-D amine + WA	4.5	8.6	8.5	11.1	14.8	12.8	9.2	10.83	6.9	9.6	7.9	7.0	10.2	10.0	8.60
2,4-D ester	2.25	9.3	8.9	17.0	9.2	8.8	13.0	11.03	6.2	7.5	13.8	6.7	10.8	12.2	9.53
2,4-D ester	4.5	7.1	8.6	9.3	11.1	4.4	12.5	8.83	5.2	10.1	6.6	9.4	13.7	16.7	10.28
Fall/Spring															
2,4-D amine/ 2,4-D amine	1.12 / 1.12	5.3	12.0	12.4	12.1	11.5	7.9	10.20	4.8	11.7	8.6	12.3	11.1	18.6	11.18
Check		6.8	13.6	13.8	12.2	10.1	12.5	11.50	3.5	6.0	8.9	7.3	10.4	10.0	7.68

[a]Wetting agent used was X-77 at 0.50% (v/v).

Appendix Table 4. Dry weight of white clover forage harvested July 13, 1979

Treatment	Rate	Hyslop Farm							Schmidt Farm						
		R1	R2	R3	R4	R5	R6	Mean	R1	R2	R3	R4	R5	R6	Mean
	kg/ha	pounds/harvest sample													
Fall 1978															
2,4-D amine	2.25	2.9	2.8	3.3	3.2	4.1	4.6	3.48	2.5	2.9	2.7	3.8	3.4	3.1	3.07
2,4-D amine	4.5	2.8	3.5	4.1	2.7	6.3	3.7	3.85	2.4	4.7	2.6	3.0	3.2	3.2	3.18
2,4-D amine + WA[a]	2.25	2.3	3.6	1.8	4.4	3.0	2.8	2.98	1.6	2.9	5.0	2.3	3.2	2.6	2.93
2,4-D amine + WA	4.5	3.2	3.8	2.6	3.6	5.3	2.4	3.48	3.9	5.0	3.9	3.4	3.7	3.1	3.83
2,4-D ester	2.25	2.2	2.6	3.2	3.8	6.7	3.4	3.65	1.8	5.3	3.8	3.2	3.8	1.1	3.17
2,4-D ester	4.5	4.8	3.3	3.4	4.1	4.1	4.8	4.08	2.5	2.2	2.4	1.8	2.2	4.5	2.60
Spring 1979															
2,4-D amine	2.25	4.5	3.2	3.1	2.4	3.1	4.7	3.00	3.5	2.4	3.0	2.9	2.9	4.5	3.20
2,4-D amine	4.5	2.9	3.0	2.4	4.3	7.4	2.3	3.72	2.7	3.1	2.9	3.6	4.9	3.1	3.38
2,4-D amine + WA	2.25	3.3	2.7	2.6	2.3	4.0	3.3	3.03	6.3	3.8	3.7	4.2	3.6	4.9	4.42
2,4-D amine + WA	4.5	3.2	2.4	2.6	3.3	3.7	3.0	3.03	2.8	3.5	3.3	2.7	3.4	3.1	3.30
2,4-D ester	2.25	3.3	2.9	5.1	2.9	2.9	4.7	3.63	2.3	3.1	5.3	2.9	3.0	3.3	3.32
2,4-D ester	4.5	1.9	2.7	2.9	2.8	1.9	3.9	2.68	2.1	4.1	2.7	3.9	3.8	3.4	3.33
Fall/Spring															
2,4-D amine/ 2,4-D amine	1.12 1.12	2.4	2.5	4.0	4.4	4.2	3.1	3.43	2.2	4.6	2.9	3.9	3.7	6.9	4.03
Check		2.5	3.7	3.8	3.9	3.7	3.7	3.55	1.4	2.7	3.4	2.6	3.1	3.1	2.72

[a]Wetting agent used was X-77 at 0.50% (v/v).

Appendix Table 5. Effect of 2,4-D formulations on control of *Senecio jacobaea* at Foster Farm, Linn County, Oregon[a].

