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Title: RESPONSE OF MARAH OREGANUS TO HERBICIDES

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Marah oreganus, a perennial, belongs to the Cucurbitaceae family and it is commonly known as wild cucumber. In the past, this plant grew along fence rows, but now wild cucumber has become a weed problem in perennial grass seed fields of western Oregon. Several research studies were conducted to examine the biology of the weed and to observe the response to herbicide applications.

Two experiments were conducted to determine if the dormancy of wild cucumber seed was due primarily to the effect of the seed coat and/or a chilling requirement. Results of this study indicated that dormancy can be broken by chilling and was not the result of seed coat impermeability. There is a minimum time that wild cucumber seeds must be exposed to cold temperatures before dormancy is broken. In this research, 22 days at constant 5 C was insufficient to break dormancy. Complete germination was obtained when seeds were kept at constant 5 C, and were covered with moistened, but not saturated, peat moss for 58 days.

Other experiments in the greenhouse were conducted to examine

the response of seedling wild cucumber to herbicides and to develop a technique for growing seedling wild cucumber under controlled conditions. Preliminary trials using garden cucumber (Cucumis sativus) as an indicator plant were used to determine herbicide rates for subsequent experiments. This study indicated that picloram and phenoxy herbicides did not cause necrosis on seedling wild cucumber but were most effective as growth inhibitors. Treatment with 2,4,5-T at 0.14 kg/ha caused more severe reduction in dry weight than with 2,4-D at 4.48 kg/ha. Glyphosate at 0.28 kg/ha was the only herbicide tested that caused necrosis to the leaves and inhibited growth of wild cucumber. DPX-4189, fosamine, and Dowco 290 did not induce any visual symptoms, although reductions in growth from the check 12 days after treatment were observed.

Two field trials were conducted to evaluate the control of established wild cucumber plants. Evaluations were made over a 2-year period in the same plots. During the treatment year (1980), only two herbicides controlled wild cucumber at a level that would be commercially acceptable. The herbicides most effective for this purpose were glyphosate (2.24 or 3.36 kg/ha) and 2,4,5-T (0.84, 1.68, or 3.36 kg/ha). At one location, wild cucumber plants treated in 1980 with glyphosate and 2,4,5-T did not show regrowth in spring or summer, 1981. The other location was accidentally destroyed and no valid regrowth data were collected.

RESPONSE OF *MARAH OREGANUS* TO HERBICIDES

by

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Typed by Gloria M. Foster for Maurilio Flores

DEDICATION

This thesis is dedicated to my wife and children for their love, patience, and support throughout my graduate studies, and to my parents and brothers for their moral support.

A special dedication and appreciation also goes to Dr. M. Mohan Kohli and Mr. Anastacio Morales for encouraging me to study for my M.S. degree.

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INTRODUCTION

The Cucurbitaceae family is widely distributed in both the old and the new worlds, and consists of about 90 genera with 750 species. It is an important plant group because it supplies man with edible products. There is archeological evidence that cucurbits, using the word to cover all members of the family, were cultivated by man as far back as 4000 B.C.

The cucumber is a member of the cucurbit family and belongs to the genus *Cucumis*. There are 20 to 25 species of *Cucumis*, found mostly in Asia and Africa. *Cucumis* was known to the ancient Greeks and Romans, who introduced members of this genus to Europe. Columbus introduced *Cucumis* to the new world (24). Only two species of *Cucumis*, *sativus* and *melo*, are of much importance in the United States.

In addition to cultivated plants, some weedy species such as the perennial genus *Marah*, are found in the Cucurbitaceae. The first record of any species of *Marah* was in 1834 when Hooker reported specimens collected near the Columbia River by Scouler and Douglas to be *Sicyos angulatus*. Now we recognize these specimens as *Marah oreganus*.

Marah oreganus has a range wider than that of any other species of the genus. It is distributed along the humid Pacific coast areas from San Mateo and Santa Clara counties in California to southern

Vancouver Island in British, Columbia (21). This plant is disseminated by seeds and produces a tuber which enlarges annually and creates a more vigorous plant each year. Consequently, once the wild cucumber plant is established, one single plant can cover large areas in the field.

In the past, agriculturists were not concerned enough with the wild cucumber plants that grew along fence rows to try to eliminate them. At the present, wild cucumber has become a weed problem, mainly in perennial grass seed fields. The plant is difficult to control and may represent a problem of greater significance in the future.

The major objective of this study was to examine the biology of the weed, *M. oreganus*, and to observe the response to herbicide applications. The research is reported in three chapters. Chapter I discusses germination of *M. oreganus* seeds, Chapter II reports the response of seedling wild cucumber to herbicides in the greenhouse, and Chapter III was a study of the response of established wild cucumber to herbicides in the field.

LITERATURE REVIEW

Wild Cucumber

Marah oreganus has been reported under different scientific names, depending upon the views of different botanists. It can be found in the literature as *Sicyos angulatus* (Hooker), *Sicyos oregona* (Torrey), *Marah muricatus* (Kellogg), *Megarrhiza oregona* (Torrey), *Echinocystis oregona* (Cogniaux), and *Micrampelis oregona* (Greener) (4, 6, 12, 13, 21).

Asa Gray et al. (4, 6) reported that the plants collected by Scouler and Douglas on the banks of the Columbia River (Oregon), had been the first gathering of the genus *Marah*. Hooker, in 1834, designated these specimens as *Sicyos angulatus* (12). In 1840, Torrey and Gray distinguished the Columbia River plants as *Sicyos oreganus*. Kellogg's specimens, found in San Francisco, were designated as *Marah muricatus* (4, 21). Dunn (6) reported that Howell, in 1897, named such specimens *Marah oreganus*.

Stocking (21) reported that *Marah quadalupensis*, which might now be extinct because of the goats which had overrun the island of Guadalupe, might be the closest relative of *Marah oreganus*. He speculated that *Marah watsonii* was a second species which has derived from *Marah oreganus*, and *Marah fabaceus* was the third possible species. *Marah oreganus* has been found more widely distributed than any other species of the genus.

The genera most closely allied to *Marah* are apparently *Echinopepon* and *Echinocystis* (6, 21). *Echinopepon* has been reported as the oldest of these three genera. It is chiefly tropical and ranges from Central Argentina to New Mexico and Arizona (6). Stocking (21) mentioned that Echinocystis might have given rise from Echinopepon, and Marah from Echinocystis. Moreover, he said that under vegetative conditions, the three genera mentioned above were often confused. Kellogg, in 1853, was the first who noticed the peculiar germination, the large tuber, and the distinct fruiting character in the genus Marah. The presence of big tubers and hypogeous germination as characteristics of the genus Marah made it distinguishable from Echinocystis and Echinopepon (6). In 1881, Marah constitued a section of Echinocystis.

In the genus Marah, the underground tubers are reported to reach the size of a man's body, and the germination resembles that of some monocots (10). Asa Gray (4) and subsequently Darwin (5), were the first to describe the peculiar germination of the seeds of Megarrhiza californica. Marah muricatus (Kellogg), now Marah oreganus, has a germination similar to that of Marah macrocarpus (Megarrhiza californica) (10). In a study of germination of Megarrhiza californica, Darwin (5) concluded that the cotyledons never free themselves from the seed coats and were hypogeal. He also said that their cotyledonary petioles were completely confluent, forming a tube which terminates downwards. It has been found that once the confluent petioles protrude from the seed, they bend down and penetrate the ground. Elongation of the cotyledonary petioles takes place to carry the radicle and plumule out of the seed. The plumule eventually escapes due to the splitting of the base of the petiolar tube (5).

Hill (10) mentioned that the petiole tube of Marah muricatus (Kellogg), now Marah oreganus, grew as much as 16 cm vertically into the ground and carried the plumule deep into the soil as a protection against drought, and it is possible that in its native home, it might attain a greater length. In Hill's seed germination study (10), it was found that during the germination of the seeds of Marah the fused petiole carried the plumule and radicle into the ground and later the plumule penetrated the side of the petiole tube and grew above the soil (Figure 1).

Stocking et al. (18, 21) mentioned that the epicotyl was recognizable as a shoot and grew upward, and the hypocotyl developed into the tuber and tap root which grew downward. In a survey of anatomy, Scott (19) reported that in Marah, the transition to root structure occurred near the base of the storage region, so the tuber presumably developed from the hypocotyl. It has been found that the size of tubers in Marah during the first two seasons' growth is about the size of a carrot (19). In 1943, Scott mentioned that when fully grown, the tuber might measure 20 to 40 cm in diameter, 51 to 91 cm in length, and might weight 18 to 30 kg. Moreover, the shoots might measure 275 cm or more. Stocking (21) reported a tuber which weighed 58 kg. The heaviest tuber found was reported to weigh 90 kg (Science Newsletter, 1948). Marah produces annual shoots in the spring from the tuber (6, 19). Stocking (21)

