CONTROLLING WEEDS IN NEWLY PLANTED GROUND COVERS WITH HERBICIDE - MULCH COMBINATIONS USING ACTIVATED CARBON AS A DETOXIFYING AGENT

by

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ABSTRACT

This study was initiated to determine the best chemical weed control method for use in establishing new plantings of ground covers. Varying levels of herbicides, different mulches, and activated carbon as a protectant were tested at Newark, Delaware during 1969 and 1970. The experimental design was a split plot, and was replicated three times.

The ground cover plants studied were *Ajuga reptans*, *Hedera helix*, *Pachysandra terminalis*, and *Vinca minor*. Herbicides studied were simazine (4 lbs./A), dichlobenil (6 lbs./A), diphenamid (6 lbs./A), simazine (2 lbs./A) combined with diphenamid (4 lbs./A), and dichlobenil (4 lbs./A) combined with diphenamid (4 lbs./A). Mulches studied were licorice root (one-inch depth) and "Foli-Cote" (diluted in water at a ratio of one to five). One half of all plant material was root-dipped in activated carbon.

Herbicide toxicity to the ground cover was rated by a standard visual evaluation on a scale from one to five. Weed infestation was determined as stand (number of

plants) and vigor (dry weight in grams). Growth of ground cover plants was measured by using a grid, and the percentage of ground covered by the plants within this grid was estimated. The stand (number of plants) and the vigor (fresh weight in grams) of the ground cover plants was also determined.

With no mulch, weed control studies indicated that dry weight production of Panicum dichotomiflorum (fall panicum) was significantly reduced by the simazine-diphenamid and the dichlobenil-diphenamid herbicide treatments. Also with no mulch, the stand and vigor of Portulaca oleracea (purslane) was significantly reduced by simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination. The no mulch-herbicide treatments were not effective in controlling Eragrostis cilianesis (stinkgrass) and Amaranthus retroflexus (redroot pigweed). However, studies indicated that weed control of all weed species was significantly improved when licorice root mulch was applied at a one-inch depth over all herbicide treatments.

Herbicide injury studies indicated that activated carbon did detoxify all herbicides tested. Plants root-dipped in activated carbon showed less herbicide injury, greater fresh weight, and more growth (percentage of ground covered) than those plants that were not so treated.

INTRODUCTION

Because of their beauty and versatility, use of ground covers in gardening is becoming more popular each year. Although use of these plants for reduced long-term maintenance is becoming more popular each year, many homeowners and professional gardeners are apprehensive about starting a ground cover planting because of the immediate high maintenance. This maintenance involves controlling weeds during the time between the initial planting and maturity. As more ground covers are used in the landscape, the need for efficient methods to establish healthy, well-developed plantings becomes more pressing.

Controlling weeds in newly planted ground covers is a problem for many municipal parks, botanical gardens, industrial landscapes, private nurseries, as well as for homeowners. Besides being unsightly, weeds are competitive for light, water, and nutrients and, therefore, can be a very expensive aspect of any maintenance program. With the rising cost of labor, hand cultivation must be minimized for successful management from an economical standpoint.

Many ways of controlling weeds in new plantings of ground cover are being practiced today. These practices include hand cultivation, soil sterilization, the use of organic mulches, and herbicides. Perhaps the easiest and most economical method is to use herbicides and mulches, either alone or in combination.

In many cases organic mulches such as peat moss, sawdust, wood chips, and licorice root work very well for controlling weeds when used in large quantities. Using licorice root mulch at a two to three inch depth does control weeds well, but in most cases it is expensive to apply this mulch at these levels. Since these organic mulches do break down, are washed away by water, or are blown away by wind, they must be replaced periodically, until the ground cover planting becomes well established. This, of course, adds to the cost of planting not only because of the addition of new mulch, but also because of the labor required in applying this mulch. The ideal situation from an economical standpoint may be to use a minimum amount of mulch with a herbicide.

In most cases ground cover plants are planted on six-inch centers. To develop a vigorous stand of ground cover, these plantings should be kept relatively free of weeds for about three to four years, or until the ground cover plants "take over" to shade weed seed and prevent germination, or to crowd out weeds that have germinated. Herbicides, depending on their nature and concentration can cause damage or death to ground cover plants.

Some reasearchers have demonstrated that herbicide toxicity to desirable plants may be alleviated by dipping the roots of these plants in activated carbon. Although most of the work in this area has been done with vegetable transplants, the use of activated carbon as a detoxifying agent for ornamentals looks promising.

The purpose of this investigation was to determine whether herbicides in varying concentrations and combinations, together with different mulches might be of aid in establishing plantings of ground covers. In addition, activated carbon applied to the roots was tested as a means for reducing or circumventing herbicide injury to the ground cover plants.

LITERATURE REVIEW

Herbicide-Mulch Combinations

Using mulches in new plantings of ground covers not only adds beauty to the planting, prevents erosion, conserves soil moisture, keeps soil temperature more constant; but also aids in controlling weeds. Mulches may be used to control weeds in three ways: (1) by using mulch alone, (2) by applying the mulch over a herbicide, (3) by using mulches that are impregnated with herbicides.

In initial studies with and without crop plants, Lanphear (20) observed that dichlobenil 4% granular when incorporated in organic mulches at different rates and applied to the soil at different depths, provided equal or better weed control than either the dichlobenil or the mulch used alone.

In other studies Lanphear (19) observed that dichlobenil at 4 or 8 lbs./acre incorporated in peat moss and applied at 1 or 2 inch depths in ornamental plantings was very effective. However, he found that simazine at 1lb./acre and diphenamid at 6 lb./acre was less effective when applied with organic mulches than when applied alone.

Dunham, Fretz, and Rubin (13) showed that satisfactory weed control in landscape plantings could be achieved by mixing 37.5 pounds of Casoron 4G[3] (dichlobenil) with fifteen tons of licorice root mulch spread to a depth of 1 inch. Fretz, Dunham, and Rahn (15) studied the effect of licorice root, shredded pine bark, and sugar cane mulches that were mixed with diphenamid and dichlobenil and observed that weed control was better with mulch and herbicide, than with mulches without herbicides and that this method did not reduce the effectiveness of the herbicide. Further studies by Dunham, Rahn, and Fretz (12) observed that dichlobenil incorporated in licorice root at 8 pounds per acre and applied to new ground cover plantings at depths of 1/2" or 1" provided excellent weed control, but was injurious to both newly planted Vinca and Ivy.

In two-year trials, Yurnia (29) observed that mulching around young apple trees with granulated peat treated with simazine at 4 g./sq.m. and spraying the surrounding areas with simazine at 0.4 g./sq.m. gave satisfactory weed control. However, Perehodkin (24) observed that mulching apple trees before or after spraying or mulching with simazine treated peat, reduced the herbicidal action of the simazine and increased the cost of treatment.

Usually as the depth of the mulch is increased from 1" to 3" weed control improves. Haramaki, Nuss, and Williams (17) when testing dichlobenil, diphenamid, and simazine incorporated in oak bark mulch applied to beds of Forsythia and Taxus species, observed that weed control was improved when either the concentration of herbicide, depth of mulch, or their combinations were increased. Bing (10) when testing different mulches with different herbicides observed that some mulches without herbicide did not adequately control weeds, and that other mulches would control weeds only if used in applications of 2" to 3".

Testing three granular herbicides, simazine, CIPC, and dichlobenil with and without organic mulches and with mulches to a depth of 1" around small nursery plants, Fitzgerald and Havis (14) observed that all combinations of herbicides and mulches gave good weed control. Dichlobenil was the only herbicide that gave satisfactory weed control when used without mulch.

Mulches may also aid in conserving different herbicides so that they may be effective for longer periods of time. Ahrens and Miller (6) testing simazine under salt hay and black plastic observed that a year after the initial treatment, the amount of simazine in the soil was directly related to the mulch, and the type of mulch used. Compared with bare soil, about 15 times as much simazine was found under the hay, and 20 times as much under the black plastic when simazine was applied at 4 lbs. per acre. The effectiveness of some herbicides may be related to the organic matter content and the moisture level of the soil. Grover (16) observed that the addition of the organic matter reduced the effectiveness of simazine in the soil and that toxicity of simazine decreased as the soil moisture level was reduced. Dallyn (11) observed that high organic matter levels in soil reduce the activity of the herbicide, and that crops grown on soils low in organic matter are more subject to herbicidal injury than those grown on higher levels. Miller, Demoranville, and Charig (22) in testing the persistence of dichlobenil in cranberry bogs observed that the chemical was not readily leached downward in the soil and that most of the herbicide is believed to be held in an ineffective state by the organic matter in the soil.

Time of application is also an important factor to consider when applying herbicides. Bing (9) observed that fall treatments of granular simazine on certain herbaceous perennials gave good to excellent weed control. Bell (8) observed that single applications of diphenamid at different periods from mid-September to early December, gave good to excellent control of most weeds in strawberry plantings until the end of the fruiting season.

Selection of the proper herbicide also depends on the specific weed problem, and the crop being grown. Most herbicides are injurious to some crops. Peabody, Dwight, and Crandall (23) tested several herbicides including simazine and diphenamid on different strawberry plantings and observed that diphenamid was shown to control a wide range of annual weed species while causing little or no injury to either new or established strawberry plantings. Simazine was found to cause injury in some of the strawberry plantings. Bing (9) studied the effect of several herbicides on different perennials and observed that simazine was very harmful to some perennials. Lanphear and Warren (21) tested several herbicides on herbaceous ground covers and observed that neburon applied as a spray gave the most complete weed control and did not injure any of the ground covers. Dichlobenil was effective in controlling grasses only, and was injurious to Ajuga at 3 and 6 pounds per acre rates. Alder and Wright (7) tested the effect of diphenamid on several horticultural crops and observed that diphenamid controlled annual grass and several broadleaf weeds and that some of the crops tested were tolerant to diphenamid. Wright and Alder (28) in tolerance trials observed that diphenamid does control certain weeds under certain conditions and that some horticultural crops are tolerant to diphenamid and some are not.

Plant maturity (stage of growth) also seems to be an important factor to consider when selecting a herbicide. Ahrens (3) in testing the effect of dichlobenil and diphenamid for controlling weeds in container grown nursery stock observed that differences in sensitivity to dichlobenil were evident not only between varieties or species but among plants of different ages in the same taxon. The older plants seemed to be more tolerant to herbicide injury.

Activated Carbon

Weber and Gould (27) showed that adsorption on activated carbon is an effective means of removing pesticides from water. Over the past few years some research has been conducted concerning the effects of activated carbon as a detoxifying agent in field studies of herbicide effects on a number of plants.

Robinson (25) tested seven adsorbents, activated charcoal, kieselguhr, vermiculite, dried farmyard manure, dried grass, non-activated charcoal, and soot. He found that activated charcoal was the most effective in protecting newly planted strawberry runners against simazine. In this study Robinson observed that dipping the roots of runners in charcoal before planting was more effective and practicable than placing a similar quantity around each runner at planting.