		Control				
Treatment	Rate	R1	R2	R3	R4	R5
November 1979	kg/ha	%				
2,4-D amine	2.25	99	99	99	99	99
2,4-D amine + WA[b]	2.25	99	99	99	99	99
2,4-D ester	2.25	99	99	99	99	99
Control		0	0	0	0	0

[a]Evaluation made March 26, 1980.

[b]X-77 applied at 0.50% (v/v).

Appendix Table 6. Emergence of *Tyria Jacobaeae* from pupae treated with 2,4-D amine at 2.2 kg/ha.[a]

	Total[b]		Total
Treated:		Untreated:	
Cage 1	6		10
Cage 2	12		9
Cage 3	13		13
Cage 4	11		11
c.v.		23%	

[a]First adult emerged May 18, 1980.

[b]No adults emerged after July 5, 1980.

Appendix Table 7. Dry weight of above-ground tansy ragwort plants at Ellmaker State Park, Lincoln Co., Oregon.

	Site I mean	Site II mean
	gm/0.1 m^2	gm/0.1 m^2
1979		
June	2.65 ± 1.05	3.32 ± 1.46
July	1.19 ± 0.38	2.70 ± 1.09
August	0.29 ± 0.13	0.55 ± 0.22
September	0.45 ± 0.18	1.23 ± 0.65
1980		
June	0.87 ± 0.44	3.24 ± 1.44
July	0.79 ± 0.34	3.07 ± 1.43
August	0.27 ± 0.31	1.46 ± 0.69
September	0.13 ± 0.07	1.01 ± 0.40

Appendix Table 8. Cinnabar moth eggs at Ellmaker State Park, Lincoln County, Oregon[a].

	Site I	Site II
1979	916	606
1980	762	515

[a]Numbers represent the total number of eggs from 30, 0.25 m^2 subplots at each site.

Appendix Table 9. Tyria jacobaeae eggs per $0.25/m^2$ plot at Ellmaker State Park, Lincoln County, Oregon.

		Site I								Site II					
		June 2, 1979			June 16, 1980					June 2, 1979			June 15, 1980		
Transect	Subplot	Eggs	Shells	Masses	Eggs	Shells	Masses	Transect	Subplot	Eggs	Shells	Masses	Eggs	Shells	Masses
A	0	0	0	0	0	0	0	D	0	2	95	1	7	0	1
	3	79	0	1	0	0	0		2	67	47	3	0	0	0
	6	1	31	2	0	0	0		4	3	10	2	10	0	1
	7	0	0	0	0	0	0		12	34	0	1	0	0	0
	9	0	0	0	0	0	0		17	0	0	0	52	0	1
	11	0	0	0	0	0	0		18	71	19	3	53	32	3
	12	0	0	0	23	0	1		19	0	0	0	39	0	3
	18	0	0	0	121	0	1		20	0	12	1	0	0	0
	21	1	0	1	0	56	1		24	0	0	0	0	0	0
	29	0	0	0	60	13	2		26	25	52	3	83	31	3
B	0	0	0	0	0	0	0	E	3	34	0	1	128	41	5
	3	0	0	0	0	0	0		8	0	0	0	0	0	0
	5	199	23	10	0	0	0		10	0	0	0	0	0	0
	6	0	0	0	0	0	0		13	0	0	0	0	0	0
	7	0	0	0	0	0	0		14	0	0	0	0	0	0
	8	113	29	2	0	0	0		15	0	0	0	0	0	0
	9	0	0	0	0	0	0		17	1	48	1	0	0	0
	14	118	0	1	0	0	0		18	20	0	1	39	0	1
	19	0	0	0	36	0	1		25	66	0	2	0	0	0
	27	85	0	4	54	0	1		26	0	0	0	0	0	0
C	3	0	0	0	0	0	0	F	0	0	0	0	0	0	0
	4	50	0	0	0	0	0		6	0	0	0	0	0	0
	6	0	0	0	0	0	0		7	0	0	0	0	0	0
	10	6	51	1	0	0	0		10	0	0	0	0	0	0
	16	0	0	0	0	0	0		11	0	0	0	0	0	0
	19	67	33	3	113	6	5		13	0	0	0	0	0	0
	22	0	0	0	26	0	2		17	0	0	0	0	0	0
	24	0	0	0	0	0	0		25	0	0	0	0	0	0
	27	0	0	0	129	125	6		27	0	0	0	0	0	0
	28	36	0	1	0	0	0		29	0	0	0	0	0	0
TOTAL		749	167	25	562	200	20			323	283	29	411	104	17