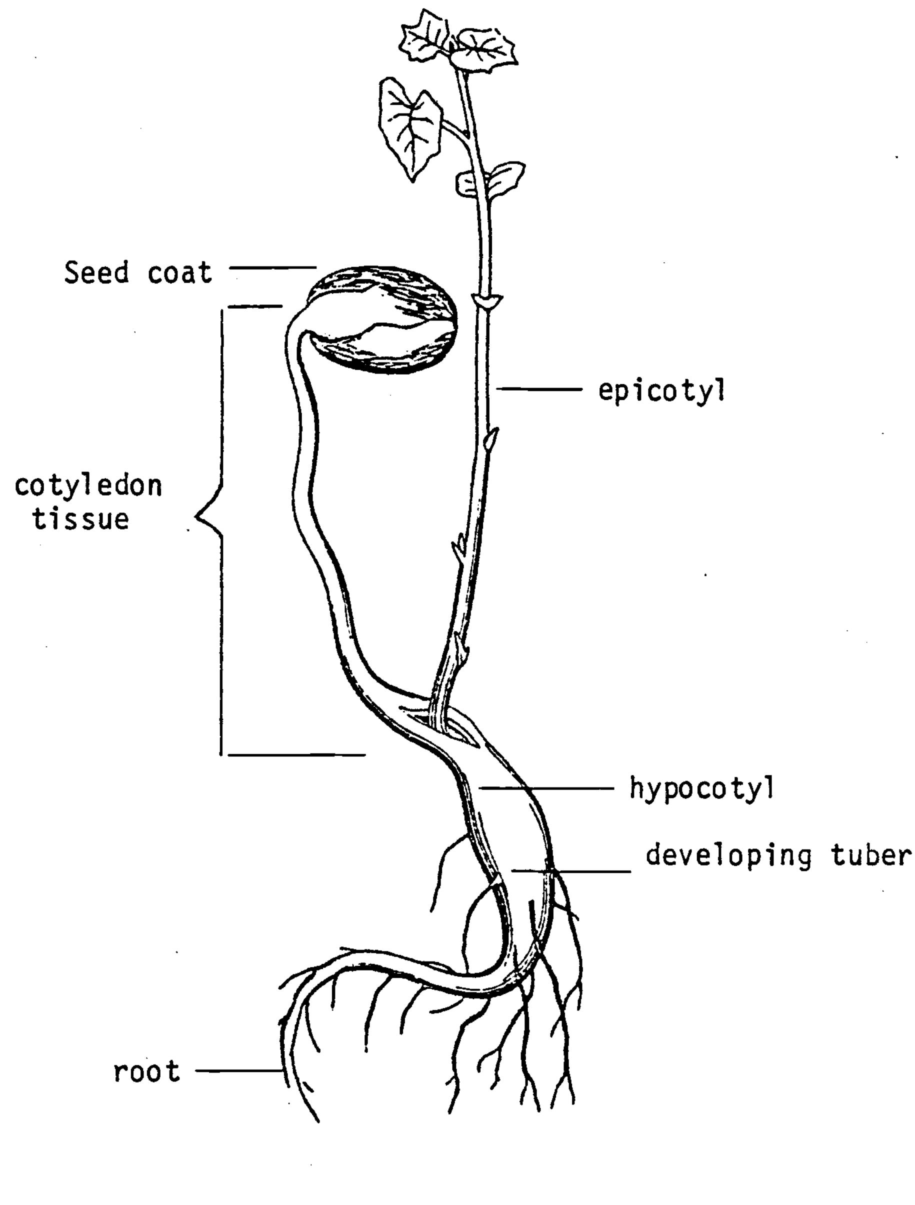

Figure 1. Germination of *Marah oreganus*. From Asa Gray and Darwin.

observed tubers of Marah oreganus growing in light loam soil.

The wild cucumber plant Marah oreganus is monoecious. In the early summer, racemes of white male flowers and solitary female ones are produced from the axils of the leaves. In late summer, or early fall, the large prickly fruits are a conspicuous feature (6). Marah oreganus has been found fruiting on the shores of Klamath Lake and the banks of the Willamette River in August and September (4). It has been reported that Marah can compete effectively with grasses and angiosperms. Also, Stocking (21) mentioned that Marah prospered in various well-grazed pastures. It has been reported that squirrels (Citellus beechyi) compete for the seeds of Marah (21). Rodents play an important role in seed dispersion, and gravity on steep hillsides has been observed as another means of seed distribution. Stocking (21) said that various species of Marah, including oreganus, have stored hundreds of pounds of starch, and suggested the possibility of using it. He also mentioned that the seeds of Marah might be a valuable source of oil

Herbicides

Phenoxy herbicides are related to naturally-occurring plant growth regulators (17). The phenoxy carboxylic herbicides are those composed of an aromatic (benzene) ring, an oxygen atom substituted for one hydrogen bonded to the ring, a carboxylic group bonded indirectly to the oxygen atom by an aliphatic chain and various substituents on the ring (2). The phenoxy compounds are relatively old materials as far as research and accumulated experience in the use of herbicides is concerned. Members of the phenoxy-carboxylic group include 2,4-D, MCPA, 2,4,5-T, silvex, and others. The phenoxy herbicides are usually applied as foliar treatments for the control of annual and perennial broadleaf weeds. The Council for Agriculture Science and Technology known as CAST (1975), reported that in 1971, the production of 2,4-D, 2,4,5-T, and silvex represented over 90% of all phenoxy production in the United States. Phenoxies, when applied to the foliage, are translocated in the photosynthate stream. Anderson (2) reported that when phenoxies in their salt or ester forms are applied to plants, the plant converts these forms to the corresponding acid form, and this acid form is the one which is phytotoxic. Silvex and 2,4,5-T are generally reported to be more phytotoxic herbicides than 2,4-D or MCPA (3). The CAST report of 1975 (1) stated that phenoxy herbicides are of low toxicity to man and animals under normal conditions of use. However, the dioxin, TCDD, that may be present in 2,4,5-T and silvex is highly toxic to man. This report also said that 2,4,5-T formerly contained from 1 to 80 ppm of TCDD, but new production techniques are able to reduce the dioxin level to less than 0.1 ppm. Anderson (2) reported that 2,4,5-T resisted degradation in plants, while other phenoxies are readily degraded in plants.

Picloram, the trade name of which is Tordon, is a hormone-type herbicide used for the control of a wide range of annual and deep-rooted perennial broadleaf plants (23). Anderson (2) reported that picloram is rapidly absorbed by the foliage and is translocated in the phloem under such conditions. Picloram has been reported to be accumulated in regions of active growth. Picloram can be taken up by the roots also and, in this case, it is translocated in the apoplast. It is highly active and persistent in the soil.

Dowco 290 is a picolinic acid closely related to picloram. Dowco 290 is strongly active on members of the Polygonaceae, Leguminoseae, and Compositae. Dowco 290 induces an auxin-type response in growing dicotyledonous plants. It is absorbed by roots and leaves and is rapidly translocated through the plant. Soil persistence of Dowco 290 is much shorter than picloram (25).

Glyphosate has the trade name Roundup. It is formulated as the isopropyl amine salt of glyphosate. It is a non-selective, broad-spectrum herbicide and can be applied as a postemergence foliar treatment to the weeds (23). Glyphosate has been reported to be phytotoxic to most annual, biennial, and perennial herbaceous plant species. Glyphosate symptoms usually first appear about 10 days or more after application for perennial plants, and after 3 days for annuals (3).

Krenite has the common name of fosamine (23). It was formerly named DPX-1108. It is used as a foliage herbicide and formulated as a liquid containing 41.5% ai (4 lb ai/gal).

DPX-4189 (chlorsulfuron) is an experimental herbicide being developed by du Pont and will be sold commercially in the United States as Glean. It has been reported to provide outstanding control of most broadleaf weeds. A product bulletin dated February 1980, reported the primary physiological effect of DPX-4189 was to stop growth by inhibiting cell division. Plant death is slow since photosynthesis, respiration, or protein synthesis are not immediately affected. It has been reported that growth inhibition caused by DPX-4189 does not result in leaf, petiole, and stem-twisting characteristics similar to the phenoxy-type herbicides.

CHAPTER I

A GERMINATION TECHNIQUE FOR THE SEED OF *MARAH OREGANUS*

Abstract. Seeds of wild cucumber (*Marah oreganus*) have a dormancy mechanism. Two experiments were conducted to determine if the dormancy was due to the effect of the seed coat and/or a chilling requirement.

Dormancy in wild cucumber was not the result of impermeability of the seed coat. Seeds with intact seed coats germinated better than seeds in which the seed coat was removed. Chilling was an important requirement for germination. This research indicated that 22 days at constant 5 C was insufficient to break dormancy in seeds of wild cucumber. Seeds which were covered with moistened, but not saturated, peat moss germinated before seeds which were not covered. Maximum germination was obtained in this study when seeds were placed at constant 5 C and covered with peat moss. Under these conditions, 100% germination from recently harvested seeds was obtainable within 58 days.

INTRODUCTION

Seeds of many species do not germinate immediately after ripening, even under favorable conditions for growth. A dormancy (quiescence) mechanism which temporarily prevents germination provides a means of ensuring that the species can survive periods of adverse conditions.

Different species have evolved various mechanisms of seed dormancy although there are several points of similarity. Evenary (7) showed that seeds are rich sources of chemical inhibitors and that in many seeds, those inhibitors are most abundant in the seed coat. The seed coat, however, sometimes influences the dormancy of seeds by limiting the entry of water and oxygen. In addition, Moore (17) has pointed out that one common cause of seed dormancy in plants of temperate regions is a requirement for chilling. Several attempts were made to assess dormancy in wild cucumber by germinating seeds in the greenhouse under various environmental conditions. Germination experiments were not successful and it was concluded that seeds of wild cucumber have a dormancy mechanism. Further studies were conducted to determine if the dormancy was due to the effect of the seed coat and/or a chilling requirement.

MATERIALS AND METHODS

The fruit of wild cucumber was available and was collected in the Willamette Valley of Oregon from the beginning of June to the end of August, 1980. Since the fruit is a dehiscent capsule, collections of the fruit were made when it had not yet opened. Seeds were collected by drying harvested mature fruits in the sun for 1 to 2 weeks, until the fruit had opened and the seeds had dried. In the field, once the capsule had opened, it was very difficult to recover seeds from the fruits or to find seeds on the soil surface.