Ahrens (2) showed that activated carbon in transplant water greatly reduced injury to cabbage and tobacco plants set in soil containing toxic residues of atrazine or simazine. Atrazine at 1/2 lb. per acre reduced yields of cabbage 60 to 80 per cent. Cabbage growing in these same plots but with activated carbon added to the transplant water, gave reduced yields of no more than 13 per cent. Other work by Ahrens (4) showed that carbon root dips prevented injury to strawberry plants that were treated with simazine alone or in combination with DCPA or diphenamid. When using strawberry plants, Ahrens (1) observed that undipped strawberry plants were severely injured or killed by simazine at 2 to 3 lbs. per acre, while carbon-dipped plants showed no injury and produced runners equal to, or exceeding control plants.

Research has shown that activated carbon can be an effective detoxifying agent when mixed with the planting medium. Ahrens (5) showed in pot experiments that when various amounts of activated carbon were mixed with soil containing known levels of herbicide before planting test plants, protection from herbicide toxicity did occur in most cases.

Kratky and Warren (18) in field and greenhouse experiments using 1 lb. of activated carbon mixed with three liters of vermiculite, observed that the carbon-vermiculite treatment gave from 0 to 100 per cent protection to crops having from little to moderate tolerance to the two herbicides neburon and simazine. Protection was observed on soybeans, cucumbers, and barley in a field trial where simazine at 2 lbs. per acre gave 99 per cent weed control.

In preliminary studies Schubert (26) observed that following the use of herbicides in cash crops, wheat could be successfully established as a cover crop when seed was moistened, coated with activated carbon, and sown immediately afterwards.

METHODS

The study was conducted at the University Farm in Newark, Delaware. The planting site was on a Metapeake Silt-Loam, with a pH of 6.0. The soil was not amended in any way. Irrigation was supplied throughout the season as needed.

The experimental design was a split plot, and was replicated three times. The main plot treatments were herbicides, the first sub-plot was mulches, the second sub-plot was activated carbon, and the third sub-plot was varieties.

The six herbicide treatments were, (1) control, (2) simazine (4 lbs./A), (3) dichlobenil (6 lbs./A), (4) diphenamid (6 lbs./A), (5) simazine (2 lbs./A) combined with diphenamid (4 lbs./A), and (6) dichlobenil (4 lbs./A) combined with diphenamid (4 lbs./A). The three mulch treatments were (1) no mulch, (2) licorice root (one-inch depth), and (3) "Foli-Cote" (diluted in water at a ratio of one to five). The two carbon treatments were (1) no carbon, and (2) carbon. The four ground covers used were (1) *Ajuga reptans*, (2) *Hedera helix*, (3) *Pachysandra* terminalis, and (4) Vinca minor.

Four-inch aluminum edging was used to separate the herbicide and mulch treatments. See Figure 1 for a schematic drawing showing treatments of one replication.

The ground cover plants were planted the week of October 17, 1969. Twenty-four plants of each variety were planted on six-inch centers in each main plot with eight plants to each mulch split. Within each mulch split, four plants of each variety were root-dipped. The root-dipping procedure consisted of dipping the moist bare root plants in activated carbon. In the case of the Ajuga reptans which were purchased in three-inch peat pots, a water slurry of activated carbon (1 1/2 lbs./gal.) was used so that the peat pot could be dipped intact.

The herbicide treatments were applied on October 28, 1969. Since a 4 per cent granular was used in the dichlobenil (6 lbs./A) treatment, a small can with holes was used to apply this herbicide.

After the herbicides were applied the mulches were put down. The "Foli-Cote", which is a sixty per cent paraffin emulsion, was applied with a watering can. The licorice root mulch, which is a by-product from the processing of licorice juice, was applied by hand. On

November 15, 1969 all plots were lightly covered with salt hay for winter protection. This was removed from all plots on April 20, 1970.

On May 13, 1970 Peters 20-20-20 soluble fertilizer was applied to all plots at the rate of two pounds per one hundred square feet.

Herbicide toxicity was rated by a standard visual evaluation on November 10, 1969, June 15, 1970, and August 7, 1970. These visual ratings were made by assigning each ground cover plant a number from 1 to 5 depending on the amount of injury observed. These numerical values were made using a standard of: 1 = No Injury, 2 = Slight Injury (some to 25% leaf damage), 4 = Heavy Injury (50% to nearly all leaf area damaged), and 5 = Complete Kill. See Figures 2 thru 9.

Weed population in each plot was measured on July 15, 1970 and again on September 15, 1970. The stand (number of plants) and vigor (dry weight) of the weed population by species were measured in each plot. Weeds were counted by species in each mulch split, cut off at ground level, placed in paper bags according to species, dried and weighed.

On August 5, 1970, data was taken to obtain the percentage of ground covered by the ground cover plants in each split plot. A grid 14" X 16" was used. This grid was placed over the four ground cover plants and the amount of ground covered by the plants within this grid was estimated as a percentage. See Figures 10 thru 17.

The stand and vigor of the ground cover plants by species in each split were observed on October 1, 1970. Within each split the ground cover plants were counted, dug with roots intact, and weighed (fresh weight was used).

MATERIALS

The materials and quantity used were as follows:

	ITEM	QUANTITY
1.	Four-inch aluminum edging	550 feet
2.	*Ajuga reptans*	432 plants
3.	*Hedera helix*	432 plants
4.	*Pachysandra terminalis*	432 plants
5.	*Vinca minor*	432 plants
6.	Simazine 80 W	12.69 grams
7.	Dichlobenil 4% granular	253.26 grams
8.	Dichlobenil 50 W	13.5 grams
9.	Diphenamid 50 W	47.5 grams
10.	Licorice Root Mulch	27 cu. ft.
11.	"Foli-Cote" 60%	1 gallon
12.	Activated Carbon	20 pounds
13.	Peters 20-20-20 fertilizer	10 pounds

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11. "Foli-Cote" was supplied by the Sun Oil Company, Marcus Hook, Pennsylvania

12. Activated Carbon was purchased from Thompson-Hayward Chemical Company, Kansas City, Kansas 61106

RESULTS AND DISCUSSION

WEED CONTROL - STAND AND VIGOR

In every case, weed control was improved when licorice root mulch was applied over a herbicide treatment. The four weed species evaluated were: *Panicum dichotomiflorum* (fall panicum), *Eragrostis cilianensis* (stinkgrass), *Portulaca oleracea* (purslane), and *Amaranthus retroflexus* (redroot pigweed).

A complete listing of the F values and significance level of the stand and vigor of all weed species is in Appendix I.

Panicum _dichotomiflorum_ - Influence of treatments on Stand.

The herbicide treatments were an important factor in controlling the stand of this weed. As observed in Table I, the number of plants in the control treatments, and in each mulch treatment without herbicide, was significantly higher than in the herbicide treatments.

Although all herbicide treatments were highly significant without mulch, dichlobenil (6 lbs./A), the simazine - diphenamid combination, and the dichlobenil-diphenamid combination, gave the best control of fall panicum (Table 1).

Licorice root was the best mulch for controlling the stand of fall panicum in all herbicide treatments. Although licorice root was effective in controlling fall panicum without herbicides, weed control was improved when this mulch was applied over a herbicide application, except in the simazine - diphenamid combination treatment. With licorice root mulch, simazine (4 lbs./A), dichlobenil (6 lbs./A), diphenamid (6 lbs./A), and the dichlobenil-diphenamid combination gave better control of fall panicum than any of the other herbicide-mulch treatments (Table 1).

"Foli-Cote" did result in some control of fall

TABLE I. STAND (NO. OF PLANTS) AND VIGOR (DRY WT. IN GRAMS) OF WEED SPECIES TREATED WITH DIFFERENT HERBICIDES AND MULCHES

TREATMENTS	FALL PANICUM		STINKGRASS		PURSLANE		REDROOT	PIGWEED
	STAND	VIGOR	STAND	VIGOR	STAND	VIGOR	STAND	VIGOR
H1 Control	28.00	140.00	20.67	50.36	10.43	98.60	2.00	8.43
Licorice root	12.00	34.00	19.45	48.67	6.37	54.76	.67	2.67
Foli-Cote	18.67	166.67	20.34	36.67	8.28	60.67	3.67	3.33
H2 Simazine	9.67	40.00	24.67	48.33	2.33	18.67	2.67	7.67
Licorice root	2.33	88.00	0.00	0.00	0.00	0.00	1.67	1.67
Foli-Cote	10.67	84.67	3.67	13.33	.33	6.67	2.67	6.00
H3 Dichlobenil	6.67	80.00	35.34	62.67	10.67	110.67	4.00	4.00
Licorice root	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foli-Cote	6.67	78.67	21.67	135.00	50.33	366.67	7.00	10.00
H4 Diphenamid	11.00	136.67	13.33	36.00	0.00	0.00	1.67	5.67
Licorice root	0.00	0.00	0.00	0.00	0.00	0.00	1.67	2.00
Foli-Cote	10.00	96.67	30.00	84.67	3.67	55.00	2.33	4.00
H5 Sim. & Diph.	5.67	110.00	11.33	50.00	.67	.33	1.67	8.67
Licorice root	4.00	22.00	.67	4.67	0.00	0.00	0.00	0.00
Foli-Cote	7.67	60.00	10.67	44.67	6.67	120.00	3.67	29.33
H6 Dich. & Diph.	5.00	66.67	17.00	70.00	6.00	70.00	3.67	10.00
Licorice root	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foli-Cote	8.67	133.34	25.33	130.00	16.00	136.67	3.67	12.67
LSD (.05)	2.90	77.28	17.48	45.79	5.33	76.08	N.S.	11.16
LSD (.01)	3.92	N.S.	N.S.	N.S.	7.22	103.10	N.S.	N.S.

H1 = No Herbicide, H2 = Simazine (4lbs/A), H3 = Dichlobenil (6lbs/A), H4 = Diphenamid (6lbs/A), H5 = Simazine (2lbs/A) & Diphenamid (4lbs/A), H6 = Dichlobenil (4lbs/A) & Diphenamid (4lbs/A) panicum in the no mulch, control (no herbicide) treatment. However, there was no difference between "Foli-Cote" and no mulch when herbicides were applied for controlling the stand of fall panicum (Table I).

Panicum dichotomiflorum - Influence of treatments on Vigor.

The vigor (dry weight in grams) of fall panicum was greater in the control treatments (no herbicide).

Simazine (4 lbs./A) and the dichlobenil-diphenamid combination treatments controlled the vigor of fall panicum better than any other herbicide treatment with no mulch (Table I).

Licorice root mulch did control the vigor of fall panicum with no herbicides compared to the no-mulch, no-herbicide treatment and to the "Foli-Cote" no-herbicide treatment. However, dichlobenil (6 lbs./A), diphenamid (6 lbs./A), and the dichlobenil-diphenamid combination with licorice root mulch, were the best treatments for reducing the vigor of fall panicum (Table I).

In most cases the vigor (dry weight in grams) did not directly relate to stand (number of plants) of fall panicum. Perhaps because of less competition, the fewer the number of weeds, the more vigorously these weeds grew. An example of this may be seen by comparing the simazine-licorice root combination treatment, with slightly above two weeds and a dry weight (vigor) of eighty-eight grams, with the dichlobenil-no mulch treatment which had almost seven weeds and gave a dry weight of eighty grams (Table I).

Eragrostis _cilianensis_ - Influence of treatments on Stand.

Licorice root mulch applied over all herbicides was very effective in controlling the stand of stinkgrass.