Appendix Table 10. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, June 7, 1979

Site I					Site II				
Transect	Subplot	Seedlings	Rosettes	Dry Weight	Transect	Subplot	Seedlings	Rosettes	Dry Weight
		plts./0.1 m^2		g/0.1 m^2			plts./0.1 m^2		g/0.1 m^2
A	0	12	0	0.53	D	0	25	7	8.28
	3	2	0	1.20		2	15	5	7.16
	6	8	2	1.55		4	17	1	2.11
	7	2	0	0.11		12	10	9	12.58
	9	3	0	0.12		17	36	10	13.72
	11	1	0	0.19		18	69	5	9.82
	12	0	0	0.00		19	33	1	3.16
	18	4	2	1.55		20	53	1	7.51
	21	15	9	9.78		24	27	0	2.67
	29	2	2	0.54		26	48	3	7.75
B	0	9	9	9.50	E	3	7	1	1.24
	3	0	0	0.00		8	18	7	5.15
	5	14	0	0.95		10	5	0	0.36
	6	10	2	2.43		13	2	0	0.07
	7	2	0	0.09		14	3	0	0.20
	8	4	0	0.50		15	0	0	0.00
	9	16	4	5.48		17	7	0	0.31
	14	8	0	0.30		18	3	3	1.95
	19	15	0	0.72		25	5	0	1.27
	27	10	4	6.70		26	5	3	1.46
C	3	20	4	6.20	F	0	3	0	0.25
	4	24	3	3.60		6	5	0	0.37
	6	28	3	3.40		7	3	0	0.08
	10	36	1	3.65		10	6	2	1.27
	16	17	3	3.42		11	8	0	0.34
	19	16	1	1.84		13	6	2	3.44
	22	26	6	5.21		17	11	0	1.08
	24	7	3	1.73		25	12	0	1.03
	27	36	3	6.50		27	36	4	4.41
	28	21	1	1.77		29	5	1	0.57

Appendix Table 11. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, July 7, 1979

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Bolting	Dr. Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	4	0	0	0.12	D	0	33	10	0	3.49
	3	6	1	0	0.41		2	24	13	3	6.03
	6	7	1	0	0.27		4	35	11	1	4.36
	7	0	3	0	0.19		12	11	7	3	4.78
	9	7	3	0	0.59		17	20	13	0	3.72
	11	1	2	0	0.02		18	22	14	1	6.39
	12	4	1	0	0.22		19	23	26	2	8.45
	18	14	6	0	1.02		20	58	25	0	8.48
	21	15	5	0	1.50		24	18	27	0	9.11
	29	6	5	0	0.69		26	21	10	0	5.46
B	0	4	1	0	0.56	E	3	7	8	1	4.73
	3	13	6	0	1.66		8	26	8	0	2.93
	5	6	0	0	0.22		10	7	0	0	0.70
	6	6	0	0	0.14		13	1	0	0	0.10
	7	7	6	0	2.87		14	2	1	0	0.20
	8	8	0	0	0.30		15	0	0	0	0.00
	9	26	2	0	1.66		17	5	0	0	0.31
	14	5	2	0	2.30		18	6	0	0	0.23
	19	9	3	0	1.46		25	3	4	0	0.89
	27	23	8	0	3.01		26	3	1	0	0.20
C	3	15	4	0	0.83	F	0	1	2	0	0.47
	4	14	7	0	1.45		6	4	0	0	0.12
	6	11	8	1	3.07		7	5	0	0	0.29
	10	6	6	1	1.87		10	2	0	0	0.14
	16	3	6	0	1.16		11	6	2	0	1.53
	19	8	3	0	0.89		13	7	0	0	0.48
	22	3	2	0	0.58		17	7	1	0	0.44
	24	5	2	0	0.52		25	11	0	0	1.81
	27	20	10	0	2.36		27	1	0	0	0.15
	28	18	10	0	3.64		29	25	5	0	5.09

Appendix Table 12. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, August 6, 1979.