Dried seeds of wild cucumber (25 seeds per set) were placed on a bed of peat moss in 24 by 24 by 2.5 cm plastic containers. Each container was covered with a plastic lid. All sets, except one, were covered with peat moss. Each set of seeds was placed in a germination chamber at constant 5 C on July 23, 1980. After 22 days at 5 C, two sets were moved to alternating temperatures of 15 C for 8 hours and 25 C for 16 hours. The seed coat was broken in one set. Seeds were maintained at good moisture for germination during the study.

Another experiment was established using 16 sets of 10 seeds per set. Each set was placed in a 11.5 by 11.5 by 2.5 cm covered plastic container. Moist paper towels were used as blotter material. In eight sets, the seed coat was removed. On August 14, 1980, all sets were placed in a germination chamber at 5 C. A seed set with the seed coats intact and one with the seed coats removed, were changed to alternating 15 C for 8 hours and 25 C for 16 hours at intervals of 1 week. The seeds which remained under 5 C maintained good moisture throughout the study. However, seeds which were changed to alternating 15 C to 25 C had to be watered once a week to maintain adequate moisture levels. Each experiment was conducted twice.

RESULTS AND DISCUSSION

Seeds of wild cucumber, with or without seed coats, held in peat moss, did not germinate when exposed to 5 C for 22 days and followed with an increase in temperature to alternating 15 C for 8 hours and

25 C for 16 hours. Wild cucumber seeds covered with peat moss and held constantly at 5 C broke dormancy, and 100% of the seeds germinated by 58 days after initiation of the cold treatment. Seeds not covered with peat moss but held at constant 5 C, germinated more slowly and reached 80% germination by 79 days after the beginning of the cold treatment. Dormancy in wild cucumber is broken by chilling the dried seed. Not all seeds break dormancy at the same time. While temperature appears to be most important, germination was increased when the entire seed was in contact with the moisture-holding medium (peat moss) instead of having the seed rest on a bed of peat moss (Table 1.1).

The seed coat of wild cucumber did not reduce the germination of seeds held at different temperatures. Seeds with intact seed coats germinated better than seeds from which the seed coat had been removed, although the seed coat offered some protection from fungi. The dormancy in wild cucumber seeds did not appear to be the result of an impermeable seed coat (Table 1.2).

In this study, maximum germination was obtained when seeds were placed at constant 5 C and covered with moist peat moss. Under these conditions, 100% germination from recently harvested seeds was obtained within 58 days. There was a minimum time that wild cucumber seeds had to be exposed to cold temperature (chilling requirement) before dormancy was broken.

Table 1.1. Germination percentage of wild cucumber (*Marah oreganus*) seeds.

Temperature	Treatments: Seed coat intact	Treatments: Seed coat removed	Treatments: Seed covered with peat moss	Treatments: Seed placed on the peat moss	0 days 7-23-80 temp °C	0 days 7-23-80 germ %	22 days 8-14-80 temp °C	22 days 8-14-80 germ %	36 days 8-28-80 temp °C	36 days 8-28-80 germ %	50 days 9-11-80 temp °C	50 days 9-11-80 germ %
Alternating	X		X		5	0	15-25	0	15-25	0	15-25	0
Alternating		X	X		5	0	15-25	0	15-25	0	15-25	0
Constant	X		X		5	0	5	0	5	28	5	80
Constant	X			X	5	0	5	0	5	0	5	0

Temperature	Treatments: Seed coat intact	Treatments: Seed coat removed	Treatments: Seed covered with peat moss	Treatments: Seed placed on the peat moss	58 days 9-18-80 temp °C	58 days 9-18-80 germ %	65 days 9-25-80 temp °C	65 days 9-25-80 germ %	79 days 10-9-80 temp °C	79 days 10-9-80 germ %
Alternating	X		X		15-25	0	15-25	0	15-25	0
Alternating		X	X		15-25	0	15-25	0	15-25	0
Constant	X		X		5	100	--	--	--	--
Constant	X			X	5	8	5	60	5	80

Table 1.2. Germination percentage of wild cucumber seeds, with and without seed coats, under various temperature regimes.

Trt*	0 days 8-14-80 temp °C	7 days 8-21-80 temp °C	14 days 8-28-80 temp °C	21 days 9-4-80 temp °C	28 days 9-11-80 temp °C	35 days 9-18-80 temp °C	42 days 9-25-80 temp °C	49 days 10-2-80 temp °C	56 days 10-9-80 temp °C	79 days 11-1-80 temp °C Seedcoat intact % germ	79 days 11-1-80 temp °C Seedcoat removed % germ
1	5	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	0	0
2	5	5	15-25	15-25	15-25	15-25	15-25	15-25	15-25	0	0
3	5	5	5	15-25	15-25	15-25	15-25	15-25	15-25	0	0
4	5	5	5	5	15-25	15-25	15-25	15-25	15-25	0	0
5	5	5	5	5	5	15-25	15-25	15-25	15-25	0	0
6	5	5	5	5	5	5	15-25	15-25	15-25	50	0
7	5	5	5	5	5	5	5	15-25	15-25	50	20
8	5	5	5	5	5	5	5	5	15-25	90	20

*Each treatment consisted of one set with the seed coat intact, and one set with the seed coat removed.

CHAPTER II

RESPONSE OF SEEDLING WILD CUCUMBER (MARAH OREGANUS) TO HERBICIDES

Abstract. Research in the greenhouse was conducted to develop a technique for growing seedling wild cucumber (Marah oreganus), and to study the herbicide sensitivity of seedlings under controlled conditions. Preliminary trials using garden cucumber (Cucumis sativus) and wild cucumber as indicator plants, were used to determine suitable rates of herbicides for seedling wild cucumber studies. After preliminary studies, further experiments were completed where plants were placed in a growth chamber at constant 21 C, with a 12-hour light cycle, for 5 days to precondition them prior to treatment with herbicides. Immediately after application, plants were returned to the growth chamber. Twelve days following treatment, plants were evaluated for phytotoxicity and fresh weights were determined by cutting at the soil surface. Dry weights were determined after 40 hours of drying at 80 C. Differences in growth were observed in wild cucumber during the treatment period, although not all treatments differed significantly from the check. Dry weights of wild cucumber plants treated with DPX-4189 [2-chloro-N-{4-methoxy-6-methyl-1,3,5-triazin-3-yl)aminocarbonyl} benzenesulfonamide] at 1.12 kg/ha, fosamine [ethyl hydrogen (aminocarbonyl)phosphonate] at 4.48 kg/ha, and Dowco 290 (3,6-dichloropicolinic acid) at 0.56 kg/ha were not significantly different from the check. Growth of seedling wild cucumber was reduced most dramatically from applications of

glyphosate [N-(phosphonomethyl)glycine] at 0.28 kg/ha, picloram (4-amino-3,5,6-trichloropicolinic acid) at 1.12 kg/ha, and the phenoxy herbicides 2,4-D [(2,4-dichlorophenoxy)acetic acid] at 4.48 kg/ha, MCPA [{(4-chloro-O-tolyl)oxy} acetic acid] at 1.12 kg/ha, 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] at 0.14 kg/ha, and silvex [2-(2,4,5-trichlorophenoxy)propionic acid] at 0.28 kg/ha.

INTRODUCTION

Herbicides may be grouped on the basis of chemical similarities or biological effects, and the use of them may vary according to the above characteristics or the plant species involved. Usually herbicide families are formed as a group comprising chemicals with similar molecular composition and configuration (2). However, not all plant species are equally susceptible to specific herbicides. Among the herbicides grouped in the growth regulator family, as an example, differences in sensitivity in broadleaf plant species are known. Hoagland et al. (11) mentioned that the urea herbicide fenuron (1,1-dimethyl-3-phenylurea), the carbamate herbicide propham (isopropyl carbanilate), and the acid amide herbicide propanil (3'-4'-dichloropropionanilide) were hydrolyzed to non-herbicidal products by *Echinocystis lobata*, Torr., a relative of *Marah oreganus*. Germination of cucurbits is generally epigeous except for the genus *Marah*. Germination in *Marah* is hypogeous and resembled the germination of some monocots (10). Wild cucumber is a perennial which develops a large underground tuber that is reported to reach the size of a man's body on occasion (6).

The purpose of this research was to examine the biology of wild cucumber and study the response of seedling wild cucumber, *M. oreganus*, to herbicides.

MATERIALS AND METHODS

Studies were conducted at Oregon State University in Corvallis, Oregon between October 1980 and May 1981.

Greenhouse. Preliminary experiments were conducted under greenhouse conditions. The greenhouse was maintained at 21 C during the day and 18 C during the night. The first preliminary trials to determine suitable rates of herbicides for wild cucumber were conducted using garden cucumber as a test species. Other preliminary herbicide trials using wild cucumber seedlings were completed during the development of the technique for growing wild cucumber from seed under controlled conditions.

Garden cucumber was sown directly into sandy loam soil in 10.2- by 10.2-cm plastic pots. Plants were treated at the 4- to 5-true leaf stage of growth. For the first trial, evaluation of injury was made visually. For the second experiment, plants were harvested 12 days after treatment and dry weights were determined 48 hours after drying at 80 C.

Preliminary wild cucumber trials were sown in 17.8- and 30.5-cm deep pots. Broadcast herbicide applications were made with a compressed-air back pack sprayer. Dry weights were determined after placing the harvested plants at 70 C for 24 hours in the oven.