There were no differences in the stand of stinkgrass among the mulches in the control (no herbicide) treatment. This could be because the high stand and vigor of the fall panicum in the control treatment with no mulch prevented the stinkgrass from competing favorably. This could also account for the fact that there was no difference in stand between the control (no herbicide) with no mulch and the herbicide treatments with no mulch (Table I).

However, there were differences when herbicides were applied under licorice root mulch for controlling stinkgrass. All herbicide treatments were better in controlling this weed when applied under licorice root mulch (Table I).

Eragrostis _cilianesis_ - Influence of treatments on Vigor.

As with stand, licorice root mulch applied over most herbicide treatments was very effective in controlling the vigor of stinkgrass (Table I).

In comparing all treatments tested, the vigor of stinkgrass was less using licorice root mulch with the simazine (4 lbs./A), dichlobenil (6 lbs./A), diphenamid (6 lbs./A), and the dichlobenil-diphenamid combination treatments (Table I).

The licorice root mulch-herbicide combinations controlled the stand (number of plants) and vigor (dry weight in grams) of stinkgrass more effectively than any other treatment (Table 1).

Portulaca oleracea - Influence of treatments on Stand.

Licorice root mulch applied over a herbicide was the most effective method of controlling the stand of purslane.

In the plots receiving no herbicides mulches were not effective in controlling the stand of this weed (Table I).

With no mulch, simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination treatments reduced the stand of purslane (Table I).

With all herbicides tested, licorice root mulch reduced the stand of purslane (Table I).

"Foli-Cote" mulch alone or with a herbicide treatment had no effect in controlling the stand of purslane (Table 1).

Portulaca oleracea - Influence of treatments on Vigor.

In some cases the vigor of purslane was inversely proportional to the stand. That is, in a treatment with fewer weeds, each weed was more vigorous than those in a treatment with more weeds. This could be due to less competition within the treatment with fewer weeds.

Mulches alone were not effective in controlling the vigor of purslane (Table 1).

However, as with stand (with no mulch) simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination significantly affected the vigor of purslane (Table 1).

Although not statistically significant, licorice root mulch with all herbicides tested did appear to reduce the vigor of purslane. Here again, the stand and vigor of the fall panicum may have restricted the growth (vigor) of the purslane. The same may hold true for the "Foli-Cote"-herbicide combinations, which were also not statistically significant (Table 1).

<u>Amaranthus retroflexus</u> - Influence of treatments on Stand.

There was no difference in the stand of redroot pigweed among the herbicide and herbicide-mulch treatments. This could have been due to the high stand and vigor of the earlier germinating fall panicum weeds in the control treatments with and without mulches. Because of the high stand and vigor of the fall panicum, the redroot pigweed was not able to compete favorably (Table I).

However, there was a difference among the mulches in controlling the stand of this weed. Licorice root mulch treatments reduced the stand of redroot pigweed compared to no mulch and "Foli-Cote" mulch treatments (Table II).

TABLE II. STAND (NUMBER OF PLANTS) OF *Amaranthus retroflexus* (REDROOT PIGWEED) TREATED WITH DIFFERENT MULCHES

	MEANS	
No mulch	2.28	
Licorice root	.67	LSD (.05) 1.29
"Foli-Cote"	3.83	LSD (.01) 1.55

<u>Amaranthus retroflexus</u> - Influence of treatments on Vigor.

Differences in the vigor of redroot pigweed were significant only in the simazine-diphenamid treatment between the licorice root and "Foli-Cote" mulches (Table I).

There were no significant differences in the vigor of this weed among the mulches in the control treatment or among the herbicide treatments and control within each mulch (Table I).

Although not statistically significant, licorice root mulch with all herbicides tested (including control) did appear to reduce the vigor of redroot pigweed compared with the two other mulch treatments (Table I).

HERBICIDE INJURY TO GROUND COVERS

Visual observations of herbicide injury to ground covers were made by assigning each ground cover plant a number from 1 to 5 depending on the amount of injury observed. See Figures 2 thru 9 for examples.

A complete listing of the F values and significance level of herbicide injury by visual ratings is in Appendix II.

THE EFFECTS OF HERBICIDES

Data taken June 15, 1970 on herbicide injury to ground covers showed that certain herbicides were injurious to some species of ground cover. However, this injury was often of a temporary nature and in some cases did not effect the growth of these plants at a later date. See Figures 18 thru 21.

Ajuga reptans - All herbicide treatments except diphenamid (6 lbs./A) were injurious to this plant at this time (Table III).

Hedera helix - Although some significant results were obtained, the mortality rate of this plant made a valid evaluation difficult. Simazine (4 lbs./A) was the only herbicide treatment that was not injurious to this plant at this time (Table III).

<u>Pachysandra terminalis</u> - All herbicide treatments were significantly injurious to this plant at this time (Table III).

<u>Vinca Minor</u> - This plant was the least injured of all plants tested. Diphenamid (6 lbs./A) and the simazine-diphenamid combination were not injurious to this plant (Table III).

TABLE III. VISUAL OBSERVATIONS OF HERBICIDE INJURY TO GROUND COVERS TREATED WITH DIFFERENT HERBICIDES. JUNE 15, 1970.

	Ajuga	Hedera	Pach.	Vinca
Control (No herbicide)	1.46	3.23	1.62	1.15
Simazine (4lbs/A)	4.41	3.80	2.51	2.07
Dichlobenil (6lbs/A)	3.66	4.51	2.61	2.13
Diphenamid (6lbs/A)	1.89	4.19	2.80	1.12
Sim.(2lbs/A) & Diph.(4lbs/A)	4.26	3.91	2.62	1.26
Dich.(4lbs/A) & Diph.(4lbs/A)	3.17	4.52	3.14	2.54

LSD (.05) .61
LSD (.01) .82

These numerical values were made using a standard based on: 1 = No injury, 2 = Slight injury (some to 25% leaf damage), 3 = Moderate injury (25% to 50% leaf damage), 4 = Heavy injury (50% to nearly all leaf area damaged), and 5 = Complete kill (Tables III, IV, and V).

THE EFFECTS OF ACTIVATED CARBON

Activated carbon was an important factor in reducing herbicide toxicity to all ground covers tested (Table IV).

TABLE IV. VISUAL OBSERVATIONS OF HERBICIDE INJURY TO GROUND COVERS TREATED WITH AND WITHOUT CARBON. JUNE 15, 1970.

	NO CARBON	CARBON
Ajuga reptans	3.83	2.46
Hedera helix	4.36	3.52
Pachysandra terminalis	2.96	2.15
Vinca minor	2.11	1.31

LSD (.05) .31
LSD (.01) .41

Protection was conferred on all ground covers tested that were root-dipped in activated carbon.

THE EFFECTS OF ACTIVATED CARBON AND HERBICIDES

Activated carbon reduced the toxicity of all herbicides tested. However, there was some injury to one or more of the ground covers that were root-dipped in activated carbon with all of the herbicides except possibly diphenamid at 6 lbs./A (Table V).

TABLE V. VISUAL OBSERVATIONS OF HERBICIDE INJURY TO GROUND COVERS IN DIFFERENT HERBICIDE TREATMENTS WITH AND WITHOUT CARBON, JUNE 15, 1970.

	NO CARBON	CARBON
Control (No herbicide)	2.03	1.70
Simazine (4lbs/A)	3.81	2.56
Dichlobenil (6lbs/A)	3.68	2.77
Diphenamid (6lbs/A)	2.76	2.16
Sim.(2lbs/A) & Diph.(4lbs/A)	3.52	2.53
Dich.(4lbs/A) & Diph.(4lbs/A)	3.96	2.74

LSD (.05) .40
LSD (.01) .56

STAND, VIGOR, AND GROWTH OF GROUND COVERS

The stand (number of plants) and vigor (fresh weight in grams) of each ground cover was measured in each plot.

Growth (percentage of ground covered) of the ground cover plants in each plot was estimated to evaluate the effects of herbicides, mulches, activated carbon, and their combinations. A grid 14" X 16" was used. This grid was placed over the ground cover plants in each carbon split and the amount of ground covered by the plants within this grid was estimated as a percentage. For examples see Figures 10 thru 17.

A complete listing of the F values and significance level of stand, vigor, and percentage of ground covered by the various species of ground cover is in Appendix II.

THE EFFECTS OF HERBICIDES

Certain herbicides affected the stand (number of plants), vigor (fresh weight in grams), and growth (percentage of ground covered) of certain ground cover species (Tables VI, VII, VIII).

Ajuga reptans - Diphenamid at 6 lbs./A was the only herbicide treatment that did not reduce the stand, vigor and growth of this plant.

Hedera helix - Simazine at 4 lbs./A and the simazine-diphenamid combination treatments did not effect the stand of this ground cover. Because of the high mortality rate, a valid evaluation of vigor and growth of this plant was not possible.

Pachysandra terminalis - Dichlobenil (6 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination treatments did not effect the stand of this ground cover. Although no herbicide tested was injurious to vigor, the dichlobenil-diphenamid combination treatment was injurious to the growth of this plant.

Vinca minor - Simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination treatments were the only herbicides tested that did not effect the stand, vigor, and growth of this plant.

TABLE VI. STAND (NUMBER OF PLANTS) OF GROUND COVER PLANTS TREATED WITH DIFFERENT HERBICIDES

	Ajuga	Hedera	Pach.	Vinca
Control (No herbicide)	3.67	1.72	2.78	4.00
Simazine (4lbs/A)	.83	1.50	1.89	3.61
Dichlobenil (6lbs/A)	1.06	.50	2.22	2.94
Diphenamid (6lbs/A)	2.94	.72	2.28	3.78
Sim. (2lbs/A) & Diph. (4lbs/A)	.89	1.17	2.78	3.83
Dich.(4lbs/A) & Diph.(4lbs/A)	1.94	.67	1.22	3.11
LSD (.05)	.64			
LSD (.01)	.86			

TABLE VII. VIGOR (FRESH WEIGHT IN GRAMS) OF GROUND COVER PLANTS TREATED WITH DIFFERENT HERBICIDES

	Ajuga	Hedera	Pach.	Vinca
Control (No herbicide)	622.78	35.56	40.11	208.33
Simazine (4lbs/A)	109.89	56.44	44.22	270.56
Dichlobenil (6lbs/A)	174.45	12.33	40.72	90.28
Diphenamid (6lbs/A)	560.67	16.67	33.78	198.33
Sim.(2lbs/A) & Diph.(4lbs/A)	170.56	34.41	39.56	251.94
Dich.(4lbs/A) & Diph.(4lbs/A)	362.22	19.78	17.44	76.67
LSD (.05)	67.83			
LSD (.01)	93.44			

TABLE VIII. GROWTH (PERCENTAGE OF GROUND COVERED) OF GROUND COVERS TREATED WITH DIFFERENT HERBICIDES

	Ajuga	Hedera	Pach.	Vinca
Control (No herbicide)	83.33	12.78	22.50	75.56
Simazine (4lbs/A)	11.39	16.11	15.00	63.88
Dichlobenil (6lbs/A)	24.17	3.34	13.61	30.28
Diphenamid (6lbs/A)	79.44	5.27	14.72	75.00
Sim.(2lbs/A) & Diph.(4lbs/A)	19.44	12.22	17.22	75.00
Dich.(4lbs/A) & Diph.(4lbs/A)	38.89	3.61	7.22	30.83

LSD (.05) 10.61
LSD (.01) 14.42

THE EFFECTS OF MULCH

Certain mulch treatments did effect the stand (number of plants), vigor (fresh weight in grams), and growth (percentage of ground covered) of the ground covers tested (See Table IX).

