To the Graduate Council:

I am submitting herewith a thesis written by Jennifer Lee Sanders Panter entitled "The Origin and Dissemination of Weed Seed in Container-Grown Nursery Stock." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Ornamental Horticulture and Landscape Design.

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Donald B. Williams, Major Professor

We have read this thesis
and recommend its acceptance:

Willard T Witte

Elmer L Ashburn

Accepted for the Council:

Lou Minkel
Vice Provost
and Dean of The Graduate School

THE ORIGIN AND DISSEMINATION OF WEED SEED IN CONTAINER-GROWN NURSERY STOCK

A Thesis

Presented for the

Master of Science

Degree

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Jennifer Lee Sanders Panter

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ABSTRACT

A major problem in container nurseries is weed control. Most weed related research pertains to control of existing weeds with herbicides.

In 1983 and 1984, research was conducted to help determine the origin and dissemination of weed seed in nursery container plants. Tests involving the dispersal of weed seed by wind, irrigation water, raindrop splash, and seedpod rupture were conducted. Potting media was also investigated as a possible source of weed seeds.

Weed seed dispersal by wind was not a serious problem in this study. Irrigation water was a factor in the dispersal of weed seeds, but the relatively few seeds found prevented this method of dispersal from being significant. Raindrop splash proved to be an important factor in the method of dissemination of weed seeds. The throwing of seeds by Oxalis sp. and a Cruciferae plant proved to be important as the seeds were found 1.2 to 1.8 m from the plant. The infestation of weed seeds in potting media was not serious in this study.

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CHAPTER I

INTRODUCTION

The container nursery industry has greatly increased in recent years. The production of woody ornamentals in containers has many advantages over field production. Some of these advantages are lower labor requirements, more efficient use of space, lower shipping costs, easier marketing, improved plant quality, and shorter time period for producing a plant (16).

Although there are many advantages, there are still problems. A major problem is the control of weeds in the container. This problem is the primary cause of high labor costs. Padgett and Frazier (15) calculated that a total of 624 man-hours of labor is required for manual weeding of an acre of 1 gallon container nursery stock. There are also problems encountered with the use of herbicides. Some of these problems include the lack of control due to difficulty in obtaining uniform application and the requirement for several applications during the season (12).

Competition between weeds and nursery stock in the containers is the reason for efficient weed control. According to a study by Fretz (7,8) in 1972 and 1973, 47-75% growth loss was reported depending on weed species and densities. This loss is significant for the nurseryman.

The purpose of this study was to evaluate possible sources of weed seed contamination in the container nursery. Weed seeds are dispersed by wind, water, animals, forceful rupturing of seedpods, man and machinery (1). In container nurseries, the source of potting media may be an important source of weed seed contamination.

This study will focus on evaluating weed seed contamination by wind, irrigation water, splashing effect of raindrops, forceful rupturing of seedpods, and potting media.

CHAPTER II

LITERATURE REVIEW

Weed seeds are dispersed by both artificial and natural means. Natural means include wind, water, animals, and forceful rupturing of seedpods. Artificial means include dispersal by man and machines (1).

Wind is the most common form of dispersal, although it is not very well documented (13). Smith and Kok (18) conducted field experiments to measure the effects of wind velocity on the distance and dispersal pattern of musk thistle seeds. When measured for the highest velocity, 5.62 m/s, the majority of the seeds were deposited within the first 40 m of the source. However, a few seeds were deposited more than 90 m. When measured for the lowest wind velocity, 0.76 m/s, all seed were deposited within the first 40 m. According to this research, very few musk thistle seeds are carried long distances by wind regardless of wind velocity.

Water is another natural means of weed seed dispersal. The dissemination of weed seeds by flowing water or irrigation water has been well documented (5,9,10,11,17,19).

Egginton and Robbins (5) believed that ditch banks along irrigation canals were an important source of weed seeds. This theory was tested by taking 156 samples from three different irrigation ditches over a 2 year period. Eighty-one different

species of weeds were found during the irrigating season. Hope (10) followed the work of Egginton and Robbins and found similar results in irrigation water in Alberta, Canada.

Preliminary laboratory studies were conducted in North Dakota to calculate how far weed seeds can be carried in irrigation water. Results from these studies show that many seeds can travel a distance of 24 miles per day assuming a water flow of 1 mile per hour or at 3 miles per hour, the seeds can travel 72 miles per day (9).

Shull (17) conducted a study to determine the kind and seasonal distribution of weed seeds being transported in irrigation water. Bermudagrass was found in the water during all months. Seeds belonging in the Compositae family were found from June to November. Bentgrass was found during May and then again during the summer months. The number of seed was not calculated during this study.

Studies conducted in Alberta, Canada, revealed that 1.7 million seeds of 13 weed species, were carried in irrigation water over a 24 hour period in September. These seeds were carried past a given point in the upper 1.6 inch layer of a 10 foot wide irrigation canal (1).

Kelley and Bruns (11) sampled irrigation water in three different waterways during 1970, 1971, and 1973-1974. These samples were taken at weekly intervals at three different places in the waterway. During the 1970 irrigation season, seeds from 137 plant

species were collected, an average of 2,222 seeds per 254 kl of water. An average of 10,800 kl of water per hectare was delivered on the land during the season; thus, the average number of seeds dispersed per hectare of land was 94,500. In 1971, a different waterway was sampled. Seeds from 84 plant species were found, an average of 682 seeds per 254 kl of water. The average amount of water per hectare of land dispersed during the season was 3,850 kl, giving an average of 10,350 seeds per hectare of land disseminated by irrigation water. In 1973-1974, the third waterway, the Columbia River, was sampled. Seeds from 77 plant species were collected, an average of 336 per 254 kl of water. There was an estimated 4,300 kl of water per hectare of land delivered that season; thus, an average of 14,100 seeds dispersed per hectare of land was distributed by irrigation water. Kelley and Bruns concluded that the number of seeds may not be as important as the fact that the seeds are carried and transported to land that has not been previously infested.

Wilson (19) recorded similar results to Kelley and Bruns in 1977 and 1978. The study was conducted in Western Nebraska to determine the seasonal variation in kind and number of weed seeds that are transported in irrigation water onto farmland. The number, kind, and seasonal distribution of seeds found were similar to the results of Kelley and Bruns. There was no correlation between water volume and the number of seeds collected. The 10 weed species causing the greatest problem in the fields were found in irrigation water.

The viability of weed seeds after being in fresh water for a long period of time is as important as finding the seeds in the water. If the seeds are not viable, there is no reason for concern. Bruns and Rasmussen (4) studied the viability of seeds after being stored in fresh water. Seeds from five weed species were used in the study. The seeds were collected from fields, divided into samples of 100 seeds, and put in Lumite screen bags. These bags allowed water to circulate readily. The bags were put in the water at 12 and 48 inch depths, and removed at various intervals over a 22 month period. When removed, the number of seeds germinated and/or disintegrated were counted, and the seeds that appeared to be stable were placed in a germinator for 4 weeks. Germination counts were made at six different intervals during a 4 week period. Some seeds germinated while in the water. Fluctuations in percentage of germination in four species occurred after 10-11 months of submergence. There were sharp decreases in germination after 9-10 months, then sharp increases in germination between 11-12 months. At the end of 22 months, the average percentage of germination ranged from near 0 up to 19. There were no consistent and significant differences in percent germination for seeds held at different depths of water. However, there was a slight trend for lower percent germination taken at 48 inch depths during the latter stages of the study. Bruns and Rasmussen reported that the temperature of the water seemed to have a greater effect on the viability of the seeds than light and oxygen.