Growth Chamber. The wild cucumber seeds used for these experiments had been held for 150 days at 5 C in the germination chamber, and the tuber and epicotyl had been formed. These plants were transplanted in the greenhouse immediately after removal from 5 C. These seeds gave uniform and fast emergence. The germinated seeds were placed in 17.8- by 30.5-cm pots in a sandy loam soil that had been screened. Wild cucumber plants were in the greenhouse for 10 days after planting. At that time, plants had between two and three leaves. Plants were then placed in a growth chamber at constant 21 C for 5 days to precondition them prior to treatment with herbicides. Wild cucumber plants were taken from the growth changer for herbicide treatment. Plants averaged 23 cm tall and had six to nine leaves at time of treatment (Appendix Tables 4, 5).

Each experiment was arranged in a randomized complete block design with three replications. Individual wild cucumber plants were used to define an experimental unit. Broadcast applications were made with a compressed-air back pack sprayer. The sprayer was calibrated to deliver 850 L/ha of spray solution with a TeeJet Al 8004E nozzle tip at 30 psi. Immediately following the treatments, the plants were returned to the growth chamber. Twelve days following treatments, wild cucumber plants were evaluated for phytotoxicity. Number of leaves and height of plants were recorded immediately before harvesting (Appendix Tables 6, 7). Wild cucumber plants were clipped at the base near the soil surface. Fresh weights were determined immediately after cutting (Appendix Table 8). Dry weights were measured 2 days later, after 40 hours of drying at 80 C (Appendix Table 9).

RESULTS AND DISCUSSION

Greenhouse. In the first preliminary garden cucumber trial, some rates of herbicides tested were too high or too low. Rates used in subsequent experiments were those which caused symptoms in the plants without killing them (Appendix Table 1). In the second preliminary cucumber trial, glyphosate, picloram, 2,4-D, MCPA, and 2,4,5-T were the most active herbicides in reducing dry weight (Appendix Table 2). Based on this second preliminary cucumber trial, wild cucumber trials were started in the greenhouse. During the three preliminary wild cucumber experiments, dry weights did not show a consistent pattern (Figure 2.1). It is believed that greenhouse conditions and uneven plants were responsible for this variation, and subsequent experiments were conducted in a growth chamber so that light and temperature could be controlled. Seeds were prechilled for 150 days at 5 C prior to transplanting to obtain uniform plants.

Growth Chamber. Wild cucumber plants transplanted from peat moss in germination trays did not grow well in plastic pots that were 10.2- or 17.8-cm deep . The cotyledon must be elongated by 12 to 15 cm before the plumule is noticeable. In the shallow pots, the

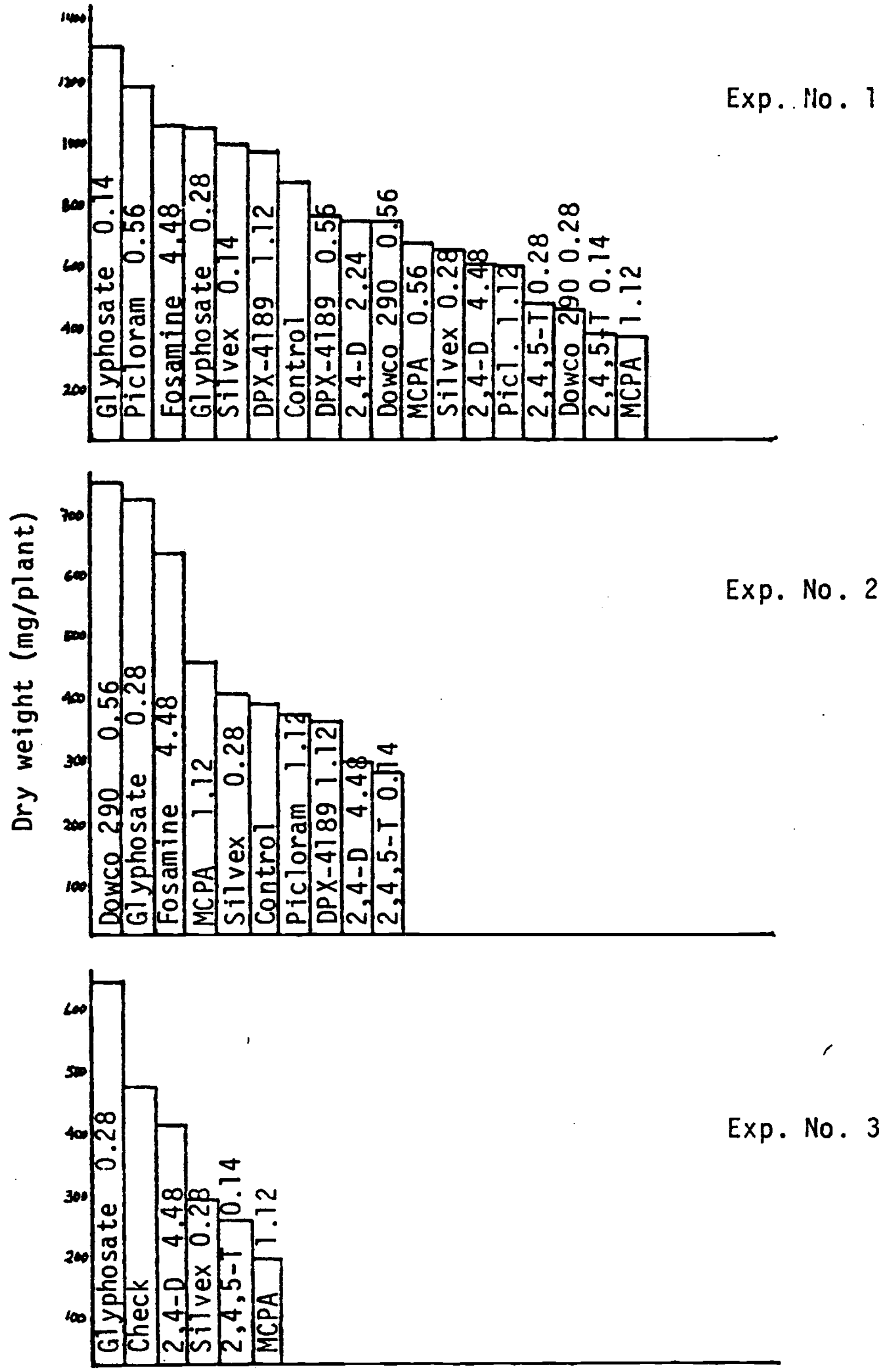

Figure 2.1. Dry weights in mg per plant of three preliminary experiments in the greenhouse of wild cucumber (*Marah oreganus*.

elongated cotyledon or the developing tuber reached the bottom of the pot and growth was stopped. The best plants were developed in fiber pots that were 30.5 cm deep. The degree of cotyledonary elongation before transplanting caused large differences in percent emergence. When the elongation was only 0.3 cm, almost no plants emerged in the following 30 days. The emergence was faster when the elongation of the cotyledon was longer (Table 2.1). The most uniform plants were obtained when seeds were left in the germination chamber at 5 C for at least 150 days, and the tuber and epicotyl had been formed. Daily observations of wild cucumber plants showed that they grew 2.5 cm per day. Therefore, differences in growth due to herbicide effects could be measured.

Table 2.1. Relationship among cotyledon elongation, days to emerge and % emerged in wild cucumber (*M. oreganus*) in the greenhouse.

Seeds days at 5 C	Cotyledon elongation	Days to emerge after transplanting	% emerged
60	0.3 cm	30	8.0
70	2.5 cm	30	62.5
80	5.1 cm	30	98.0
150	12.7 cm + tuber and epicotyl	5	99.0

Among the herbicides used, picloram and phenoxy herbicides were the best inhibitors of growth at the rates tested (Figure 2.2). In wild cucumber, 2,4-D at 4.48 kg/ha showed some twisting. No necrosis occurred at the rate tested. Application of 2, 4,5-T at 0.14 kg/ha caused some yellowness and twisting. Wild cucumber plants were