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Regrowing/ Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Regrowing/ Bolting	Dry Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	1	1	1	0.25	D	0	1	0	4	0.61
	3	0	0	0	0.00		2	0	0	11	0.88
	6	0	0	0	0.00		4	1	0	1	0.73
	7	0	0	1	0.06		12	3	0	9	0.68
	9	1	0	0	0.01		17	0	0	9	0.98
	11	1	0	0	0.07		18	1	0	14	1.31
	12	0	0	0	0.00		19	10	0	17	0.95
	18	0	0	3	0.47		20	5	0	18	1.55
	21	1	0	10	1.16		24	0	0	6	0.81
	29	0	0	2	0.71		26	3	0	7	0.96
B	0	2	0	2	0.15	E	3	1	0	9	1.33
	3	0	0	3	0.67		8	0	0	0	0.00
	5	0	0	0	0.00		10	0	0	0	0.00
	6	0	0	4	0.54		13	0	0	0	0.00
	7	0	0	2	0.17		14	0	0	2	0.12
	8	0	0	0	0.00		15	0	0	1	0.06
	9	0	0	2	0.19		17	1	0	0	0.02
	14	1	0	0	0.04		18	0	1	0	0.04
	19	0	0	1	0.15		25	0	0	0	0.00
	27	1	0	1	0.71		26	0	0	0	0.00
C	3	0	0	0	0.00	F	0	0	1	0	0.20
	4	0	0	0	0.00		6	0	1	0	0.15
	6	0	0	2	0.46		7	0	3	0	0.35
	10	0	0	1	0.04		10	0	0	0	0.00
	16	0	0	1	0.29		11	0	0	1	0.09
	19	2	0	6	1.25		13	0	0	0	0.00
	22	1	0	4	0.67		17	0	5	0	2.34
	24	0	0	1	0.10		25	2	3	0	1.16
	27	1	0	4	0.56		27	0	2	0	0.79
	29	0	0	0	0.00		29	0	1	0	0.40

Appendix Table 13. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, September 11, 1979.

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Regrowing/ Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Regrowing/ Bolting	Dry Wt.
		plts./0.1 m^2			$g/0.1\ m^2$			plts./0.1 m^2			$g/0.1\ m^2$
A	0	7	12	0	0.36	D	0	5	13	4	1.54
	3	1	2	0	0.05		2	13	16	9	2.34
	6	1	0	0	0.01		4	2	13	4	3.58
	7	1	0	0	0.01		12	27	38	3	2.04
	9	2	6	0	0.77		17	4	7	1	0.39
	11	0	0	0	0.00		18	8	12	2	1.55
	12	0	0	3	0.19		19	16	25	5	1.93
	18	7	5	0	0.53		20	11	26	2	1.51
	21	9	1	0	0.28		24	11	10	1	0.94
	29	0	1	0	0.03		26	5	27	5	3.13
B	0	16	2	0	0.31	E	3	3	0	0	0.06
	3	1	3	0	0.24		8	0	0	0	0.00
	5	9	9	4	1.13		10	12	12	0	0.69
	6	9	0	0	0.19		13	3	0	0	0.06
	7	4	0	0	0.07		14	0	1	0	0.08
	8	9	3	1	0.79		15	1	1	0	0.06
	9	6	9	0	0.87		17	5	5	5	0.64
	14	0	0	0	0.00		18	3	0	1	0.12
	19	4	2	1	0.11		25	1	1	0	0.05
	27	14	11	6	1.29		26	1	1	0	0.06
C	3	9	13	3	0.91	F	0	1	1	0	0.05
	4	2	5	1	0.13		6	6	2	2	0.65
	6	2	10	4	0.63		7	13	3	0	0.39
	10	6	10	0	0.34		10	0	2	0	0.28
	16	2	4	1	0.25		11	1	2	1	0.65
	19	8	11	2	0.46		13	6	9	0	0.99
	22	22	7	0	0.34		17	40	6	1	8.85
	24	3	1	0	0.05		25	8	8	0	1.23
	27	15	33	8	2.17		27	46	14	0	2.20
	29	8	14	3	0.84		29	1	6	0	0.81

Appendix Table 14. *Senecio jacobaea* infestation at Ellmaker State Park, Lincoln County, Oregon, on June 26, 1980.