The movement of soil particles by the splashing of raindrops can be related to the movement of weed seeds. Ellison (6) found that when raindrops hit the ground or the thin films of water covering the ground, the drops splash small bits of soil into the air. The distance of the splashed particles varies in height, ranging from 0 to more than 2 feet. The particles may move horizontally up to more than 5 feet on level surfaces.

Forceful rupturing of seedpods or capsules is yet another way seeds are moved. Oxalis is an example of a plant which "throws" its seeds. The capsule wall is thin and is alone too weak to throw seeds. However, when touched, the capsule wall ruptures and seeds are expelled violently. The seeds can be thrown several feet and can cling to many objects due to a sticky substance on their surface (13).

Potting media is another possible source of weed seed contamination in nursery containers. While monitoring an uncovered pile of a bark-sand mix for changes in pH and soluble salts over a year, Bilderback (3) encountered weed seed contamination. The pile was 14 cubic yards of 80% bark and 20% sand by volume. There was no weed germination during the summer months, and only two weeds germinated in September. However, in the following spring months, March, April, and May, there was an increase to 24, 1, and 17, respectively. These data suggested there could be a problem with weed growth in the summer months.

CHAPTER III

MATERIALS AND METHODS

I. WIND

The objective of this test was to determine how far weed seeds could be blown from a given point under normal weather conditions in Knoxville, Tennessee. This experiment was initiated on October 29, 1983. Two tests were conducted adjacent to unmowed areas bordering Fort Loudoun Lake on the University of Tennessee Plant Sciences Farm. One test area was on an upward slope away from the weed source and the second test area was on level ground away from the weed source. A third test area was an unmowed area of level ground on the University of Tennessee Agriculture Campus. Naturally occurring stands of goldenrod (Solidago sp.) and thistle (Compositae family) were the primary weeds in all three tests. Weed height was approximately 1 to 2 m for all plants.

One-gallon plastic containers were weighted down with limestone gravel. A 5.1 cm wide strip of sticky insect tape was placed across the top diameter of the container. The containers were put in an area of 10.5 m by 7.5 m, in seven rows of five containers starting 1.5 m from the edge of the weed source. Containers were placed on a closely mowed surface so the trapping area would not be a source of weeds. The containers were 1.5 m apart in rows which were also 1.5 m apart. These containers were removed from the

area after 6 weeks. A magnifying glass was used to identify the weed seeds on the tape.

II. WATER

Irrigation Water

The purpose of this test was to determine if weed seeds were in the water used to irrigate nursery container plants. Irrigation water samples were taken from five nurseries where the water source was either a pond, reservoir, or creek. Three of these nurseries were in Warren County, Tennessee, and two nurseries were in Knox County, Tennessee. Samples were taken monthly from July, 1983 to September, 1983 (Table 1).

Sampling was accomplished by flowing water through a piece of Formax fabric during normal irrigation practice. This fabric is a finely woven polyester, its hole size being 224 by 112 microns, and will only allow water to pass through. The flow rate was calculated by timing how fast a 19-liter container was filled.

The samples were taken to the laboratory and filtered onto 15.0 cm Whatman 541 filter paper and air dried. A binocular microscope was used to examine the samples.

Splashing of Raindrops

Cups. The objective of this test was to determine the height that weed seeds could be scattered by the splashing effects of raindrops. The test was initiated on July 11, 1983 in the nursery

Table 1. Source, date, and volume of irrigation water samples from five nurseries.

Nursery	Source of Water	Date	Liters of Water Sampled
1[a]	pond	7-1-83	946
		7-28-83	568
		8-31-83	189
		10-5-83	757
2[b]	reservoir	6-30-83	946
		7-28-83	1136
		8-31-83	972
		10-5-83	632
3[c]	creek	7-1-83	1590
		7-28-83	1136
		8-31-83	1136
		10-5-83	1136
4[d]	pond	7-25-83	1363
		8-28-83	3407
		9-29-83	1136
5[e]	pond	7-26-83	568
		8-30-83	454
		10-8-83	568

[a]Globe Wholesale Nurseries, McMinnville, TN.

[b]Pleasant Cove Nursery, Rock Island, TN.

[c]Mountain Creek Nursery, McMinnville, TN.

[d]Kinsey Gardens, Inc. #2, Knoxville, TN.

[e]Associated Nursery, Knoxville, TN.

research area on the University of Tennessee Agriculture Campus. There were three treatments and three replications of each treatment arranged in a randomized complete block. Within each treatment, there were three replications of four different heights of cups. Treatments were surfaces of gravel, bare soil, and polyethylene black plastic. The heights of the cups were 8.0, 15.0, 23.0, and 31.0 cm above the surface. The test was repeated three times. The time period of each test was determined by the occurrence of rainfall.

Styrofoam cups, with an area of 38.3 cm^2, were used to catch the weed seeds. Cups were held in place with tops parallel to the soil by being attached to sticks cut to the different heights needed.

Large crabgrass (Digitaria sanguinalis) was sowed over the treatment areas at a rate of 41.2 kg/ha. Pepperweed (Lepidium virginicum) was sowed over the treatment areas at a rate of 38.4 kg/ha. Seeding was accomplished prior to placement of the catch cups.

The total plot area was 57.3 m^2, each treatment area being 4.5 m^2. In each treatment area, three rows of four cups each were placed 0.6 m apart and 0.3 m from each edge. There was a distance of 0.4 m between each cup within the row. The cups were changed three times, on July 15, 1983 following 8.0 mm of rain, on July 21, 1983, following 33.0 mm of rain, and on July 26, 1983 following 13.0 mm of rain. The contents of the cups were filtered onto filter paper and allowed to air dry. At a later date, the contents were observed through a binocular microscope for possible weed seeds.

Containers. The purpose of this test was to determine if weed seeds could be splashed by raindrops into nursery containers. The test was initiated on July 11, 1983. Pepperweed (Lepidium virginicum) and large crabgrass (Digitaria sanguinalis) were spread on level soil surfaces at the rate of 38.4 kg/ha and 41.2 kg/ha, respectively. The test area consisted of three plots, each having an area of 4.5 m^2.

One-gallon plastic containers were filled with unsterilized potting media. Eight containers were used in each plot. Four were covered with black polyethylene plastic and four were left uncovered. In each plot, the containers were randomized and placed in two rows, each row having four containers. The containers were 0.6 and 0.3 m from the edges. There was a distance of 0.6 m between the rows and the containers within the rows.

On July 26, 1983, following three hard rains totalling 54.0 mm, containers were removed and placed in the greenhouse for possible germination of weed seeds. Plastic was removed from the covered containers and media was watered daily to promote germination and growth of weeds. These containers were left in the greenhouse until germination of any weed seeds ceased.

III. RUPTURING OF SEEDPODS

Greenhouse

The objective of this test was to determine how far Oxalis plants could "throw" their seeds naturally. Oxalis seedlings were

transplanted into 4-inch square containers filled with potting media. These plants were put under mist in the greenhouse until new growth began. When seed heads began to form, plants were removed from under the mist and watered daily. On April 27, 1984, the test was initiated.

Fly paper, 3.8 cm^2 wide, was tacked to yardsticks and placed horizontally at the same level as the top of the container on two opposite sides. Yardsticks, with fly paper attached, were also placed vertically, 4.4 cm away from the container, on the remaining two sides.