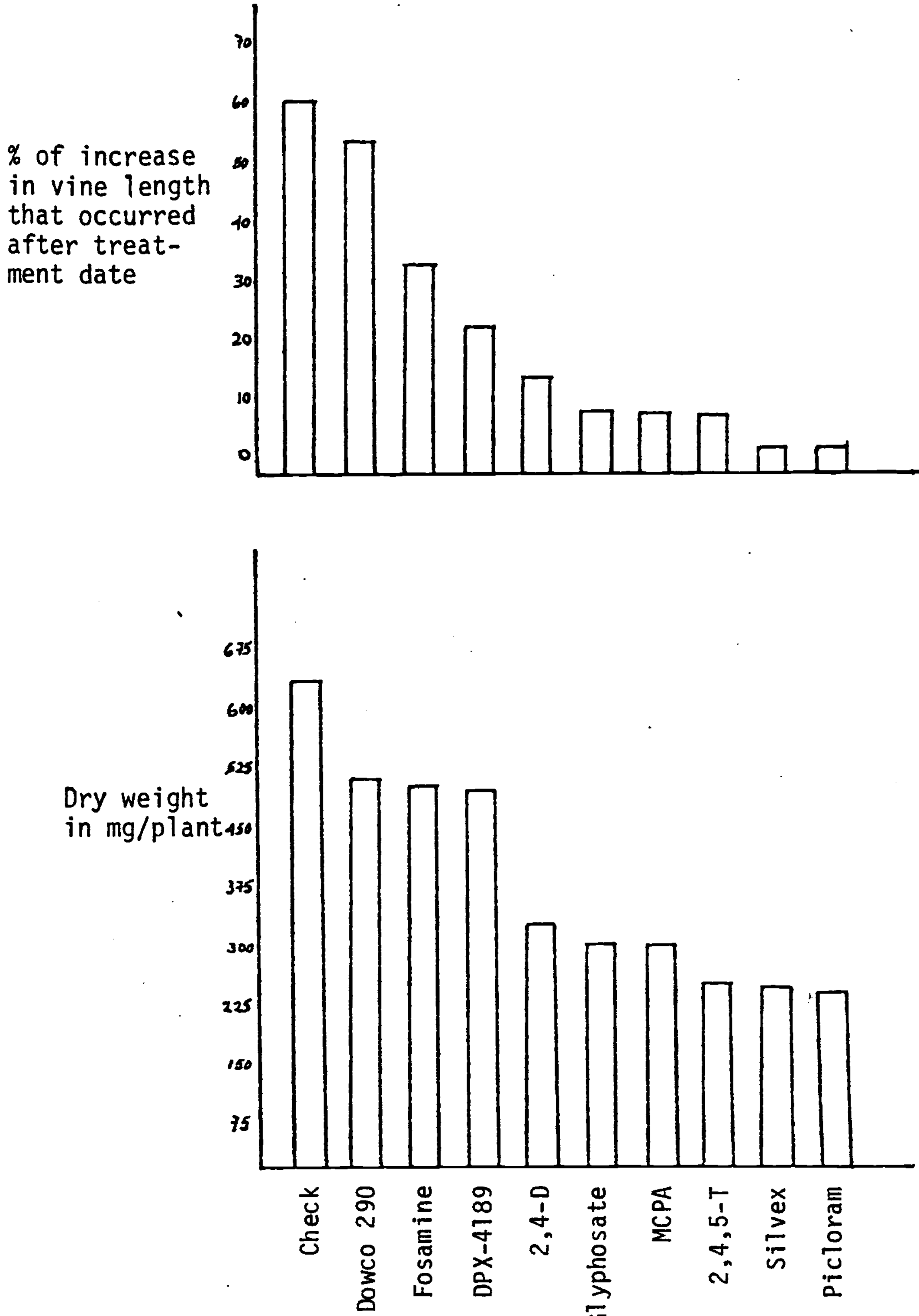

Figure 2.2. Percentage of total growth occurring after treatment, and dry weight in mg per plant (average of three growth chamber experiments) of wild cucumber (*Marah oreganus*).

withered and not much growth was evident after plants were treated. MCPA at 1.2 kg/ha caused epinasty in wild cucumber. Even though MCPA did not cause any burning to the wild cucumber seedlings, growth was rapidly stopped. Silvex at 0.28 kg/ha caused more severe symptoms to treated plants. Epinasty was evident and plants became yellow. After treatment, wild cucumber plants did not show any more growth. Picloram at 1.12 kg/ha caused epinasty. Although this treatment did not cause any burning, the terminal growing points were affected, and the damage was detected by visual evaluation. Glyphosate at 0.28 kg/ha was the only herbicide which caused burning to the leaves at the top of the plants. It took 2 to 3 days to detect the burning in wild cucumber plants. Visual symptoms were not detected in plants treated with DPX-4189 at 1.12 kg/ha, fosamine at 4.48 kg/ha, and Dowco 290 at 0.56 kg/ha. However, differences in growth after treatment were observed. The control plants grew well during the research as expected.

Dry weights were analyzed and LSD was used to detect differences between the check and the treatments. In experiment No. 1, using wild cucumber in the growth chamber, the F value showed differences at the 5% and the 1% level of probability (Appendix Table 10). In this trial, phenoxies and picloram were most effective and differences from the check were noticeable. The dry weight of the 2,4-D-treated plant was greater than the control, which was inconsistent with the 2,4-D response in preliminary experiments (Table 2.2). This experiment was repeated two more times. The dry weights of 2,4-D-treated

Table 2.2. Dry weights of wild cucumber (in the growth chamber) expressed as mg per plant, Experiment No. 1

Herbicide	Rate (kg/ha)	$\bar{X}^a$	SE
2,4-D	4.48	670.0	±173.0
Control	--	646.7	±111.8
Fosamine	4.48	495.3	± 93.8
Dowco 290	0.56	430.0	±110.0
DPX-4189	1.12	381.0	± 49.4
Glyphosate	0.28	310.3	± 58.1
MCPA	1.12	286.7	± 44.7
2,4,5-T	0.14	253.0	± 83.8
Silvex	0.28	249.7	± 41.1
Picloram	1.12	243.7	± 0.33
LSD (05)		250.1	
LSD (01)		342.6	

[a]Mean weight from three replications.

plants in other trials were consistently less than the control.

In the second experiment, the F value showed significant differences. The check was not significantly different from Dowco 290, DPX-4189, and fosamine (Table 2.3). Phenoxies, glyphosate, and picloram were significantly better than the other treatments.

In the third experiment, significant differences among treatments occurred as well. Even though plants were selected for uniformity on the basis of number of leaves per plant and plants of similar size were used to make each replication, one of the control plants grew abnormally, so a missing plot was calculated for this experimental unit. After the missing plot calculation, the same general pattern was observed. In this experiment, glyphosate and picloram were significantly different from the check and were as effective as phenoxy herbicides (Table 2.4).

Dry weights of wild cucumber plants treated with DPX-4189 at 1.12 kg/ha, fosamine at 4.48 kg/ha, and Dowco 290 at 0.56 kg/ha were not significantly different from the check. Growth of seedling wild cucumber was reduced most dramatically from applications of glyphosate at 0.28 kg/ha, picloram at 1.12 kg/ha, and the phenoxy herbicides 2,4-D at 4.48 kg/ha, MCPA at 1.12 kg/ha, 2,4,5-T at 0.14 kg/ha, and silvex at 0.28 kg/ha.

Table 2.3. Dry weights of wild cucumber (in the growth chamber) expressed in mg per plant, Experiment No. 2.

Herbicide	Rate (kg/ha)	$\bar{X}$[a]	SE
Control	--	424.7	±91.4
Dowco 290	0.56	421.3	±56.4
DPX-4189	1.12	387.7	±22.1
Fosamine	4.48	354.0	±91.7
2,4-D	4.48	239.7	±34.3
Glyphosate	0.28	219.0	±38.8
MCPA	1.12	192.3	±30.8
Silvex	0.28	162.3	±34.9
2,4,5-T	0.14	162.0	± 5.8
Picloram	1.12	158.7	±20.3
LSD (05)		128.7	
LSD (01)		176.3	

[a]Mean weight from three replications.

Table 2.4. Dry weights of wild cucumber (in the growth chamber) expressed in mg per plant, Experiment No. 3.

Herbicide	Rate (kg/ha)	$\bar{X}^a$	SE
Control	--	817.7*	±60.3
DPX-4189	1.12	696.7	±56.0
Dowco 290	0.56	649.3	±72.2
Fosamine	4.48	592.7	±51.0
Glyphosate	0.28	418.3	±99.4
MCPA	1.12	373.7	±90.5
2,4-D	4.48	326.7	±79.1
Silvex	0.28	309.7	±65.4
2,4,5-T	0.14	279.7	±62.8
Picloram	1.12	273.3	± 9.7
LSD (05)		196.8	
LSD (01)		270.4	

[a]Mean weight from three replications.

*A missing plot was calculated (20)

CHAPTER III

RESPONSE OF ESTABLISHED WILD CUCUMBER (*MARAH OREGANUS*) TO HERBICIDES

Abstract. Two field trials were conducted to evaluate the control of wild cucumber (*Marah oreganus*) in Benton and Marion counties, Oregon. In each location, a randomized complete block design with three replications was used for the study.

During the treatment year (1980), only two herbicides controlled wild cucumber at a level that would be commercially acceptable. The herbicides most effective in this research were glyphosate at 2.24 or 3.36 kg/ha and 2,4,5-T at 0.84, 1.68, or 3.6 kg/ha. Herbicide rates in the field were higher than in the growth chamber studies, previously reported, because complete kill of wild cucumber was the object in the field and growth reduction the objective in the growth chamber. Treatments in Benton county (Ashling farm) were not as effective as similar treatments in Marion county (Wolf farm). It is believed that this was due to a canopy effect in the Benton county plot area. The Benton county plot location was destroyed by highway maintenance workers during the winter of 1980, and no information on regrowth was collected in 1981. Plants treated in 1980 with glyphosate and 2,4,5-T at the Wolf farm showed no regrowth in spring or summer of 1981.

INTRODUCTION

Marah oreganus was first reported by Hooker in 1834. It was found near the Columbia River and was first designated as Sicyos angulatus. In 1840, Torrey and Gray designated such specimens as Sicyos oreganus. Kellogg, in 1855, observed some cucurbit plants in San Francisco which had gigantic tubers. He named them Marah muricatus. Today, both Torrey and Gray's and Kellogg's specimens are recognized as Marah oreganus (21).

This plant belongs to the Cucurbitaceae family. Although this family is most commonly found in the tropics and subtropics, the perennial genus Marah is exceptional in that it is able to prosper at latitudes of 45° N or more. The reason the plant is so vigorous is the development of deeply-buried large tubers. Tubers of Marah have been observed to develop from the hypocotyl (18, 19). Stocking (1955), reported a wild cucumber tuber estimated to be 14 years old that weighed about 58 kg.