Ajuga reptans - The stand, vigor, and growth of this plant was increased by the use of licorice root mulch. The stand and growth was higher in the no mulch treatments when compared to the "Foli-Cote" treatment.

Hedera helix - The stand of this plant was higher in the no mulch and licorice root mulch treatments when compared with "Foli-Cote" mulch. This plant showed no differences in vigor or growth in any of the mulch treatments.

Pachysandra terminalis - The stand of this plant was higher in the licorice root mulch treatment compared to the other mulch treatments. This plant showed no differences in vigor or growth in any of the mulch treatments.

Vinca Minor - The stand of this plant was not affected by any of the mulch treatments. However, licorice root mulch did increase the vigor and growth of this plant.

TABLE IX. STAND (NUMBER OF PLANTS), VIGOR (FRESH WEIGHT IN GRAMS), AND GROWTH (PERCENTAGE OF GROUND COVERED) OF GROUND COVERS TREATED WITH DIFFERENT MULCHES

	STAND			VIGOR			GROWTH		
	NO MULCH	LIC. ROOT	FOLI-COTE	NO MULCH	LIC. ROOT	FOLI-COTE	NO MULCH	LIC. ROOT	FOLI-COTE
Ajuga reptans	2.00	2.31	1.36	276.33	471.94	199.17	43.33	53.75	31.25
Hedera helix	1.19	1.17	.78	30.53	34.53	22.39	9.58	9.30	7.64
Pachysandra terminalis	1.94	2.69	1.94	30.89	45.75	31.11	14.58	16.25	14.31
Vinca Minor	3.42	3.69	3.53	133.33	248.75	165.97	54.31	64.30	56.80
LSD (.05)	.43			43.21			6.89		
LSD (.01)				58.64			9.17		

TABLE X. STAND (NUMBER OF PLANTS), VIGOR (FRESH WEIGHT IN GRAMS), AND GROWTH (PERCENTAGE OF GROUND COVERED) OF ALL GROUND COVER PLANTS TREATED WITH AND WITHOUT ACTIVATED CARBON

	STAND		VIGOR		GROWTH	
	NO CARBON	CARBON	NO CARBON	CARBON	NO CARBON	CARBON
Ajuga reptans	1.19	2.63	173.89	457.19	25.83	59.72
Hedera helix	.54	1.56	11.80	46.50	4.07	13.61
Pachysandra terminalis	1.63	2.76	21.69	50.20	9.91	20.19
Vinca minor	3.07	3.87	129.53	234.35	42.03	74.81
LSD (.05)	.34		33.61		5.25	
LSD (.01)			44.48		6.94	

THE EFFECTS OF ACTIVATED CARBON

In all instances of herbicide damage, except for the vigor of *Pachysandra terminalis*, root-dips of activated carbon reduced injury to all ground cover plants tested.

The stand (number of plants), vigor (fresh weight in grams), and growth (percentage of ground covered), of the carbon-treated plants was higher than the stand, vigor, and growth of plants not treated with activated carbon (Table X).

THE EFFECTS OF ACTIVATED CARBON AND HERBICIDES

For every herbicide treatment (not control), the stand (number of plants), vigor (fresh weight in grams), and growth (percentage of ground covered) of those plants that were root-dipped in activated carbon was higher than the stand, vigor, and growth of those plants not treated with carbon (Table XI).

TABLE XI. STAND (NUMBER OF PLANTS), VIGOR (FRESH WEIGHT IN GRAMS), AND GROWTH (PERCENTAGE OF GROUND COVERED) OF ALL GROUND COVER PLANTS TREATED WITH DIFFERENT HERBICIDES WITH AND WITHOUT CARBON

	STAND		VIGOR		GROWTH	
	NO CARBON	CARBON	NO CARBON	CARBON	NO CARBON	CARBON
Control (No herbicide)	3.00	3.08	220.50	250.72	48.30	52.78
Simazine (4lbs/A)	1.31	2.61	63.34	178.61	13.47	39.72
Dichlobenil (6lbs/A)	1.06	2.31	18.56	140.33	6.55	29.17
Diphenamid (6lbs/A)	2.03	2.83	136.33	210.00	34.58	52.63
Sim.(2lbs/A) & Diph.(4lbs/A)	1.69	2.64	65.61	182.47	20.50	41.38
Dich.(4lbs/A) & Diph.(4lbs/A)	.78	2.69	18.94	218.43	3.47	36.81
LSD (.05)	.42		39.95		6.33	
LSD (.01)	.58		55.97		8.83	

SUMMARY OF RESULTS

THE EFFECTS OF HERBICIDES, MULCHES, AND ACTIVATED CARBON FOR CONTROLLING WEEDS IN NEW PLANTINGS OF GROUND COVER.

Different herbicide and mulch treatments tested in this study did control weed populations in new plantings of ground cover. However, in some cases these treatments were injurious to certain ground cover plants tested.

From the basis of this study, the following is a list of ground covers with recommended treatments for controlling certain weeds in new plantings of ground cover, while minimizing herbicide injury.

See Figures 18 through 21 for growth (percentage of ground covered) of ground covers in relation to herbicide, mulch, and activated carbon treatments.

Ajuga reptans (Figure 18)

The only herbicide treatment without carbon root-dip that did not seriously reduce the area of ground covered by *Ajuga reptans* was diphenamid (6 lbs./A) in combination with licorice root mulch (Figure 18).

With carbon root-dip, satisfactory growth as measured by ground covered was obtained with diphenamid (6 lbs./A), the diphenamid-dichlobenil combination, and dichlobenil (6 lbs./A) when used without licorice root mulch; and with diphenamid (6 lbs./A) and the combination of diphenamid with either dichlobenil or simazine when used with licorice root mulch.

The best control of all weeds in plantings of *Ajuga reptans* was obtained with diphenamid (6 lbs./A) and the diphenamid-dichlobenil combination both used with licorice root mulch (Table I).

It would appear then that the best treatments for establishing *Ajuga reptans* in weed-free beds were the use of carbon root-dip, licorice root mulch, and either diphenamid (6 lbs./A), or the dichlobenil-diphenamid combination. Since the diphenamid resulted in less initial injury (Table III), it should be the recommended treatment.

Hedera helix (Figure 19)

All herbicide treatments without carbon root-dip reduced the area of ground covered by *Hedera helix* (Figure 19).

With carbon root-dip, satisfactory growth as measured by ground covered was obtained with simazine (4 lbs./A), and the simazine-diphenamid combination when used with or without licorice root mulch, and diphenamid (6 lbs./A) when used with licorice root mulch.

The best weed control of all weeds in plantings of *Hedera helix* was obtained with simazine (4 lbs./A), diphenamid (6 lbs./A), and the dichlobenil-diphenamid combination when used with licorice root mulch (Table I).

It would appear then that the best treatments for establishing *Hedera helix* in weed-free beds were the use of carbon root-dip, licorice root mulch, and either simazine (4 lbs./A), diphenamid (6 lbs./A), or the dichlobenil-diphenamid combination. Since simazine resulted in less initial injury (Table III), it should be the recommended treatment.

Pachysandra terminalis (Figure 20)

All herbicide treatments without carbon root-dip reduced the area of ground covered by Pachysandra terminalis (Figure 20).

With carbon root-dip, satisfactory growth as measured by ground covered was obtained with simazine (4 lbs./A), diphenamid (6 lbs./A), the simazine-diphenamid combination, and the dichlobenil-diphenamid combination when used without licorice root mulch; and all herbicide treatments with licorice root mulch except the dichlobenil-diphenamid combination treatment.

The best weed control of all weeds in plantings of Pachysandra terminalis was obtained with simazine (4 lbs./A), diphenamid (6 lbs./A), and the dichlobenil-diphenamid combination when used with licorice root mulch.

It would appear then that the best treatments for establishing Pachysandra terminalis in weed-free beds were the use of carbon root-dip, licorice root mulch, and either simazine (4 lbs./A), diphenamid (6 lbs./A), or the dichlobenil-diphenamid combination. Since simazine resulted in less initial injury (Table III), it should be the recommended treatment.

Vinca minor (Figure 21)

The herbicide treatments without carbon root-dip that did not seriously reduce the area of ground covered by *Vinca minor* were diphenamid (6 lbs./A) without mulch, and simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination with licorice root mulch.

With carbon root-dip satisfactory growth as measured by ground covered was obtained with simazine (4 lbs./A), diphenamid (6 lbs./A), and the simazine-diphenamid combination when used with or without licorice root mulch.

The best weed control of all weeds in plantings of *Vinca minor* was obtained with simazine (4 lbs./A) and diphenamid (6 lbs./A) when used with licorice root mulch.

It would appear then that the best treatments for establishing *Vinca minor* in weed-free beds were the use of carbon root-dip, licorice root mulch, and either simazine (4 lbs./A), or diphenamid (6 lbs./A). Since diphenamid resulted in less initial injury (Table III), it should be the recommended treatment.

A SCHEMATIC DRAWING OF THE HERBICIDE, MULCH, CARBON, AND VARIETY TREATMENTS OF ONE REPLICATION.

NO MULCH	LICORICE ROOT	FOLI-COTE
8-*Ajuga reptans* 4-root dipped in activated carbon	8-*Vinca minor* 4-root dipped in activated carbon	8-*Pachysandra terminalis* 4-root dipped in activated carbon
8-*Vinca minor* 4-root dipped in activated carbon	8-*Ajuga reptans* 4-root dipped in activated carbon	8-*Hedera helix* 4-root dipped in activated carbon
8-*Hedera helix* 4-root dipped in activated carbon	8-*Hedera helix* 4-root dipped in activated carbon	8-*Ajuga reptans* 4-root dipped in activated carbon
8-*Pachysandra terminalis* 4-root dipped in activated carbon	8-*Pachysandra terminalis* 4-root dipped in activated carbon	8-*Vinca minor* 4-root dipped in activated carbon

6'

9'

4" Aluminum edging separating each replication and each mulch split.