Three replications were used and the test was repeated three times. Seed count and placement were recorded after a large percentage of the seeds had been thrown. The time period varied between tests due to the drying of the paper and the conditions in the greenhouse, i.e., high humidity and sunlight intensity.

On May 7, 1984, data were taken, two plants were replaced and the fly paper was changed. On May 11, 1984, data were taken a second time, one plant was replaced and the fly paper was changed. On May 14, 1984, the final set of data was recorded and the test was concluded.

Outdoors

Visual observation showed the seeds were thrown farther than 91.4 cm, the length of a yardstick; thus, an outdoor test was initiated. The size of the testing area was increased and the plant size was increased. An area between greenhouses was used for the test.

Sheets of plywood were placed together horizontally 0.6 m above the ground to form a 2.4 m square area. A 1 gallon container containing a plant belonging to the mustard family was placed in the center of the plywood. Cups, with an area of 20.3 cm^2, were tacked to the plywood. The cups were placed 15.0 cm apart in eight lines radiating from the center of the plant. The plant was watered daily. The test using the mustard plant was initiated on May 21, 1984 and concluded on May 24, 1984.

On May 25, 1984 the test was reset using an Oxalis plant in a 1 gallon container. In addition to the horizontal test, a vertical test was constructed. A yardstick was used as support. The same size cups were tacked to the yardstick on four sides. On the wide sides of the stick, the cups were placed at 15.0 cm intervals ranging from 15.0 cm to 75.0 cm. On the thinner sides of the stick, the cups were placed at 15.0 cm intervals ranging from 20.0 cm to 80.0 cm. The yardstick was placed in the center of the container. The vertical and horizontal tests were repeated three times. The time period for each test was dependent on the weather and the condition of the plant. The conclusion of the test with Oxalis was on June 8, 1984.

IV. MEDIA SAMPLING

The purpose of this test was to determine if various media used by nurseries contained weed seeds. In the first week of July, 1983, samples of mined sand, river sand, bark, and peatmoss

were taken from eight nurseries. Approximately 4.0 l of each medium was sampled from each nursery. The samples were each divided and put in four to eight seed flats, 20 cm long by 15 cm wide. Each sample was evenly distributed in the container for a depth of approximately 3.8 cm. The number of containers per sample was divided and half were placed on benches in the greenhouse and half on benches outside the greenhouse. This method was used to allow controlled watering of half the samples and natural watering of the remaining half. Containers were covered with a layer of cheesecloth to prevent contamination of the samples. Samples inside the greenhouse were watered daily. Samples outside the greenhouse were watered according to need. These containers were not disturbed for approximately 6 months. At the end of 6 months, weeds growing in the samples were identified and recorded.

V. SURVEY OF WEEDS

In late June and early July of 1983, seven container nurseries were visited. A block of containers was marked and the weeds in the containers were identified and counted at each nursery. Each block varied depending on the availability of the plants at each nursery. The nurserymen were instructed to treat the plants in the blocks as if a survey were not being taken, but to record any pulling of weeds or spraying of herbicides in the area. The kind and number of plants in the length of time the plants were held in the block was recorded (Appendix). These blocks of plants were monitored monthly for 4 months during the summer.

CHAPTER IV

RESULTS AND DISCUSSION

I. WIND

After 6 weeks, the sticky tape on the top of the containers was removed and the weed seeds found on the tape were counted. Seeds from goldenrod, Solidago sp., were the only species found. The results from the three tests were combined in order to give a better representation of the data. The number of weed seeds found decreased from 161, or 43% of the total number of seed found, at 1.5 m from the weed source to 11, or 3%, at 7.5 m from the weed source (Figure 1). However, from 7.5 m to 10.5 m from the weed source, a 4% increase, or 14 weed seeds, was found.

II. WATER

Irrigation Water

Irrigation water samples were analyzed for weed seeds during the summer of 1983. In the 18,711 liters of water sampled from five nurseries during the three sampling periods, three seeds were found; one Paspalum sp., one Gramineae, and one giant foxtail. The seed of the genus Paspalum was found in a sample taken from a pond on July 1, 1983. The grass seed was found in a sample taken from a creek on October 5, 1983 and the giant foxtail seed was found in a sample taken from a pond on July 26, 1983, different from the

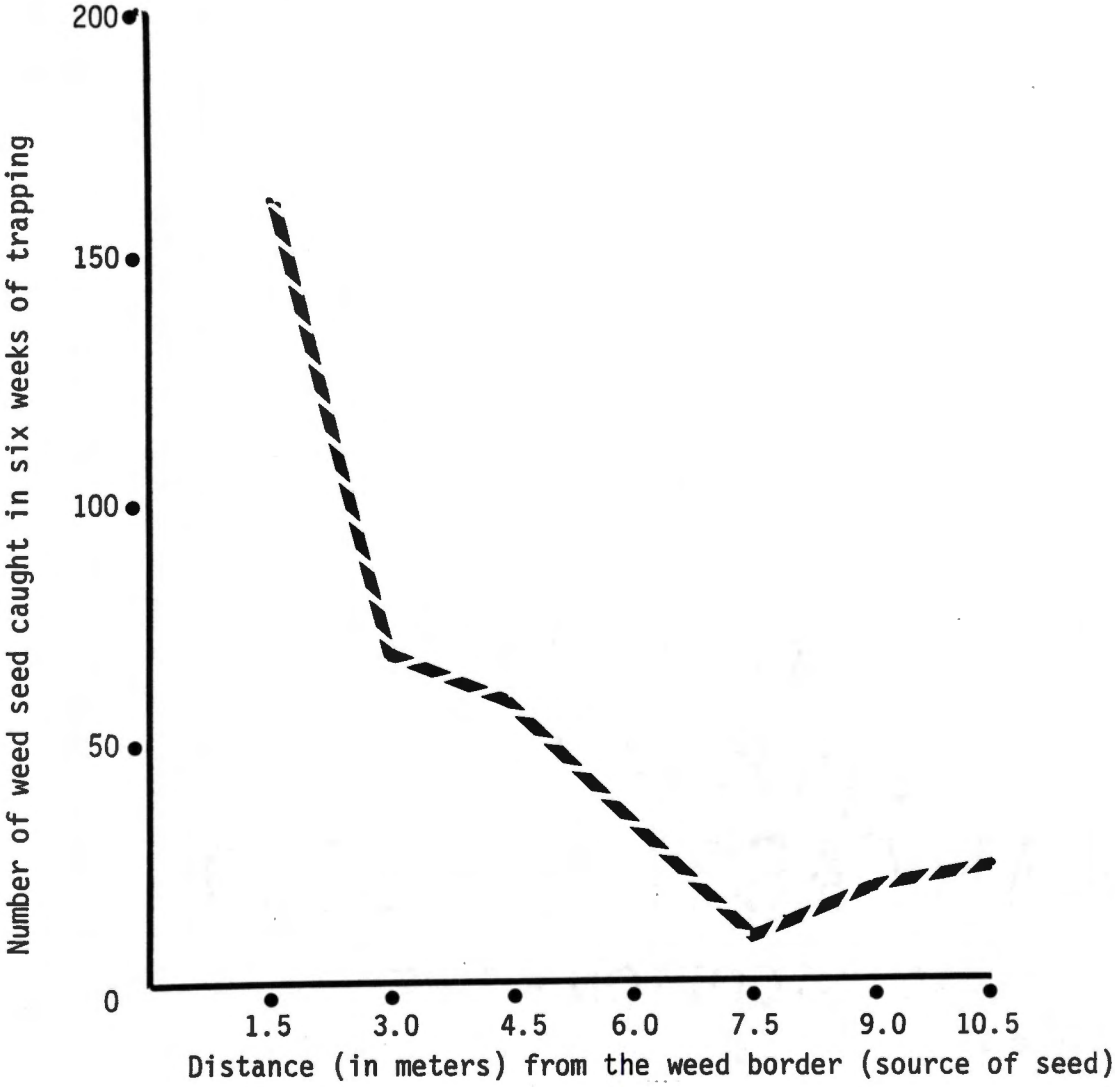

Figure 1. Wind dispersal of weed seed as determined by distance from the source after 42 days starting October 25.

pond sampled on July 1, 1983. No seeds were found in samples taken from a reservoir or from a pond where water was recycled and contained a large amount of algae.