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	0	0	0	0.00	D	0	23	16	0	6.99
	3	13	5	0	2.99		2	16	8	1	13.42
	6	4	2	0	0.61		4	28	14	1	9.51
	7	0	0	0	0.00		12	20	1	0	1.53
	9	0	0	0	0.00		17	15	14	0	4.08
	11	0	0	0	0.00		18	40	16	0	6.08
	12	4	0	0	0.27		19	41	23	3	14.28
	18	1	5	0	0.83		20	15	15	0	4.83
	21	2	0	0	0.11		24	11	14	1	7.44
	29	2	0	0	0.06		26	26	20	0	5.22
B	0	0	0	0	0.00	E	3	36	3	0	1.54
	3	0	0	0	0.00		8	3	0	0	0.26
	5	2	1	0	0.24		10	5	0	0	0.17
	6	5	12	0	2.18		13	3	1	0	0.90
	7	17	12	0	3.50		14	15	1	0	1.26
	8	7	6	0	1.67		15	25	0	1	3.47
	9	1	0	0	0.08		17	4	0	0	0.09
	14	1	0	0	0.10		18	1	0	0	0.06
	19	12	22	0	2.30		25	0	0	0	0.00
	27	2	19	0	2.63		26	0	1	0	0.18
C	3	1	0	0	0.02	F	0	6	0	0	0.35
	4	0	2	0	0.15		3	0	0	0	0.00
	6	0	1	0	0.26		6	19	0	0	0.60
	10	0	0	0	0.00		7	6	1	0	0.34
	16	1	12	0	4.19		10	2	1	0	0.66
	19	2	5	0	1.05		11	1	5	0	2.09
	22	0	1	0	0.52		13	1	0	1	2.65
	24	0	1	0	0.50		17	20	4	0	1.45
	27	2	23	0	1.40		19	5	2	1	4.92
	28	1	3	0	0.52		25	45	4	0	2.77

Appendix Table 15. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, July 16, 1980.

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Bolting	Dr. Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	0	0	0	0.00	D	0	33	11	3	16.24
	3	2	0	0	0.38		2	30	7	0	3.06
	6	7	6	0	3.57		4	25	17	0	12.40
	7	0	0	0	0.00		12	40	5	0	4.30
	9	10	0	0	1.39		17	14	4	0	1.46
	11	0	0	0	0.00		18	23	18	0	5.79
	12	10	0	0	0.33		19	24	3	0	3.23
	18	5	0	0	0.32		20	6	3	0	1.72
	21	12	0	0	1.23		24	18	3	0	1.53
	29	2	0	0	0.34		26	23	6	0	2.14
B	0	0	0	0	0.00	E	3	15	5	0	3.45
	3	0	0	0	0.00		8	10	3	2	9.38
	5	11	3	0	1.22		10	10	1	0	0.66
	6	45	0	0	2.82		13	4	0	0	0.10
	7	7	4	0	1.49		14	13	0	0	0.43
	8	8	2	0	0.53		15	13	4	0	1.92
	9	21	1	0	1.48		17	10	0	0	0.18
	14	6	2	0	0.77		18	11	2	0	0.55
	19	3	2	0	0.53		25	0	0	0	0.00
	27	17	0	0	0.73		26	0	0	0	0.00
C	3	7	0	0	0.25	F	0	24	8	1	6.64
	4	7	0	0	0.28		3	1	0	0	0.02
	6	3	3	0	1.94		6	28	1	0	2.09
	10	7	0	0	0.82		7	8	0	0	0.15
	16	1	1	0	0.17		10	23	5	1	3.33
	19	22	0	0	2.51		11	11	3	0	1.67
	22	0	0	0	0.00		13	18	8	0	5.61
	24	10	0	0	0.16		17	25	1	0	1.04
	27	7	0	0	0.37		19	15	4	0	1.80
	28	0	0	0	0.00		25	36	1	0	1.19

Appendix Table 16. *Senecio jacobaea* infestation at Ellmaker State Park, Lincoln County, Oregon, August 18, 1980