FIGURE I

VISUAL RATINGS OF HERBICIDE INJURY

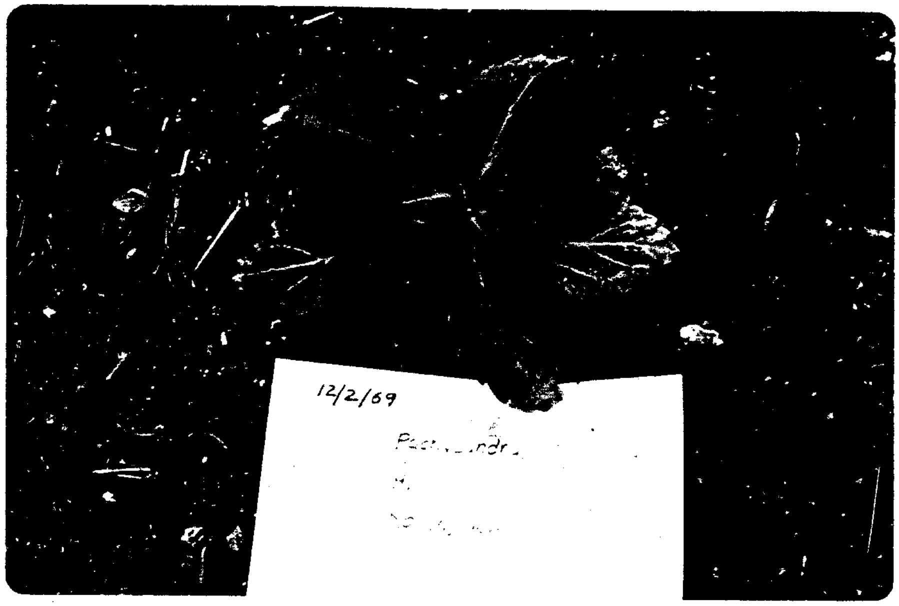


FIGURE 2. Pachysandra terminalis 1 No Injury

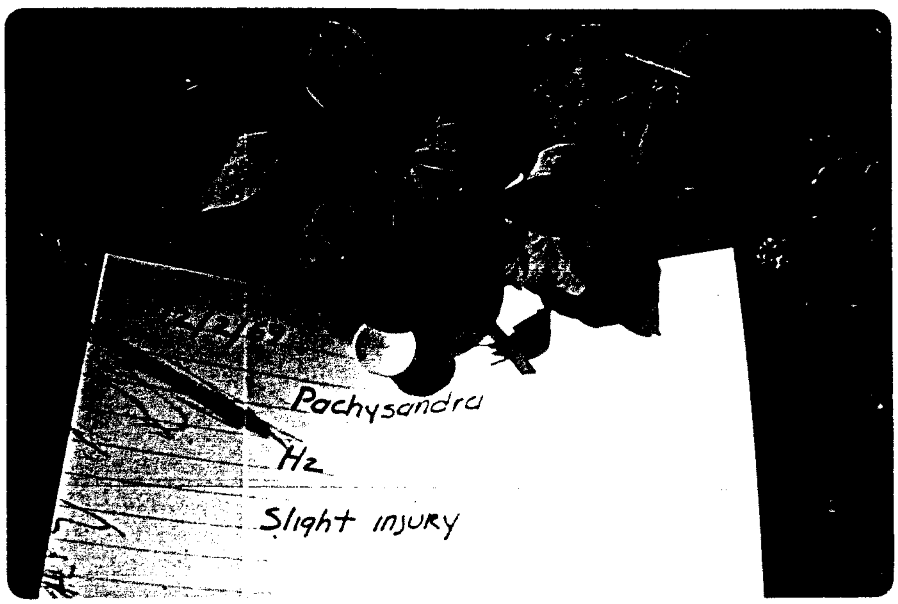


FIGURE 3. Pachysandra terminalis 2 Slight Injury

VISUAL RATINGS OF HERBICIDE INJURY (CONTINUED)

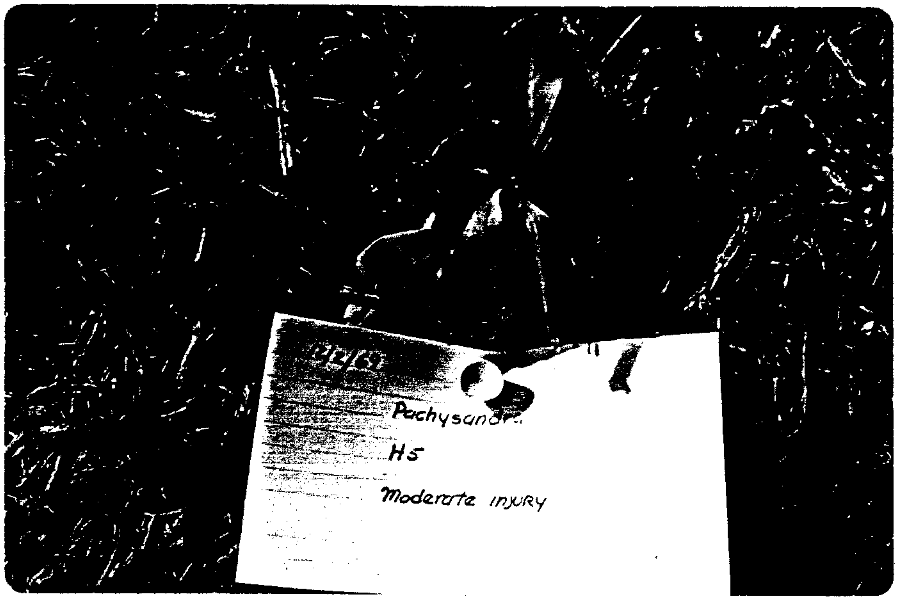


FIGURE 4. Pachysandra terminalis 3 Moderate Injury

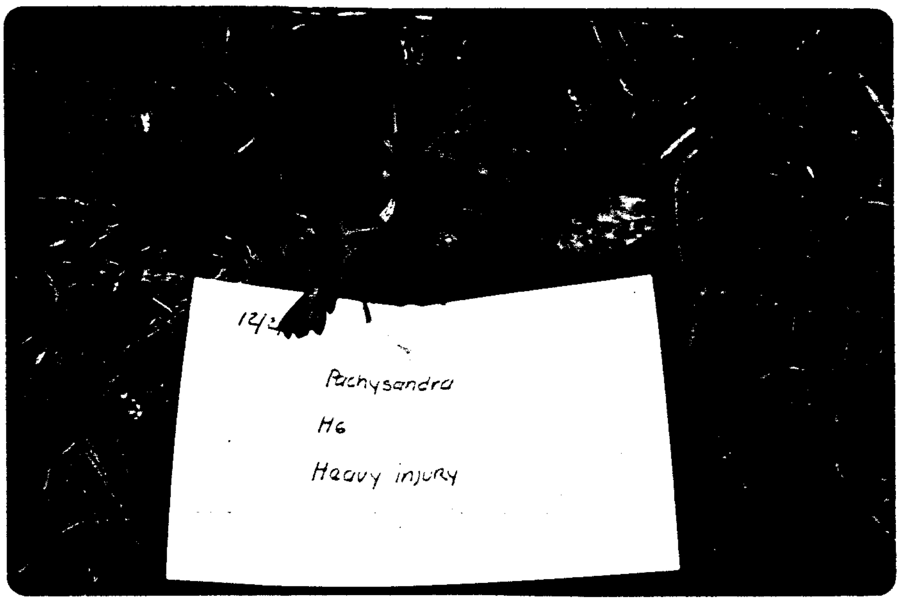


FIGURE 5. Pachysandra terminalis 4 Heavy Injury

VISUAL RATINGS OF HERBICIDE INJURY (CONTINUED)

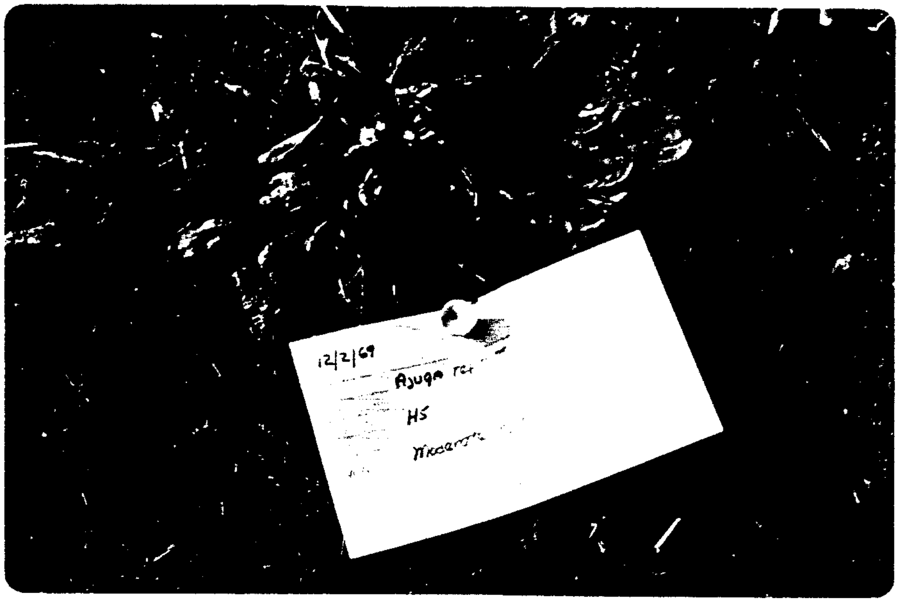


FIGURE 6. <u>Ajuga reptans</u> 3 Moderate Injury

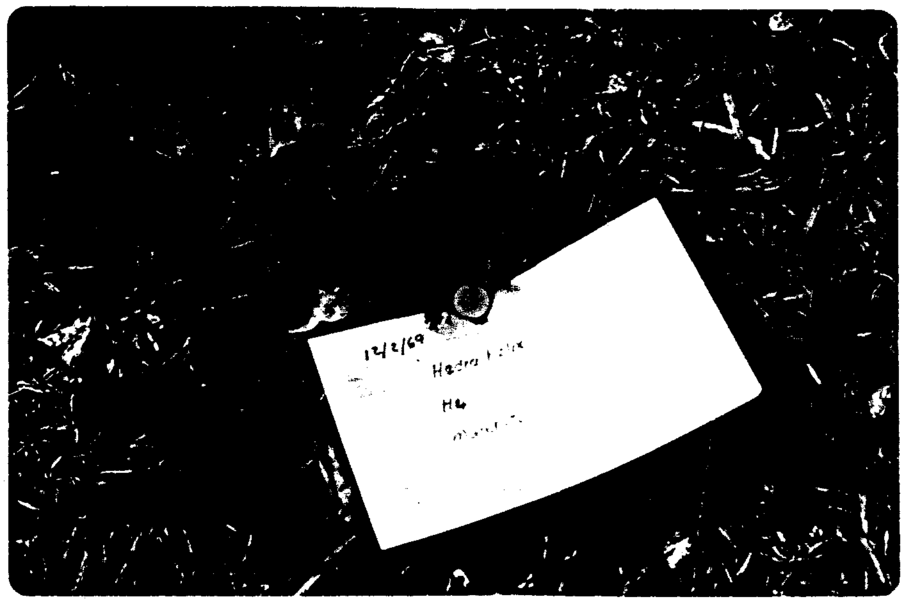


FIGURE 7. <u>Hedera helix</u> 3 Moderate Injury

VISUAL RATINGS OF HERBICIDE INJURY (CONTINUED)