Assuming 30 acre-inches of irrigation water are put on plants in a container operation in one growing season and taking the data in this test, an estimation of 498 seeds per 30 acre-inches of water applied can be calculated. However, containers in nurseries generally do not cover the entire soil surface, perhaps only 25%; therefore, the number of seeds that actually fall in a container will be less than the number calculated.

The viability of the seeds found was not tested. However, in an earlier test, Bruns and Rasmussen found that some seeds were viable after 22 months of exposure in fresh water (4).

Splashing of Raindrops

Cups. On July 15, 1983, after a 8.0 mm rain, the total number of weed seeds caught was recorded. The number of weed seeds caught was again recorded on July 21, 1983, after two rains totalling 33.0 mm, and again on July 26, 1983 after a 13.0 mm rain.

Although pepperweed, Lepidium virginicum, and large crabgrass, Digitaria sanguinalis, were the weed seeds sown over the test area, no pepperweed and very few large crabgrass seeds were caught. Large quantities of purslane, Portulaca oleracea, carpetweed, Mollugo verticillata, and goosegrass, Eleusine indica, were caught.

The number of seeds splashed varied with the type of surface used in the test. More seeds splashed from the bare soil than the polyethylene covered soil and more splashed from the polyethylene covered soil than the soil covered with gravel (Figure 2).

As expected, the number of seed caught decreased with an increase in elevation. Figure 2 shows that the relationship between height of the cup and number of seeds caught was not a linear relationship. A decrease in the number of seeds splashed occurred between the 8.0 cm and 15.0 cm heights on the bare soil. The lines of the bare surface and the polyethylene surface were similar between the 15.0 cm and 31.0 cm heights. The number of seeds caught at 31.0 cm on the gravel surface increased slightly from the number of seeds caught at 23.0 cm.

The amount of rainfall was the only environmental condition recorded in this splashing effect test. Neither the intensity of the rainfall nor the wind conditions was recorded. According to the data obtained from this test, the number of seeds splashed in the cups did not correlate well with rainfall amounts. In test III, fewer seeds were splashed in the cups by a 13.0 mm rain than in test I after a 8.0 mm rain, except for the unexplained results at the 31.0 cm height (Figure 3).

Figure 4 shows a calculated number of seed splashed in the cups based on 25 mm of rainfall. For example, in test III at the 8.0 cm level, the rate of seed splash was 130 seeds for 27 cups or an average of 4.8 seeds per cup.

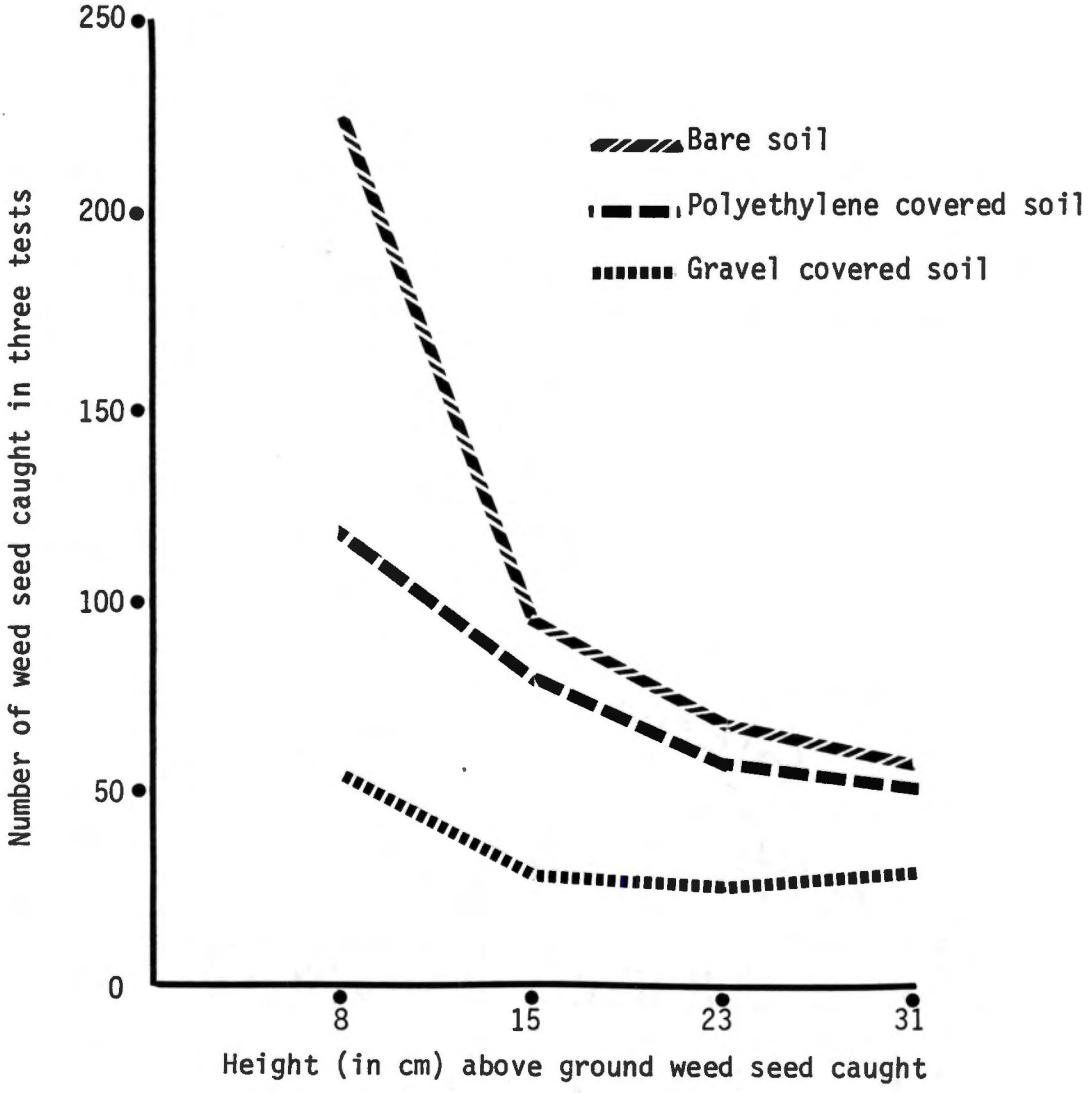

Figure 2. Height weed seed splashed above three treatments of soil cover during three tests having a total of 54.0 mm of rain. Distribution of rain: 8.0 mm, 33.0 mm, 13.0 mm.