The objective of this research was to screen, in the field, several herbicides for the control of wild cucumber. Evaluations were made over a 2-year period in the same plots to see whether or not the underground part (tuber) was affected.

MATERIALS AND METHODS

Two field trials were conducted to evaluate the control of wild cucumber, in an orchardgrass field at the Ashling farm, Palestine, Benton county, and in a waste area at the Wolf farm, Sublimity, Marion county, Oregon. Experimental plot areas were selected where a large number of wild cucumber plants were growing. A randomized complete block design with three replications was used in the plot layout. Individual wild cucumber plants were used to define an experimental unit.

Herbicide treatments were made during the summer of 1980. Treatments consisted of seven foliage-applied herbicides and a treatment of granular monobor chlorate (a non-selective herbicide composed of $Na_2B_2O_4$-68% and Na ClO_3-30%; 16 g per plant) which was placed in a hole made in the wild cucumber tuber with a soil probe.

Treatments were applied on May 31, 1980 at the Ashling farm and on June 28, 1980 at the Wolf farm. Although plots were treated a month apart, treated plants were at the same stage of growth (bud stage) at treatment time. The treated area per plot (experimental unit) was 1.5 m^2. Broadcast applications were made with a compressed-air back pack sprayer at 30 psi, using a 2-nozzle wand equipped with Al 8003 TeeJet nozzle tips. Climatic conditions at both locations were very similar (Appendix Tables 15, 16).

Visual evaluations of percentage injury to the foliage were made. Prior to analyzing the visual ratings, the data were transformed by angular transformation (arcsine $\sqrt{\%/100}$) (15).

RESULTS AND DISCUSSION

A great deal of difference in the percentage of injury to the foliage (necrosis) was detected among the herbicides tested. At the Ashling farm, Dowco 290 at 0.56 kg/ha and 2,4-D at all rates were ineffective. All other treatments caused significant injury to the wild cucumber. Fosamine caused much more necrosis to the foliage at 8.96 than at 6.72 kg/ha. Picloram was no more effective at 1.12 than at 0.56 kg/ha. The most effective wild cucumber plant killers were 2,4,5-T and glyphosate. 2,4,5-T was as effective at 0.84 kg/ha as at 3.36 kg/ha. The best treatment was glyphosate at 3.36 kg/ha, which gave 100% control (Table 3.1).

At the Wolf farm, the herbicide DPX-4189 was added as a foliage treatment but did not differ from the check plot. DPX-4189 and Dowco 290 were the only treatments that were not different from the check at the 1% probability level. As was seen at the Ashling location, the best wild cucumber killers at the Wolf farm were 2,4,5-T and glyphosate (not differing much at rates tested) (Table 3.2). Monobor chlorate was not included in the experimental design, but was effective in defoliating wild cucumber plants. Evaluation of plants treated with monobor chlorate, made at the same time as experimental observations for the other treatments, showed 100% necrosis (Table 3.3).

Visual comparisons at the Ashling and Wolf farms showed the same tendency for injury with the herbicides tested. During the treatment year (1980), only two herbicides that were tested controlled wild cucumber at a level that would be commercially acceptable. Treatments of glyphosate at 2.24 or 3.36 kg/ha, and 2,4,5-T at 0.84 or 1.68 kg/ha were effective in wild cucumber control. The lower rates of glyphosate and 2,4,5-T were not as effective at the Ashling location as the Wolf farm. Wild cucumber plants at the

Table 3.1. Visual evaluation of percentage injury to wild cucumber and arcsine transformation at the Ashling farm.

Herbicide	Rate (kg/ha)	% injury Visual evaluation* June 29, 1980	Arcsine transformation
2,4-D	0.56	6	13.13
2,4-D	1.68	8	16.20
2,4-D	2.24	8	16.57
2,4,5-T	0.84	53	46.93
2,4,5-T	3.36	70	57.00
Picloram	0.56	43	41.07
Picloram	1.12	47	43.07
Dowco 290	0.56	0.6	2.70
Glyphosate	2.24	68**	55.37
Glyphosate	3.36	100	90.00
Fosamine	6.72	13	17.73
Fosamine	8.96	40	39.20
Control	--	00	0.00
LSD (05)			10.6
LSD (01)			14.4

* Average of three replications

**Missing plot calculation for one plot (20)

Table 3.2. Visual evaluation of percentage injury to wild cucumber and arcsine transformation at the Wolf farm.

Herbicide	Rate (kg/ha)	% injury Visual evaluation* July 26, 1980	Arcsine transformation
2,4-D	0.56	7	12.27
2,4-D	1.68	12	19.87
2,4-D	2.24	18	25.20
2,4,5-T	0.84	98.5	84.60
2,4,5-T	1.68	99	87.30
Picloram	0.56	8	16.57
Picloram	1.12	22	27.53
Dowco 290	0.56	3	8.60
Glyphosate	2.24	100	90.00
Glyphosate	3.36	100	90.00
Fosamine	6.72	5	12.90
Fosamine	8.96	17	24.07
DPX-4189	2.24	2	7.00
Control	--	0	0.00
LSD (05)			8.04
LSD (01)			10.87

*Average of three replications

Table 3.3. Percentage of necrosis to the foliage, due to the monobor chlorate treatment.

Evaluation Date	Visual evaluation* % necrosis
August 2, 1980	47.5
August 9, 1980	90.0
August 16, 1980	95.0
August 23, 1980	100.0

*Average of three plants

**Application date was July 26, 1980

Ashling farm were located in an orchardgrass field and there was a dense canopy of grass at treatment time. It is believed that this canopy may have been responsible for reduced activity of these herbicides.

The trial area at the Ashling farm was destroyed by highway maintenance workers during the winter of 1980, and no valid regrowth information could be collected during the summer of 1981. Evaluations of wild cucumber regrowth from treated plants at the Wolf farm in the spring and summer of 1981, showed no regrowth from plants treated in 1980 with 2,4,5-T or glyphosate (Table 3.4). Monobor chlorate applied directly into the tuber controlled regrowth of small wild cucumber plants (vine length approximately 30 cm or less) the second year, but at the rate tested (16 grams per plant), it was not effective in controlling larger plants. Visual observations in the field would suggest a relationship between the size

Table 3.4. Evaluation of wild cucumber regrowth from treated plants (1980) at the Wolf farm.

Herbicides	Rate (kg/ha)	Replications May 10, 1981 I	II	III	Replications June 16, 1981 I	II	III
2,4-D	0.56	+	+	+	+	+	+
2,4-D	1.68	+	+	+	+	+	+
2,4-D	2.24	+	0	+	+	+	+
2,4,5-T	0.84	0	0	0	0	0	0
2,4,5-T	1.68	0	0	0	0	0	0
Picloram	0.56	+	0	+	+	0	+
Picloram	1.12	0	0	+	+	0	+
Dowco 290	0.56	+	+	+	+	+	+
Glyphosate	2.24	0	0	0	0	0	0
Glyphosate	3.36	0	0	0	0	0	0
Fosamine	6.72	0	+	0	0	+	0
Fosamine	8.96	+	0	+	+	0	+
DPX-4189	2.24	+	+	+	+	+	+
Control	--	+	+	+	+	+	+

+ Shoots regrew

0 Shoots did not regrow

of the tuber and top growth. Wild cucumber plants with large amounts of foliage and large vines (1 meter or more) were observed to have larger tubers than the plants with less foliage. This relationship may influence chemical control of wild cucumber and should be studied in more detail.

GENERAL CONCLUSIONS

Results of this study indicate that the seeds of *Marah oreganus* have a dormancy mechanism. The dormancy was not the result of seed coat impermeability since seeds with intact seed coats germinated better than seeds in which the seed coat was removed. In wild cucumber seeds, a chilling requirement is necessary to break dormancy. Seeds of *Marah* must be exposed to cold temperature for a certain minimum time. In this study, 22 days at constant 5 C was not time enough to break dormancy. While temperatures appeared to be most important, germination was increased when the entire seed was in contact with moist peat moss. In this research, maximum germination (100%) was obtained from recently harvested seeds when they were placed at constant 5 C and covered with moistened, but not saturated, peat moss for 58 days.

The growth of seedling wild cucumber plants in the greenhouse was rapid (2.5 cm per day). The degree of cotyledonary elongation in the seeds before transplanting caused large differences in percent emergence. The most uniform plants obtained in the greenhouse were those developed from seeds which were left in the germination chamber at constant 5 C for at least 150 days.

Seedlings of wild cucumber were most sensitive to glyphosate, picloram, and phenoxy herbicides. Phenoxies and picloram were the best inhibitors of growth. Among the phenoxies, 2,4-D at 4.48 kg/ha showed the least activity. Glyphosate at 0.28 kg/ha was the only herbicide that caused necrosis to the leaves. DPX-4189, fosamine, and Dowco 290 were ineffective.

Of the herbicides tested in field studies, only glyphosate and 2,4,5-T controlled wild cucumber plants at a level that would be commercially acceptable. Wild cucumber plants treated with these two herbicides in 1980 did not regrow in 1981 at the Wolf location. The other location was destroyed during the winter of 1980 and no valid regrowth evaluation was possible. Monobor chlorate at 16 grams per plant applied directly to the tuber controlled regrowth of small wild cucumber plants but was less effective on large plants. Among the phenoxy herbicides used, 2,4,5-T at 0.84 kg/ha was more effective than 2,4-D at 2.24 kg/ha. A similar response was observed with seedling wild cucumber plants in the greenhouse. Visual observations in the field suggest a relationship between the size of the tuber and top growth. This relationship may influence chemical control of wild cucubmer and should be studied in more detail.