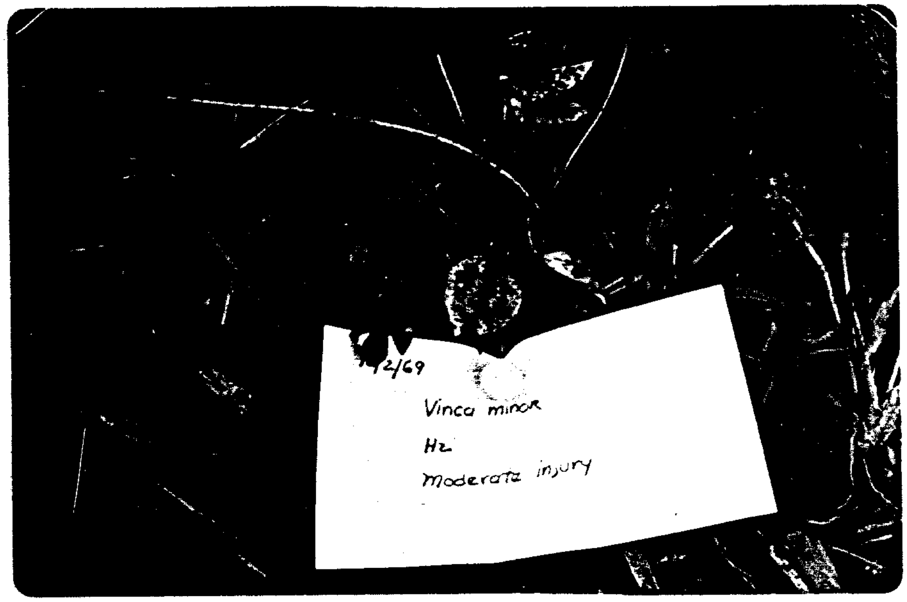


FIGURE 8. *Vinca minor* 3 Moderate Injury

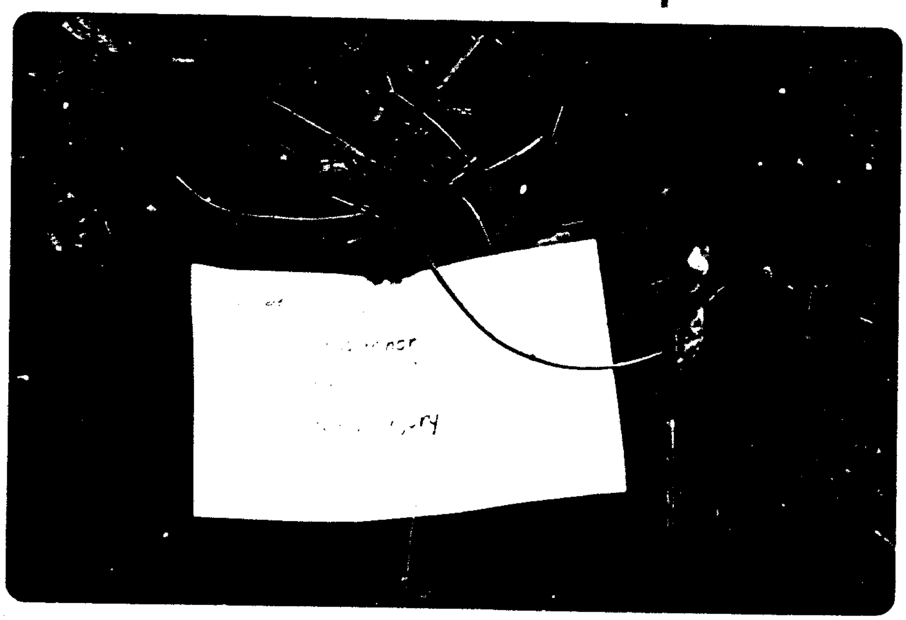


FIGURE 9. *Vinca minor* 4 Heavy Injury

PERCENTAGE RATINGS OF GROUND COVER IN GRID

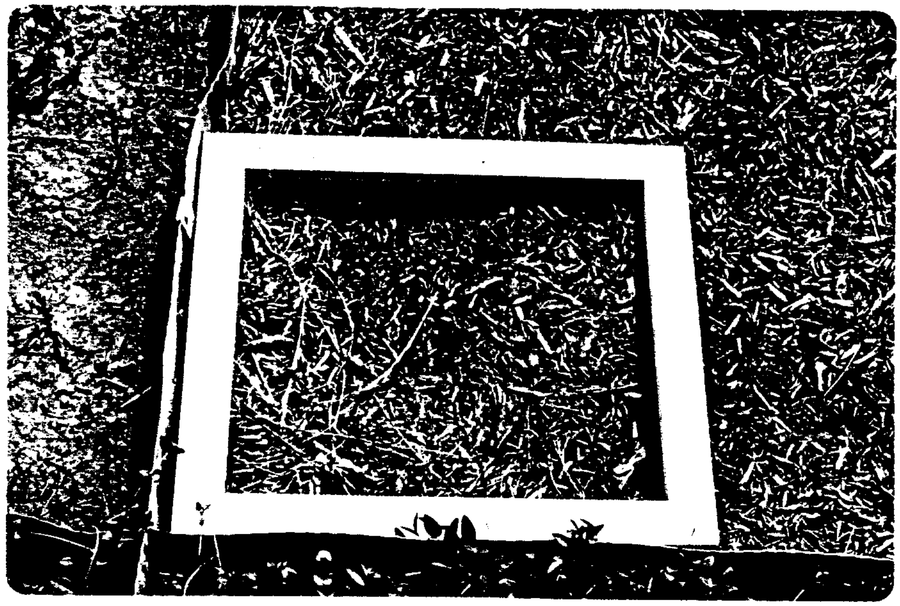


FIGURE 10. Grid Used

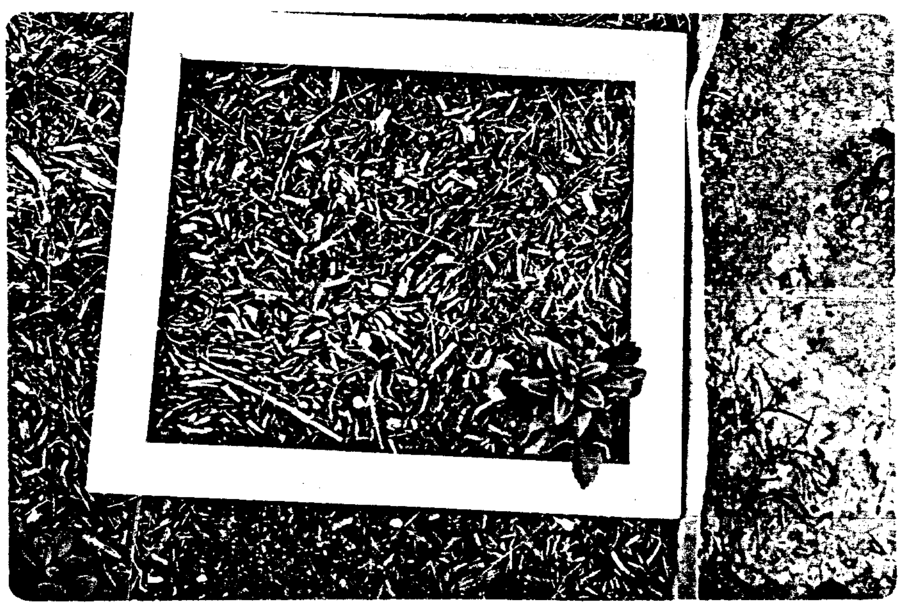


FIGURE 11. _Pachysandra terminalis_ - 10%

PERCENTAGE RATINGS OF GROUND COVER IN GRID (CONTINUED)

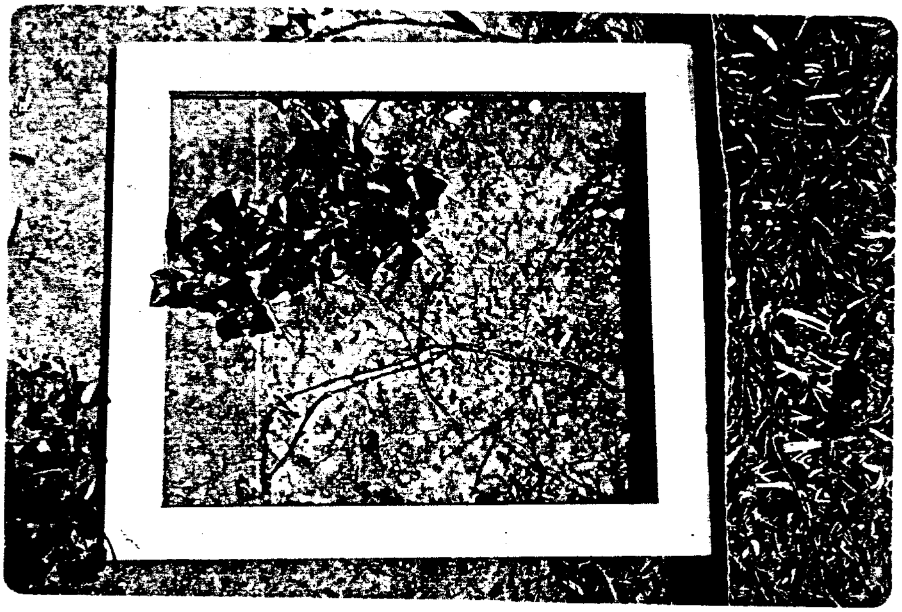


FIGURE 12. Hedera helix - 20%

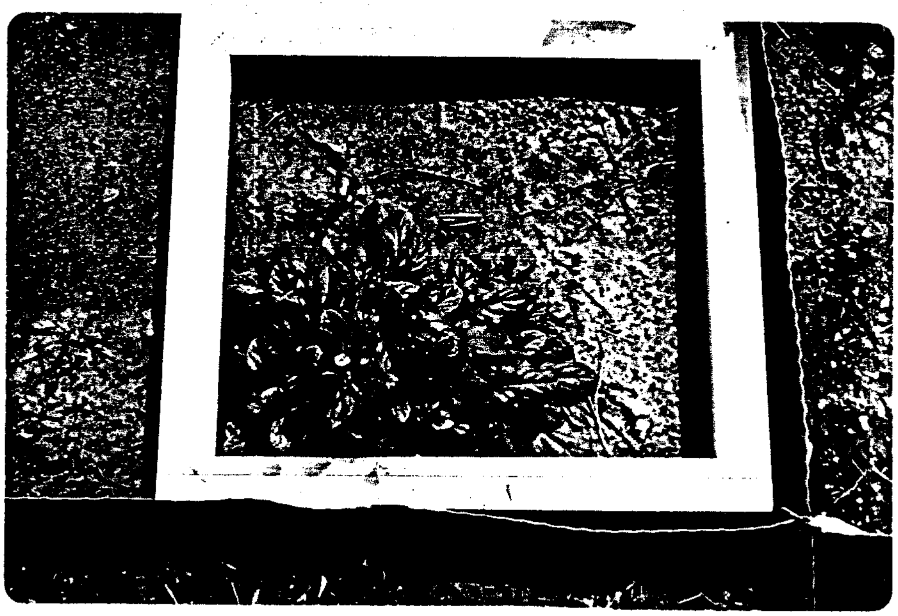


FIGURE 13. Ajuga reptans - 30%

PERCENTAGE RATINGS OF GROUND COVER IN GRID (CONTINUED)