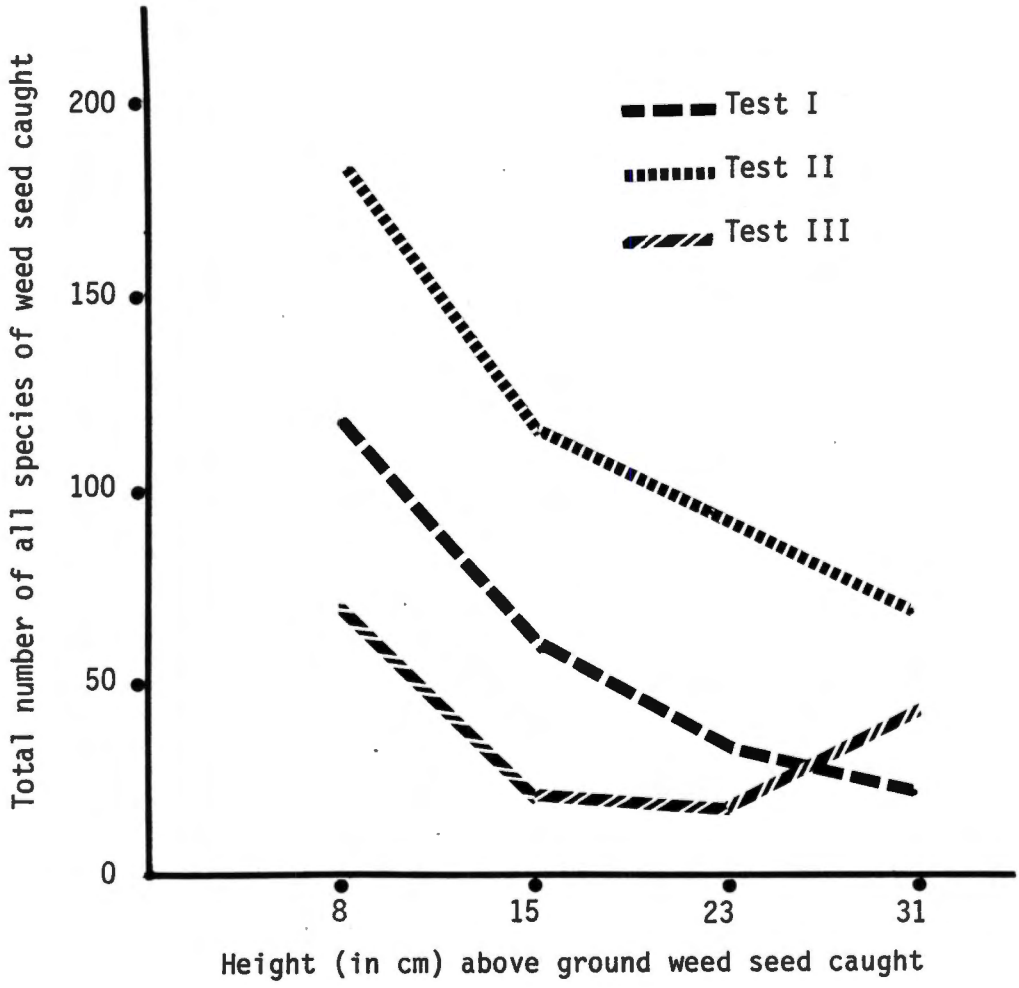

Figure 3. Number and height weed seed splashed during three tests. Rainfall for test I, 8.0 mm; test II, 33.0 mm; test III, 13.2 mm.

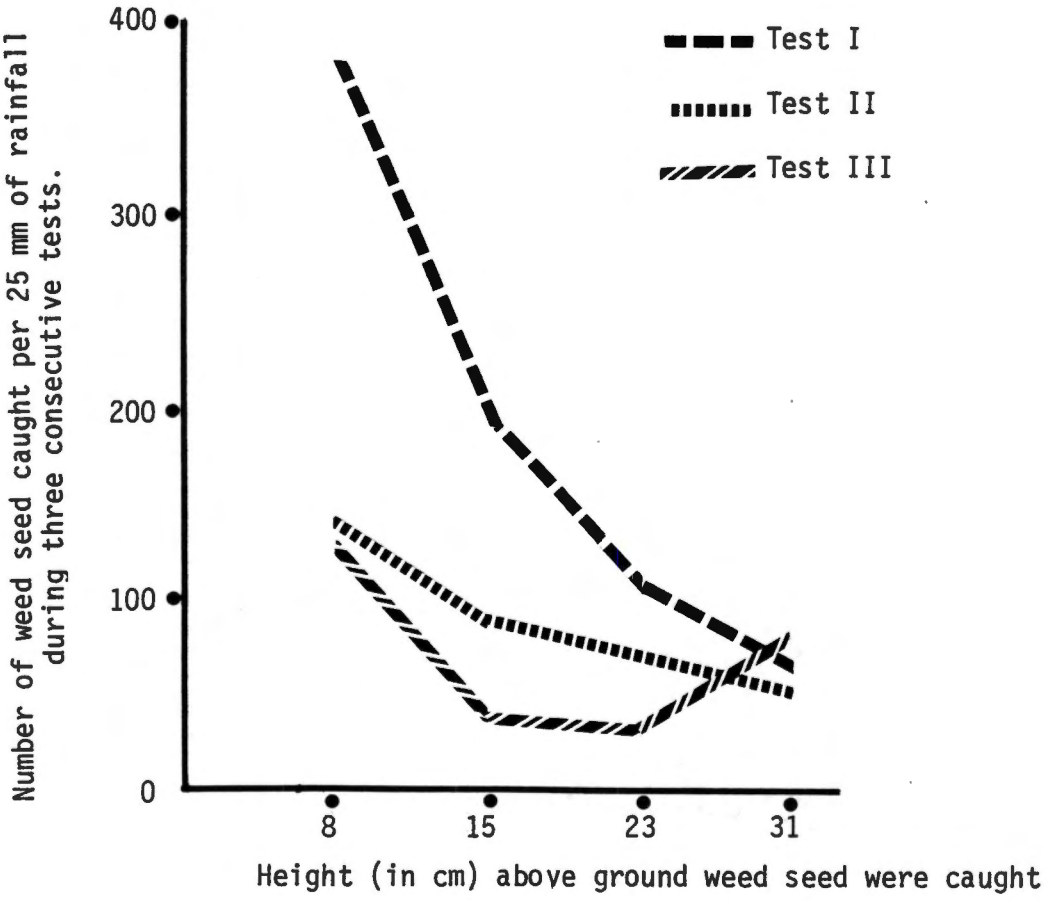

Figure 4. Height and number of weed seed splashed per 25 mm of precipitation. Actual rainfall for test I, 8.0 mm; test II, 33.0 mm; test III, 13.0 mm.

Since the amount of existing weed seeds in the plot areas was not known, the percentage of existing seeds that splashed into the cups cannot be determined. Based on the data recorded from this test, no explanation for the lack of large crabgrass or pepperweed found in the cups can be determined.

Containers. On August 11, 1983, after three rains, totalling 54.0 mm, the containers filled with potting media were taken to the greenhouse and the polyethylene was removed. These containers were covered with cheesecloth to prevent additional weed seed contamination. To help promote growth of any weed seed, the media was watered daily. These containers were observed carefully for any germination of weed seed. On January 6, 1984, the kind and number of weeds in each container was recorded. Weed growth was found in 10 of 12, or 83%, of the containers that were left uncovered in the experiment. No weed growth was observed in the covered containers. The kind and number of weeds found was mouseear chickweed (8), henbit (5), pokeweed (2), Oxalis sp. (1), Compositae (3), and Cruciferae (8). No large crabgrass or pepperweed was found. The plants belonging to the Cruciferae family could have been pepperweed, but no reliable observation could be made because the plants died before maturity. The average number of seeds found per container was 2.7 for the 10 of 12 containers which had weeds.