Based upon the data from this research, it can be suggested that in a grass seed field, spot applications with glyphosate may be feasible for the control of established wild cucumber plants. Because of its selectivity, 2,4,5-T may be even more helpful if this herbicide becomes registered again in agronomic crops.

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A P P E N D I X

Appendix Table 1. Visual evaluation of the first preliminary trial in garden cucumber (Cucumis sativus) in the greenhouse.

Herbicide	Rate (kg/ha)	(Average of 3 replications) Evaluation 12 days after treatment
2,4-D	2.24	Necrotic at the edges
	1.12	Twisting, no necrosis
	0.56	Twisting, no necrosis
	0.28	Twisting, no necrosis
2,4,5-T	2.24	Plants dead
	1.12	Plants dead
	0.56	Plants dead
	0.28	Plants dead
MCPA	2.24	Plants dead
	1.12	80% necrosis
	0.56	40% necrosis and twisting
	0.28	30% necrosis and twisting
Silvex	2.24	Plants dead
	1.12	Plants dead
	0.56	Plants dead
	0.28	70% necrosis
Dowco 290	2.24	Plants dead
	1.12	Plants dead
	0.56	80% necrosis
	0.28	10% necrosis
Picloram	2.24	80% necrosis
	1.12	70% necrosis
	0.56	Plants chlorotic
	0.28	Slightly chlorotic
Glyphosate	2.24	Plants dead
	1.12	Plants dead
	0.56	Plants dead
	0.28	90% necrosis
DPX-4189	2.00	70% chlorotic
	1.00	20% chlorotic
	0.50	Slightly chlorotic
	0.25	No symptoms
Fosamine	8.96	Withered, 60% chlorotic
	4.48	Cupping effect
	2.24	Slightly withered
	1.12	Slightly withered
Control	--	No symptoms, was flowering

Appendix Table 2. Dry weights in milligrams per plant in the second preliminary trial in cucumber (*C. sativus*) in the greenhouse.

Herbicide	Rate (kg/ha)	Dry weights (m/plant) Replications I	II	III	$\bar{x}$[a]
2,4-D	4.48	505	657	687	
		576	536	515	
		526	596	414	556.9
2,4,5-T	0.14	577	546	556	
		536	515	546	
		637	536	394	538.1
MCPA	1.12	536	566	414	
		516	465	576	
		515	556	444	510.0
Silvex	0.28	606	637	526	
		505	626	576	
		778	576	677	611.9
Glyphosate	0.28	425	334	455	
		263	253	455	
		354	384	616	393.2
Fosamine	4.48	717	767	757	
		606	666	636	
		787	686	737	706.6
DPX-4189	1.12	596	939	899	
		707	737	263	
		677	667	717	689.1
Dowco 290	0.56	1020	656	596	
		667	626	627	
		939	677	535	704.8
Picloram	1.12	546	485	586	
		445	596	576	
		545	596	626	555.7
Control	--	829	929	727	
		869	827	667	
		677	1212	980	857.4

[a]Mean of three replications and three observations per replication.

Appendix Table 3. Dry weights in mg/plant of three preliminary greenhouse trials of wild cucumber.

Herbicide	Rate (kg/ha)	Preliminary trial No. 1 Replications I	II	III	x̄	Preliminary trial No. 2 Replications I	II	III	x̄	Preliminary trial No. 3 Replications I	II	III	x̄
2,4-D	4.48	787	344	606	579	304	142	414	286.7	495	434	263	397.3
	2.24	687	787	647	707	-	-	-	-	-	-	-	-
2,4,5-T	0.28	253	344	757	451	-	-	-	-	-	-	-	-
	0.14	304	344	404	351	394	142	293	276.3	304	202	224	243.3
MCPA	1.12	490	213	344	349	566	202	556	441.3	152	101	263	172.0
	0.56	949	696	253	633	-	-	-	-	-	-	-	-
Silvex	0.28	1939	354	536	943	304	243	626	391.0	233	374	214	273.7
	0.14	314	758	748	607	-	-	-	-	-	-	-	-
Glyphosate	0.28	864	1102	1162	1043	960	879	364	734.3	657	606	637	633.3
	0.14	1384	1203	1071	1219	-	-	-	-	-	-	-	-
Fosamine	4.48	1164	1041	1041	1081	797	495	586	626.0	-	-	-	-
DPX-4189	1.12	1264	536	990	930	627	142	273	347.3	-	-	-	-
	0.56	465	1344	374	728	-	-	-	-	-	-	-	-
Dowco 290	0.56	919	244	949	704	920	940	263	707.7	-	-	-	-
	0.28	415	394	455	421	-	-	-	-	-	-	-	-
Picloram	1.12	414	627	687	576	293	627	142	354.0	-	-	-	-
	0.56	1141	950	1374	1155	-	-	-	-	-	-	-	-
Control	-	849	1031	616	832	264	415	445	374.7	516	374	485	458.0

Appendix Table 4. Height in cm of three experiments of wild cucumber in the growth chamber, before plants were treated.

Herbicides	Rate (kg/ha)	Average of three replications Exp. No. 1	Exp. No. 2	Exp. No. 3	cm/plant[a]
2,4-D	4.48	25.15	21.59	28.79	25.17
2,4,5-T	0.14	18.20	20.74	27.52	22.15
MCPA	1.12	17.78	19.05	29.63	22.15
Silvex	0.28	19.47	17.36	27.94	21.59
Glyphosate	0.28	21.17	20.74	29.21	23.71
Dowco 290	0.56	17.78	18.63	29.63	22.01
Picloram	1.12	17.78	21.59	29.63	23.00
DPX-4189	1.12	19.47	20.32	30.90	23.56
Fosamine	4.48	20.74	20.74	29.21	23.56
Control	--	16.51	19.90	32.17	22.86

[a] Means of three experiments.

Appendix Table 5. Number of leaves of three experiments of wild cucumber in the growth chamber, before plants were treated.

Herbicides	Rate (kg/ha)	Average of three replications			$\bar{x}$[a]
		Exp. No. 1	Exp. No. 2	Expt. No. 3	
2,4-D	4.48	6.7	7.0	8.7	7.5
2,4,5-T	0.14	6.3	7.0	8.3	7.2
MCPA	1.12	6.7	7.3	8.3	7.4
Silvex	0.28	7.0	6.7	9.0	7.6
Glyphosate	0.28	7.3	7.3	9.0	7.9
Dowco 290	0.56	6.6	6.7	8.3	7.2
Picloram	1.12	6.3	6.7	8.3	7.1
DPX-4189	1.12	7.0	7.3	9.0	7.8
Fosamine	4.48	7.7	7.0	8.0	7.6
Control	--	6.0	6.7	9.0	7.2

[a]Means of three experiments.

Appendix Table 6. Height in cm of three experiments of wild cucumber in the growth chamber after herbicide treatment and immediately before harvesting.

Herbicide	Rate (kg/ha)	Exp. No. 1	Exp. No. 2	Exp. No. 3	cm/plant[a]
2,4-D	4.48	42.7	22.8	30.9	32.13
2,4,5-T	0.14	18.6	22.4	29.6	23.53
MCPA	1.12	19.5	20.7	30.9	23.70
Silvex	0.28	18.6	18.2	27.9	21.57
Glyphosate	0.28	21.2	28.4	31.3	26.97
Dowco 290	0.56	21.6	51.6	68.6	47.27
Picloram	1.12	17.8	21.6	29.6	23.00
DPX-4189	1.12	23.7	28.8	36.4	29.63
Fosamine	4.48	30.5	30.5	41.5	34.17
Control	--	36.4	53.8	75.4	55.20

[a]Means of three experiments.

Appendix Table 7. Number of leaves of three experiments of wild cucumber in the growth chamber, after herbicide treatment and immediately before harvesting.

Herbicide	Rate (kg/ha)	Average of three replications			$\bar{x}$[a]
		Exp. No. 1	Exp. No. 2	Exp. No. 3	
2,4-D	4.48	11.67	7.3	9.0	9.3
2,4,5-T	0.14	7.17	7.0	9.0	7.7
MCPA	1.12	7.00	8.0	9.0	8.0
Silvex	0.28	7.67	6. 7	8.7	7.7
Glyphosate	0.28	8.33	8.0	8.0	8.1
Dowco 290	0.56	7.00	10.7	13.0	10.2
Picloram	1.12	7.00	6.7	8.3	7.3
DPX-4189	1.12	7.67	11.3	13.0	10.7
Fosamine	4.48	8.17	9.7	13.3	10.4
Control	--	6.50	12.0	16.0	11.5

[a]Means of three experiments.

Appendix Table 8. Fresh weight of three experiments of wild cucumber, in the growth chamber, expressed in milligrams/plant.