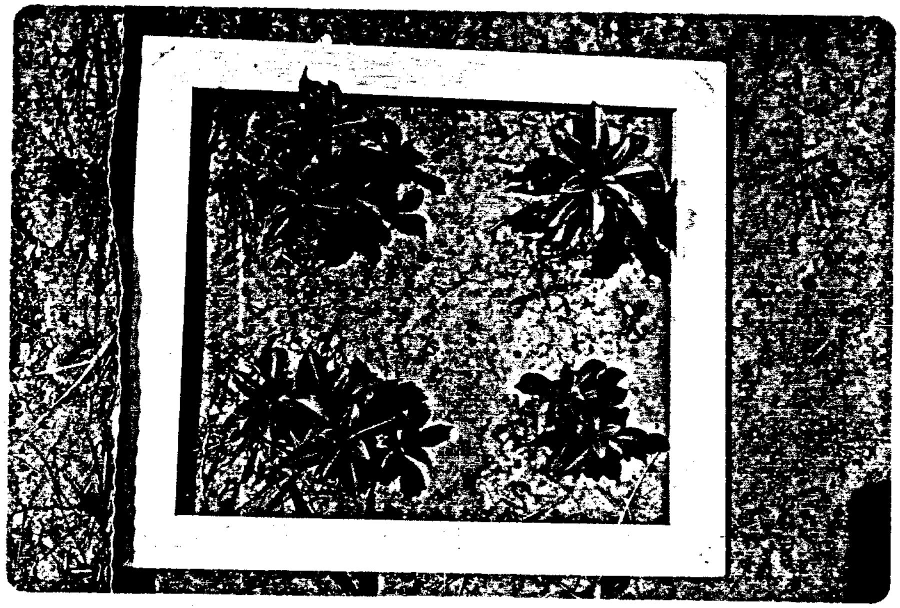


FIGURE 14. *Pachysandra terminalis* - 40%

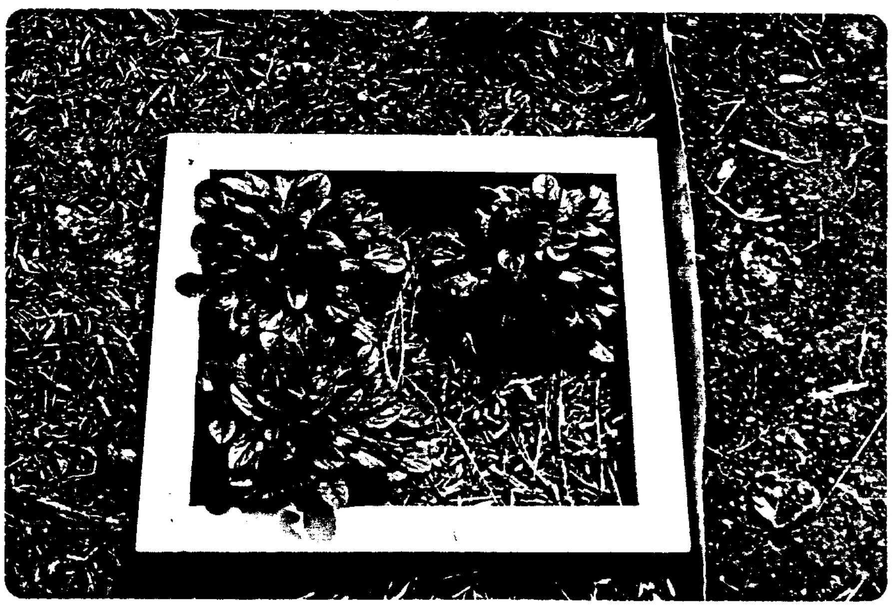


FIGURE 15. *Ajuga reptans* - 70%

PERCENTAGE RATINGS OF GROUND COVER IN GRID (CONTINUED)

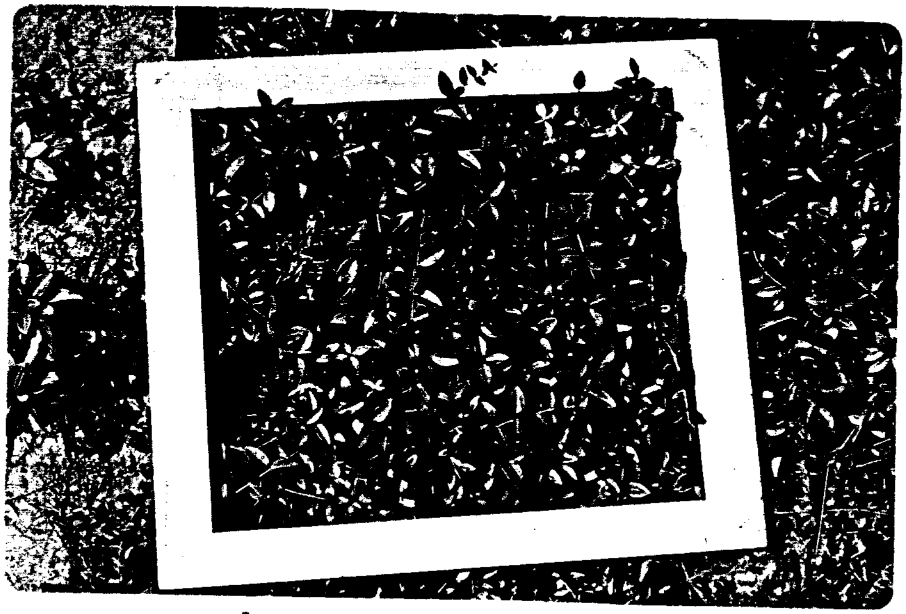
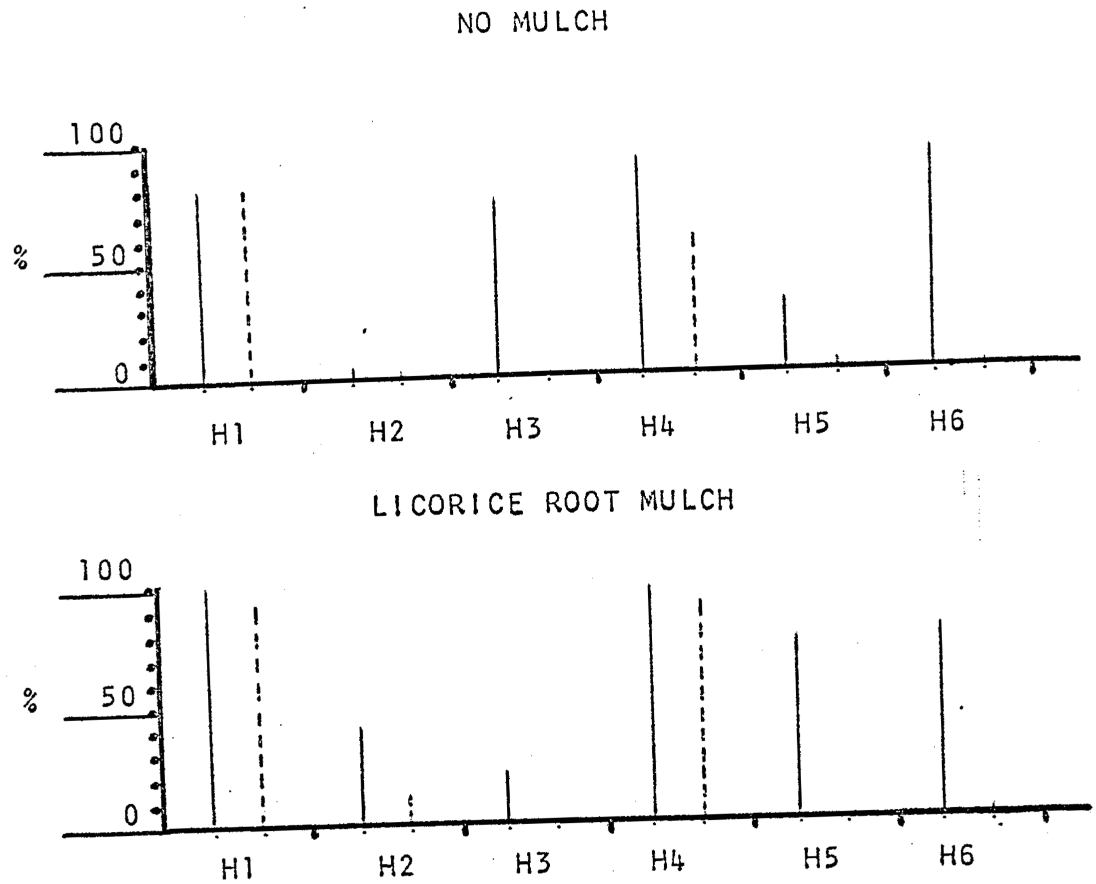


FIGURE 16. Vinca minor - 90%

FIGURE 17. Ajuga reptans - 100%

FIGURE 18. *Ajuga reptans* Percentage of Ground Covered



H1 = Control

H2 = Simazine 4 lbs./A

H3 = Dichlobenil 6 lbs./A

H4 = Diphenamid 6 lbs./A

H5 = Simazine 2 lbs./A and Diphenamid 4 lbs./A

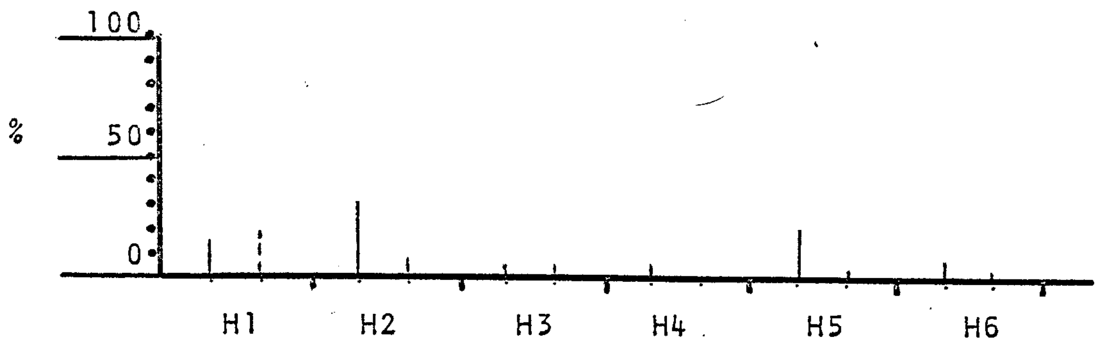
H6 = Dichlobenil 4 lbs./A and Diphenamid 4 lbs./A