The data recorded only the viable seeds that germinated. Therefore, the actual number of seeds splashed in the container may be larger.

III. RUPTURING OF SEEDPODS

Greenhouse

Data were taken three times on three plants, all *Oxalis stricta*. On May 7, 1984 after 14 days, data were recorded for plant A. In a 0.1 m^2 area of sticky tape 26 seeds thrown horizontally were caught between 2.5 cm and 73.6 cm from the source.

On May 14, 1984 after 10 days, data were recorded for plants B and C. Plant B threw 15 seeds horizontally between 4.1 cm and 85.1 cm in a 0.1 m^2 area. Plant C threw seven seeds horizontally between 9.2 cm and 71.8 cm in a 0.1 m^2 area. Since visual observation showed seeds were being thrown farther than the allowed testing space, this test served as a preliminary test for another test with a greater area. The vertical tests were not reliable in this greenhouse experiment of seedpod rupturing.

Outdoors

A plant belonging to the *Cruciferae* family was placed in the center of a 2.4 m square plywood table for 73 hours. Figure 5 shows the number of actual seeds caught in the cups ranging in distance from 15 cm to 152 cm from the center of the plant. A calculated dispersal of seed dispersal was determined by multiplying the actual number caught by a factor representing the distance from the cup to the center of the plant. For example, 10 seeds caught at 137 cm was multiplied by 9 because the cups at 137 cm were 9

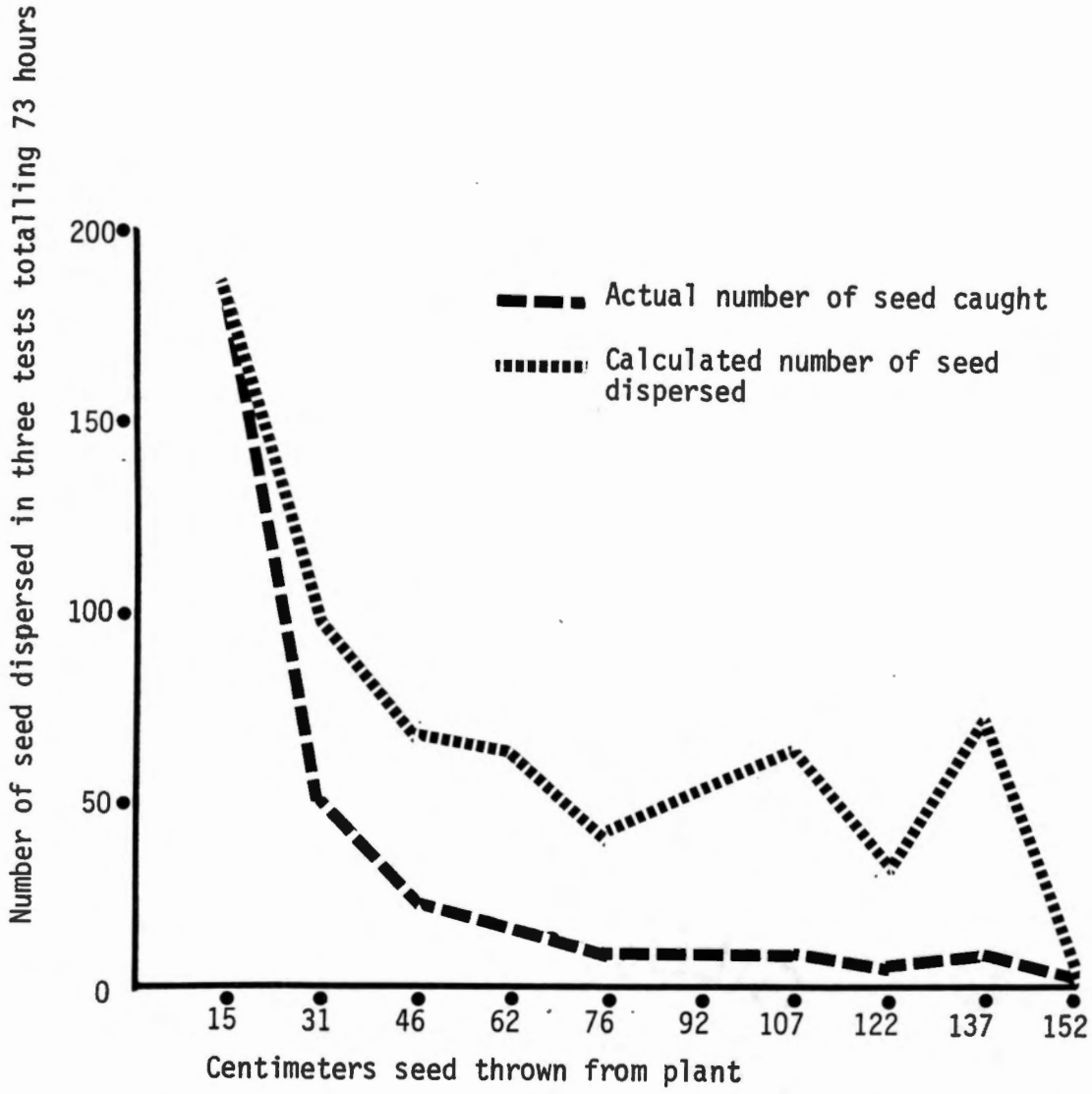

Figure 5. Lateral distribution of seed thrown from a viable plant belonging to the Cruciferae family.

times farther from the center of the plant than the cups at 15 cm. The curve representing the actual number of seeds caught decreases from 181 seeds at 15 cm to 0 seeds at 152 cm. However, the peak number of possible seeds caught beyond 31 cm was calculated at 137 cm from the center of the plant.

The distance seeds were thrown by the rupturing of seedpods of an Oxalis plant was also measured. The Oxalis plant remained in the center of a 2.4 m square table for 260 hours. Figure 6 shows the total number of seeds caught from three tests and the calculated number of seeds caught based on area. The actual number caught at 15 cm was 300 and the curve decreased to 8 seeds caught at 152 cm from the center of the plant. Beyond 31 cm, another peak number of possible seeds caught was calculated at 92 cm from the center of the plant.

A test was also constructed to measure vertical throwing of seeds. Some cups, those 15, 20, and 30 cm above the soil, were placed within the crown of the plant and were invalid measurements for the number of seeds thrown. The cups at approximately 35 cm were the first cups above the plant. Beginning at 35 cm the curve had a zig-zag appearance to the 80 cm height (Figure 7).

An assumption can be made from this data that seeds of Oxalis and Cruciferae can be thrown at distances greater than 152 cm horizontally and 80 cm vertically.