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Bolting	Dr. Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	0	0	0	0.00	D	0	32	8	0	3.70
	3	0	0	0	0.00		2	11	5	1	2.94
	6	0	0	0	0.00		4	9	3	2	5.93
	7	0	0	0	0.00		12	6	4	0	0.94
	9	0	0	0	0.00		17	10	1	0	0.91
	11	0	0	0	0.00		18	14	16	1	4.00
	12	1	0	0	0.07		19	32	5	0	3.14
	18	8	0	0	0.55		20	12	13	0	1.86
	21	15	0	0	1.32		24	29	0	0	1.06
	29	1	0	0	0.02		26	34	8	0	2.72
B	0	2	0	0	0.18	E	3	20	0	0	0.62
	3	4	0	0	0.10		8	0	1	0	0.14
	5	0	0	0	0.00		10	8	0	0	0.32
	6	20	0	0	0.41		13	11	0	0	0.25
	7	21	1	0	0.98		14	1	0	0	0.01
	8	13	0	0	0.62		15	0	0	0	0.00
	9	0	0	0	0.00		17	42	0	0	2.29
	14	2	0	0	0.40		18	18	4	0	0.97
	19	4	0	0	0.21		25	5	1	0	0.59
	27	2	6	0	0.62		26	1	0	0	0.01
C	3	0	0	0	0.00	F	0	1	0	0	0.01
	4	0	8	0	0.96		3	0	0	0	0.00
	6	9	1	0	0.67		6	3	6	0	0.54
	10	3	4	0	0.36		7	4	0	0	0.08
	16	0	0	0	0.00		10	3	1	0	0.56
	19	4	0	0	0.13		11	2	0	0	0.14
	22	2	1	0	0.13		13	3	0	1	7.27
	24	2	0	0	0.04		17	39	0	0	0.45
	27	3	10	0	0.59		19	24	3	0	2.45
	28	3	0	0	0.06		25	0	0	0	0.00

Appendix Table 17. Senecio jacobaea infestation at Ellmaker State Park, Lincoln County, Oregon, September 15, 1980.

Site I						Site II					
Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.	Transect	Subplot	Seedlings	Rosettes	Bolting	Dry Wt.
		plts./0.1 m^2			g/0.1 m^2			plts./0.1 m^2			g/0.1 m^2
A	0	0	0	0	0.00	D	0	16	8	0	2.54
	3	0	0	0	0.00		2	3	21	0	1.86
	6	0	0	0	0.00		4	12	5	0	1.86
	7	0	0	0	0.00		12	3	10	0	2.78
	9	0	0	0	0.00		17	2	3	0	0.41
	11	0	0	0	0.00		18	15	15	0	2.38
	12	0	0	0	0.00		19	11	20	0	1.86
	18	1	3	0	0.59		20	3	3	0	0.85
	21	6	8	0	0.68		24	19	13	1	3.47
	29	0	0	0	0.00		26	6	24	0	1.24
B	0	0	0	0	0.00	E	3	3	9	0	2.03
	3	0	0	0	0.00		8	0	0	0	0.00
	5	0	3	0	0.45		10	1	0	0	0.03
	6	0	0	0	0.00		13	2	0	0	0.06
	7	8	4	0	0.55		14	3	0	0	0.12
	8	0	1	0	0.12		15	1	0	0	0.05
	9	2	0	0	0.03		17	6	1	0	0.38
	14	0	0	0	0.00		18	2	11	0	1.97
	19	0	1	0	0.21		25	0	0	0	0.00
	27	1	2	0	0.33		26	0	0	0	0.00
C	3	0	1	0	0.06	F	0	1	4	0	0.86
	4	1	0	0	0.03		3	1	1	0	0.18
	6	0	0	0	0.00		6	0	0	0	0.00
	10	1	2	0	0.14		7	1	0	0	0.03
	16	0	1	0	0.08		10	0	3	0	0.19
	19	0	2	0	0.21		11	8	0	0	0.27
	22	5	1	0	0.20		13	0	3	0	0.70
	24	3	0	0	0.08		17	20	1	0	0.45
	27	1	0	0	0.02		19	40	10	0	2.91
	28	0	0	0	0.00		25	38	5	0	0.67