______ = Activated Carbon (At left in each treatment)

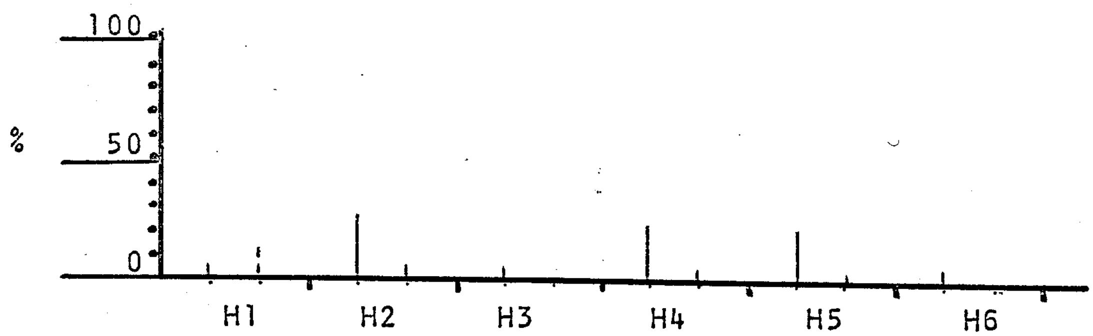
----- = No Activated Carbon

FIGURE 19. Hedera helix Percentage of Ground Covered

NO MULCH



LICORICE ROOT MULCH



H1 = Control

H2 = Simazine 4 lbs./A

H3 = Dichlobenil 6 lbs./A

H4 = Diphenamid 6 lbs./A

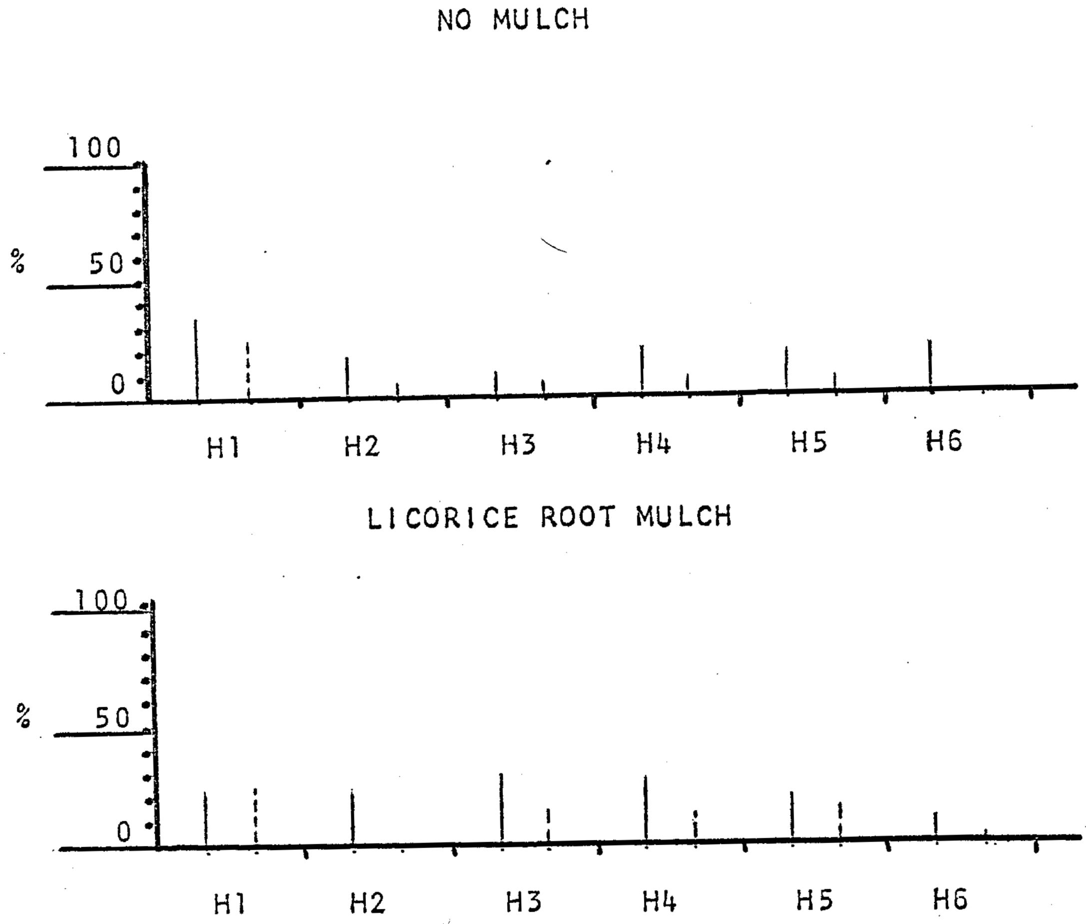
H5 = Simazine 2 lbs./A and Diphenamid 4 lbs./A

H6 = Dichlobenil 4 lbs./A and Diphenamid 4 lbs./A

______ = Activated Carbon (At left in each treatment)

----- = No Activated Carbon

FIGURE 20. <u>Pachysandra terminalis</u> Percentage of Ground Covered



H1 = Control

H2 = Simazine 4 lbs./A

H3 = Dichlobenil 6 lbs./A

H4 = Diphenamid 6 lbs./A

H5 = Simazine 2 lbs./A and Diphenamid 4 lbs./A

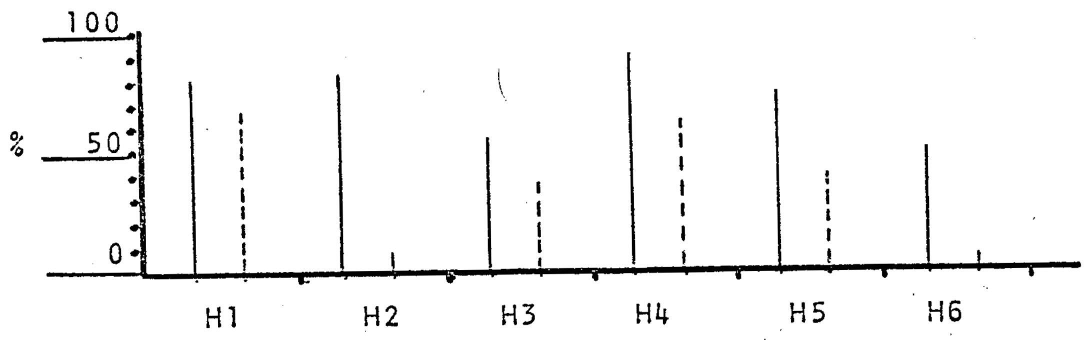
H6 = Dichlobenil 4 lbs./A and Diphenamid 4 lbs./A

______ = Activated Carbon (At left in each treatment)

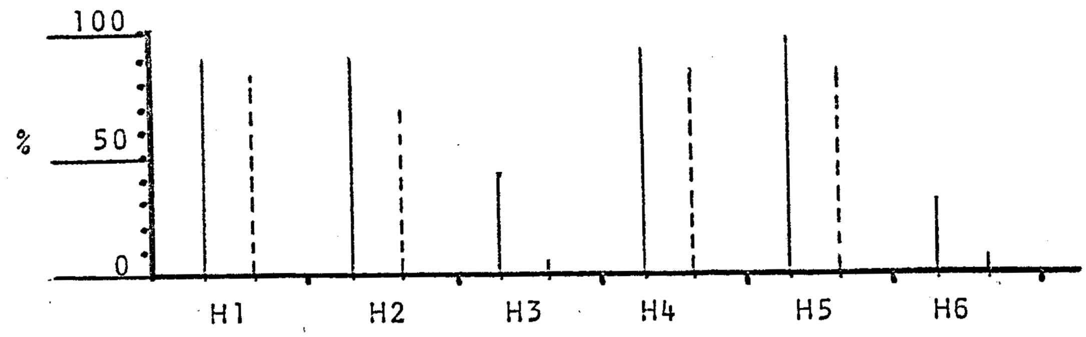
----- = No Activated Carbon

FIGURE 21. <u>Vinca minor</u> Percentage of Ground Covered

NO MULCH



LICORICE ROOT MULCH



H1 = Control

H2 = Simazine 4 lbs./A

H3 = Dichlobenil 6 lbs./A

H4 = Diphenamid 6 lbs./A

H5 = Simazine 2 lbs./A and Diphenamid 4 lbs./A

H6 = Dichlobenil 4 lbs./A and Diphenamid 4 lbs./A

——— = Activated Carbon (At left in each treatment)

----- = No Activated Carbon

CONCLUSIONS

WEED CONTROL

<u>Panicum dichotomiflorum</u> (fall panicum) - without mulch, dichlobenil (6 lbs./A), simazine (2 lbs./A) combined with diphenamid (4 lbs./A), and dichlobenil (4 lbs./A) combined with diphenamid (4 lbs./A) were the best herbicides tested for controlling this weed. However, all herbicides tested controlled this weed when licorice root mulch was applied at a one-inch depth over the herbicide treatments.

<u>Eragrostis cilianensis</u> (stinkgrass) - Herbicides alone (no mulch) did not control this weed. However, all herbicide treatments were effective in controlling this weed when licorice root mulch was applied at a one-inch depth.

<u>Portulaca oleracea</u> (purslane) - Without mulch, simazine (4 lbs./A), diphenamid (6 lbs./A), and simazine (2 lbs./A) combined with diphenamid (4 lbs./A) were the best herbicides tested for controlling this weed. However, all herbicide treatments were effective in controlling this weed when licorice root mulch was applied at a

one-inch depth.

Amaranthus retroflexus (redroot pigweed) - No significant results were obtained to determine which herbicide treatments controlled this weed. However, licorice root mulch did significantly control this weed when compared with the no mulch treatments.

HERBICIDE INJURY

Herbicide injury to ground covers indicated that activated carbon did detoxify most herbicides tested. Plants root-dipped in activated carbon showed less herbicide injury, greater fresh weight, and more growth (percentage ground covered) than plants that were not so treated.

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APPENDIX I

STAND (NUMBER OF PLANTS) OF WEEDS

F VALUES AND SIGNIFICANCE LEVEL

WEEDS	HERBICIDES	MULCH	HERBICIDE X MULCH
<u>Panicum dichotomiflorum</u>	19.80**	176.47**	19.21**
<u>Eragrostis cilianensis</u>	N.S.	21.18**	2.71*
<u>Portulaca oleracea</u>	24.59**	85.95**	30.16**
<u>Amaranthus retroflexus</u>	N.S.	12.73**	N.S.

VIGOR (DRY WT. IN GRAMS) OF WEEDS

F VALUES AND SIGNIFICANCE LEVEL

WEEDS	HERBICIDES	MULCH	HERBICIDE X MULCH
<u>Panicum dichotomiflorum</u>	N.S.	17.84**	2.37*
<u>Eragrostis cilianensis</u>	N.S.	34.14**	3.16*
<u>Portulaca oleracea</u>	10.63**	32.45**	7.07**
<u>Amaranthus retroflexus</u>	4.17*	9.92**	2.30*

N.S. (NOT SIGNIFICANT)
* (.05)
** (.01)

APPENDIX II

F VALUES AND SIGNIFICANCE LEVEL

TREATMENTS	HERBICIDE INJURY	STAND OF GROUND COVER	VIGOR OF GROUND COVER	PERCENTAGE OF GROUND COVERED BY SPECIES
HERBICIDE	21.37**	17.51**	13.12**	32.15**
MULCH	10.64**	12.31**	37.86**	10.51**
M X H	1.80 N.S.	1.99 N.S.	4.31**	3.25**
CARBON	137.95**	172.60**	225.23**	330.06**
C X H	3.78**	9.53**	7.77**	7.89**
C X M	.56 N.S.	1.44 N.S.	3.46**	1.19 N.S.
C X M X H	1.54 N.S.	1.24 N.S.	2.14*	1.86 N.S.
VARIETIES	155.41**	146.40**	239.28**	290.49**
V X H	9.41**	8.59**	25.68**	26.47**
V X M	1.99 N.S.	2.62*	17.77**	5.01**
V X C	4.15**	3.35*	45.82**	24.40**
V X H X M	.68 N.S.	1.03 N.S.	2.94**	2.30**
V X H X C	2.35**	1.63 N.S.	6.14**	3.95**
V X M X C	.70 N.S.	.34 N.S.	5.91**	2.96**
V X M X C X H	1.47 N.S.	1.39 N.S.	2.40**	2.47**

N.S. (NOT SIGNIFICANT)
*   (.05)
**   (.01)