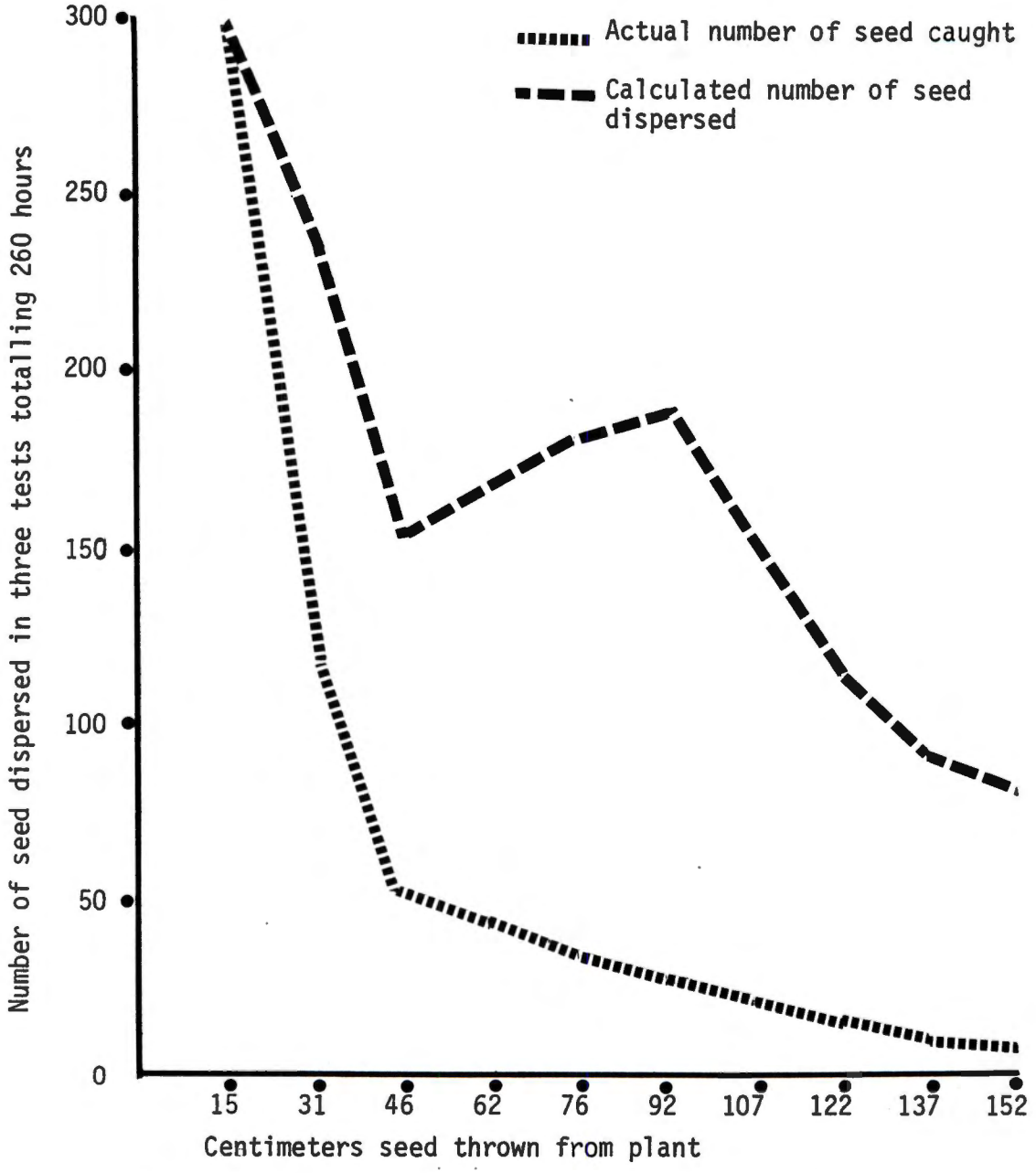

Figure 6. Lateral distribution of Oxalis stricta seed from a healthy potted plant.

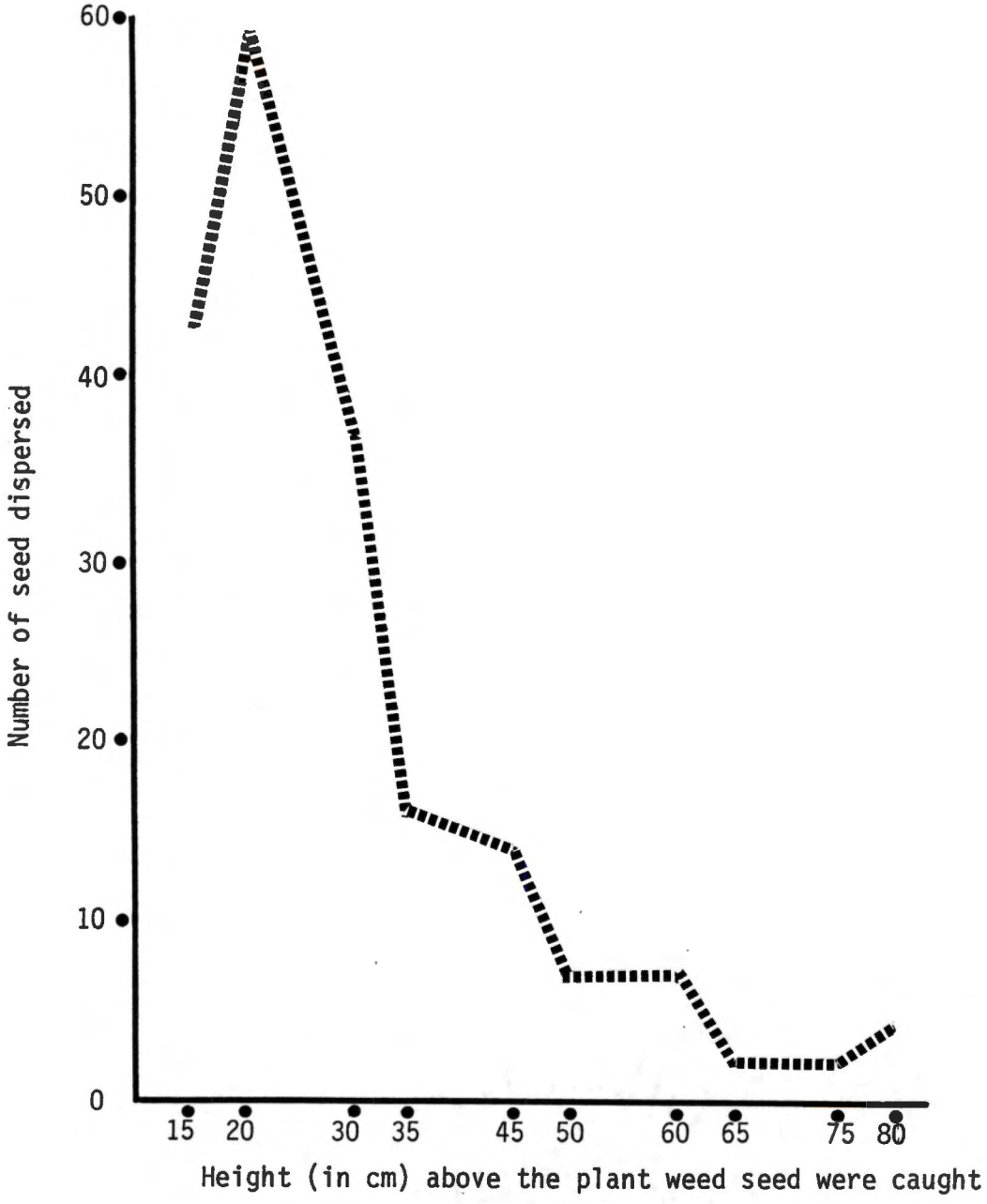

Figure 7. Vertical dispersion of Oxalis stricta seed from a healthy potted plant.

IV. MEDIA SAMPLING

Flats of bark, river sand, mined sand, and peatmoss sampled from nine nurseries were covered with cheesecloth and placed in the greenhouse in an environment suitable for plant growing for approximately 6 months. A record of the kind and number of weeds found growing in the media was made at the end of 6 months. In the samples of bark, four crabgrass plants, two Oxalis plants, two Compositae plants, and three pokeweed plants were found. In the river sand samples two Compositae plants were found. No weeds were found growing in the peatmoss or the mined sand samples used in this test.