Herbicides	Rate (kg/ha)	Exp. No. 1 Replications I	II	III	$\bar{x}$	Exp. No. 2 Replications I	II	III	$\bar{x}$	Exp. No. 3 Replications I	II	III	$\bar{x}$
2,4-D	4.48	4768	5556	2364	4229.3	2192	1848	2495	2178.3	4567	1817	2727	3037.0
2,4,5-T	0.14	2828	1172	1424	1808.0	1687.7	1717	1304	1569.3	4020	1687	2404	2703.7
MCPA	1.12	2567	2435	1647	2216.3	1667	1284	2192	1714.3	2837	1889	3354	2693.3
Silvex	0.28	1950	1919	2495	2121.3	1627	1364	2606	1865.7	2767	1889	3324	2660.0
Glyphosate	0.28	1767	2445	2214	2142.0	1798	1445	2394	1879.0	2061	2596	3807	2821.3
Dowco 290	0.56	4224	3304	1717	3081.7	3727	2586	2707	3006.7	3576	5364	5535	4825.0
Picloram	1.12	2152	2152	2093	2132.3	1525	1232	2010	1589.0	2846	2284	2846	2658.7
DPX-4189	1.12	2818	3747	2284	2949.7	2627	3526	3807	3320.0	4717	3475	4000	4064.0
Fosamine	4.48	1940	5031	2827	3266.0	4455	1212	2424	2697.0	4535	4223	4152	4303.3
Control	--	4283	5787	3846	4638.7	2686	1919	4223	2942.7	4777	6193	9374	6781.3

Appendix Table 9. Dry weight of three experiments of wild cucumber in the growth chamber, expressed in milligrams/plant.

Herbicides	Rate (kg/ha)	Exp. No. 1 Replications				Exp. No. 2 Replications				Exp. No. 3 Replications				
		I	II	III	$\bar{x}$	I	II	III	$\bar{x}$	I	II	III	$\bar{x}$	$\bar{\bar{x}}$[a]
2, 4-D	4.48	849	837	324	670.0	283	172	264	239.7	474	203	303	326.7	283.2**
2,4,5-T	0.14	414	132	213	253.0	162	172	152	162.0	404	202	233	279.7	231.6
MCPA	1.12	354	304	202	286.7	212	132	233	192.3	384	212	525	373.7	284.2
Silvex	0.28	182	243	324	249.7	162	102	223	162.3	283	212	434	309.7	240.6
Glyphosate	0.28	213	304	414	310.3	202	162	293	219.0	324	314	617	418.3	315.9
Dowco 290	0.56	596	472	222	430.0	505	314	445	421.3	505	726	717	649.3	500.2
Picloram	1.12	244	244	243	243.7	162	122	192	158.7	283	254	283	273.3	225.2
DPX-4189	1.12	384	465	294	381.0	344	404	415	387.7	767	586	737	696.7	488.5
Fosamine	4.48	364	677	445	495.3	536	243	283	354.0	495	667	616	592.7	480.7
Control	--	556	869	515	646.7	354	314	606	424.7	697	878	878*	817.7	629.7

[a]Mean of three experiments.

*Missing calculation Plot (19)

**Average of Exp. No. 1 and Exp. No. 2.

Appendix Table 10. Analysis of variance of dry weights of three experiments of wild cucumber, in the growth chamber.

Exp. No. 1

Source of variation	df	SS	MS	F
Repetitions	2	96,656.07	48,328.04	
Treatments	9	700,542.97	77,838.11	3.66**
Error	18	382,555.93	21,253.11	
Total	29	1,179,754.97		
C.V. = 35				

Exp. No. 2

Source of variation	df	SS	MS	F
Repetitions	2	52,968.1	26,484.1	
Treatments	9	338,647.5	37,627.5	6.68**
Error	18	101,372.6	5,631.8	
Total	29	492,988.2		
C.V. = 27.5				

Exp. No. 3*

Source of variation	df	SS	MS	F
Repetitions	2	61,516.5	30,758.25	
Treatments	9	1,057,262.7	117,473.63	9**
Error	(18-1) 17	221,938.2	13,055.19	
Total	(29-1) 28	1,340,717.4		
C.V. = 24				

*Analysis of variance with missing data.

Appendix Table 11. Visual evaluations and arcsine transformations for % injury on established wild cucumber in the field at the Ashling farm.

		Visual evaluation[1]				Arcsine transformation			
	Rate	Replications				Replications			
Herbicide	(kg/ha)	I	II	III	$\bar{x}$	I	II	III	$\bar{x}$
2,4-D amine	0.56	2	5	10	6	8.1	12.9	18.4	13.13
2,4-D amine	1.68	5	5	15	8	12.9	12.9	22.8	16.20
2,4-D amine	2.24	5	10	10	8	12.9	18.4	18.4	16.57
2,4,5-T	0.84	50	50	60	53	45.0	45.0	50.8	46.93
2,4,5-T	3.36	70	80	60	70	56.8	63.4	50.8	57.00
Picloram	0.56	30	40	60	43	33.2	39.2	50.8	41.07
Picloram	1.12	50	40	50	47	45.0	39.2	45.0	43.07
Dowco 290	0.56	0	2	0	0.6	0.0	8.1	0.0	2.70
Glyphosate	2.24	65	70	68*	68	53.7	56.8	55.6	55.37
Glyphosate	3.36	100	100	100	100	90.0	90.0	90.0	90.0
Fosamine	6.72	20	20	0	13	26.6	26.6	0.0	17.73
Fosamine	8.96	40	40	40	40	39.2	39.2	39.2	39.20
Control	--	0	0	0	0	0	0	0	0.00

*Missing data was calculated.

[1]Visual evaluation scale: 100 = complete kill, 0 = no injury.

Appendix Table 12. Visual evaluations and arcsine transformations for % injury on established wild cucumber in the field at the Wolf farm.

Herbicide	Rate (kg/ha)	Visual evaluation[1] Replications I	II	III	$\bar{x}$	Arcsine transformation Replications I	II	III	$\bar{x}$
2,4-D amine	0.56	10	0	10	7	18.4	0	18.4	12.27
2,4-D amine	1.68	10	15	10	12	18.4	22.8	18.4	19.87
2,4-D amine	2.24	15	25	15	18	22.8	30.0	22.8	25.20
2,4,5-T	0.84	98	98	100	98.5	81.9	81.9	90.0	84.60
2,4,5-T	3.36	98	100	100	99	81.9	90.0	90.0	87.30
Picloram	0.56	10	5	10	8	18.4	12.9	18.4	16.57
Picloram	1.12	30	15	20	22	33.2	22.8	26.6	27.53
Dowco 290	0.56	0	5	5	3	0	12.9	12.9	8.60
Glyphosate	2.24	100	100	100	100	90.0	90.0	90.0	90.0
Glyphosate	3.36	100	100	100	100	90.0	90.0	90.0	90.0
Fosamine	6.72	5	5	5	5	12.9	12.9	12.9	12.9
Fosamine	8.96	15	15	20	17	22.8	22.8	26.6	24.07
DPX 4189	2.24	0	5	2	2	0	12.9	8.1	7.00
Control	--	0	0	0	0	0	0	0	0.00

[1]Visual evaluations scale: 100 = complete kill, 0 = no injury.

Appendix Table 13. Analysis of variance of arcsine transformation from visual evaluations of % injury on established wild cucumber in the field at the Ashling farm.

Source of variation		df	SS	MS	F
Replications		2	31.73	15.87	
Treatments		12	23,711.26	1,975.94	49.85**
Error	*(24-1)	23	911.64	39.64	
Total	(38-1)	37	24,654.63		

C.V. = 18.6
*A missing plot was calculated.

Appendix Table 14. Analysis of variance of arcsine transformation from visual evaluations of % injury on established wild cucumber in the field at the Wolf farm.

Source of variation	df	SS	MS	F
Replications	2	43.98	21.99	
Treatments	13	47,336.11	3,641.24	158.38**
Error	26	597.81	22.99	
Total	41	47,977.90		

C.V. = 13.3

Appendix Table 15. Herbicide application data for field application on established wild cucumber at the Ashling farm.

Evaluation date: June 29, 1980

Crop: Orchardgrass

Planting date: 1975

Harvest date: July 13, 1980

Seeding rate; planting depth: 0.454 kg/ha; 1.25 cm

Plot size; row spacing: 1.59 m^2; 1.22 by 1.22

Soils series and type: Amity silt loam

Fertilizer: 130-40-00

Irrigation: None

Experimental design: Randomized complete block design

LSD: 0.05 = 10.6 0.01 = 1414 C.V. = 18.6

Application date: May 31, 1980
Air temperature: 22.2 C
Soil temperature: 24.97 C
% relative humidity: 65
% cloud cover: 0
Wind speed: calm
Dew present: None
Time of day: 12.30 p.m.
Soil moisture: powdery dry
Soil surface: stubble
Method of application: broadcast
Type of sprayer: compressed-air backpack
Ground speed: 4.827 KPH
Type of carrier and volume: Water, 1122 lts/ha
Length of boom and nozzle spacing: 2-nozzle wand, 20 inches
Nozzle size and type: Al 8003 TeeJet
Boom height: 91.44 cm
Pressure (psi): 30

Appendix Table 16. Herbicide application data for field application on established wild cucumber at the Wolf farm.

Evaluation date: July 26, 1980

Crop: None

Plot size; row spacing: 1.59 m^2, 1.22 by 1.22

Soil series and type: Jory silty clay loam

Experimental design: Randomized complete block

LSD: 0.05 = 8.04 0.01 = 10.87 C.V. = 13.3

Application date: June 28, 1980
Air temperature: 24.42 C
Soil temperature: 29.97 C
% relative humidity: 60
% Cloud cover: 40
Wind speed: 6.44 to 9.65 KPH
Dew present: none
Time of day: 12.30 p.m.
Soil moisture: powdery dry
Soil surface: clean, firm
Method of application: broadcast
Type of sprayer: compressed-air backpack
Ground speed: 4.827 KPH
Type of carrier and volume: Water, 1122 Lts/ha
Length of boom, nozzle spacing: 2-nozzle wand, 20 inches
Nozzle size and type: Al 8003 TeeJet
Boom height: 91.44 cm
Pressure (psi): 30