V. SURVEY OF WEEDS

Weeds, representing 31 species, were found in nursery containers over a 3-month period in the summer of 1983 (Appendix, p. 35). The weeds found in the containers were not necessarily the weeds found in the media. Therefore, a correlation between the media used and the weeds in the containers could not be established.

CHAPTER V

SUMMARY

The purpose of this study was to investigate the origin and dissemination of weed seeds in container grown nursery stock. Wind was found to disperse goldenrod (Solidago sp.) seeds at distances of 1.5 m to 10.5 m from the weed source. Seeds may have traveled distances greater than measured in this experiment based on the fact that some seeds were caught at the greatest distance measured.

Weed seeds were found in only three samples of irrigation water. The sources of the irrigation water where weed seeds were found were two ponds and a creek. Since there are spaces between containers in most commercial operations, the seeds may not have fallen in containers, but on the surface around the containers. This possibility may be significant due to the fact that in this test, seeds were splashed by rainfall into cups positioned at the same height as containers.

Weed seeds were found growing in a small number of bark and river sand samples taken from uncovered container media piles. Even though the weeds were not seen in the media, germination occurred under the proper conditions.

Since weed control is a problem in container grown plants, nurserymen should be aware of these means of weed seed dispersal (2,12). Preventative measures of weed control should be of major

importance to the nurseryman because of the high labor costs for weed removal (12).

There are a number of preventative measures the grower can take to decrease the chance of weeds entering the growing area. One measure is to keep the medium covered until it is used. Another measure is to screen irrigation water. Finally, the grower needs to keep border areas free of weeds (2,14).

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LITERATURE CITED

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APPENDIX

Table 2. Inventory of weeds in containers under commercial conditions at Associated Nursery, Knoxville, TN.

Date Inventoried	Weeds Found	Number
	White pine (100 plants) potted 7-16-83 in Morton's commercial mix	
7-26-83	none	0
10-8-83	Compositae	6
	knotweed	1
	Oxalis	2

Table 3. Inventory of weeds in containers under commercial conditions at Globe Wholesale Nurseries, McMinnville, TN.

Date Inventoried	Weeds Found	Number
	140 Pyracantha potted 6-30-83	
7-1-83	none	0
7-28-83	Compositae	8
	crabgrass	49
	Cruciferae	69
	Cyperaceae	2
	goosegrass	9
	johnsongrass	7
	knotweed	2
	nimblewill	18
	Oxalis sp.	5
	plantain	1
	misc. dicot	1
	misc. monocot	3
8-31-83	weeds had been pulled, inventory ended	
	79 Pampas grass potted 6-25-83	
7-1-83	Euphorbiaceae	1
	Gramineae	17
	misc. dicot	2
7-28-83	chickweed	1
	crabgrass	9
	Cruciferae	11
	Gramineae	11
	knotweed	2
	nimblewill	7
	Oxalis sp.	2
	Sambucus sp.	1
	misc. dicot	1
8-31-83	weeds had been pulled, inventory ended	

Table 3. (Continued)

Date Inventoried	Weeds Found	Number
	100 Pine potted 6-25-83	
7-1-83	crabgrass + misc. grasses	16
	Cyperaceae	1
	misc. dicot	6
7-28-83	Compositae	3
	crabgrass	12
	Cruciferae	17
	Cyperaceae	3
	johnsongrass	1
	knotweed	1
	nimblewill	4
	misc. dicot	1
8-31-83	inventory ended	
	200 'Silver King' Euonymus potted 6-25-83	
7-1-83	Gramineae	17
	misc. dicot	5
7-28-83	crabgrass	19
	Cruciferae	5
	goosegrass	2
	johnsongrass	3
	knotweed	2
	nimblewill	11
	Oxalis sp.	2
	plantain	1
8-31-83	inventory ended	

Table 3. (Continued)

Date Inventoried	Weeds Found	Number
	100 Spirea potted 6-25-83	
7-1-83	misc. dicot	6
	misc. monocot	23
7-28-83	artemisia	1
	crabgrass	3
	Cruciferae	5
	goosegrass	6
	johnsongrass	1
	nimblewill	14
8-31-83	inventory ended	

Table 4. Inventory of weeds in containers under commercial conditions at Forest Nursery, McMinnville, TN.

Date Inventoried	Weeds Found	Number
	576 Rhododendron potted in a mix of 80% bark, 10% sand, and 10% peat on 6-6-83	
6-30-83	none	0
7-28-83	Compositae	4
	Cyperaceae	1
	Gramineae	6
	Oxalis sp.	2
	misc. dicot	2
	misc.	1
8-31-83	crabgrass	3
	Euphorbiaceae	1
	Oxalis sp.	24
	thistle	1
	misc. dicot	36
	misc.	3
	375 Shore Junipers potted in a mix of 80% bark, 10% sand, and 10% peat on 6-6-83	
6-30-83	none	0
7-28-83	Compositae	3
	crabgrass	7
	Cyperaceae	2
	knotweed	39
	nightshade	1
	Oxalis sp.	19
	pokeweed	2
	purslane	4
	misc. dicot	10
8-31-83	inventory ended	

Table 5. Inventory of weeds in containers under commercial conditions at Kinsey Gardens, Inc. #2, Knoxville, TN.

Date Inventoried	Weeds Found	Number
	872 Cotoneaster potted in a mix of 80% bark and 20% sand on 7-23-83	
7-27-83	none	0
8-28-83	crabgrass	1
	morningglory	5
	smooth sumac	2
9-29-83	crabgrass	1
	smooth sumac	3

Table 6. Inventory of weeds in containers under commercial conditions at Little Green Garden Nursery, Knoxville, TN.

Date Inventoried	Weeds Found	Number
	98 Foster holly potted in a commercial mix	
7-26-83	none	0
8-30-83	Compositae	4
	Cruciferae	2
	smartweed	1
	vine	1
	misc. dicot	4
10-8-83	Cruciferae	17
	Oxalis sp.	2
	poor joe	2
	redroot pigweed	2
	smartweed	2
	sowthistle	14
	misc. dicot	18

Table 7. Inventory of weeds in containers under commercial conditions at Mountain Creek Nursery, McMinnville, TN.

Date Inventoried	Weeds Found	Number
	213 Azalea potted in a mix of 80% bark and 20% sand on 6-25-83	
6-30-83	Compositae	2
	Gramineae	3
7-28-83	crabgrass	4
	Cruciferae	6
	goldenrod	2
	knotweed	2
	Oxalis sp.	1
	plantain	1
	misc. dicot	2
	misc. monocot	1
8-31-83	inventory ended	

Table 8. Inventory of weeds in containers under commercial conditions at Pleasant Cove Nursery, McMinnville, TN.

Date Inventoried	Weeds Found	Number
	3069 'Blue Rug' Junipers and 'Old Gold' Junipers potted in a mix of 75% bark, 15% sand, and 10% shale on 6-1-83	
6-30-83	Compositae	3
	crabgrass	11
	Euphorbiaceae	1
	Oxalis sp.	1
	misc.	6
7-28-83	Compositae	36
	crabgrass	25
	Cruciferae	2
	Cyperaceae	1
	Euphorbiaceae	1
	Gramineae	1
	knotweed	3
	Oxalis sp.	16
	partridge pea	1
	yerba de-tago	1
	misc. dicot	2
8-31-83	inventory ended	

VITA

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