A PRELIMINARY EVALUATION OF SELECTED PREEMERGENCE AND POSTEMERGENCE HERBICIDES FOR USE IN FIRST YEAR ESTABLISHMENT OF 'CARDINAL' STRAW- BERRY

By

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CHAPTER I

INTRODUCTION

The history of the strawberry, Fragaria anasnassa Duch., goes back as far as the Romans and perhaps even as far as the Greeks. It is in the family Rosaceae. Because the fruit has never been a staple of agriculture it is difficult to find ancient references to it (13). By the 1300s the strawberry was being cultivated by the French in Europe. Commercial strawberry production began around 1800 in the United States.

Strawberries today are raised in all 50 states with an estimated acreage in 1980 of 35,650 acres and a crop value of $288,776,000 (35). California is the leading grower with 11,000 acres, followed by Oregon with 5,200, Washington is next with 2,9000, and then Michigan with 2,700. Numerous other states produce more than 1,000 acres.

In Oklahoma, the industry is confined mostly to Adair and Cherokee counties, in the northeastern portion of the state and with scattered acreage throughout the eastern and north central counties. The total acreage in 1983 is less than 1,000 acres.

The strawberry is usually grown as a perennial herb, but in some southern states it is sometimes grown as an annual (13). The plant is stemless, low creeping, and has a crown from which the leaves and fruit originate. The leaves are usually trifoliate and usually help protect the fruit from soil and sun damage. Runners occur after the fruiting season and produce roots and inflorescences at the leaf base.

The strawberry flower cluster is a series of double-branching parts bearing a blossom in the crotch of each branch. The flower in the first crotch is termed the primary flower, the two in the next two crotches are termed secondary flowers. The next four are tertiary flowers and the next eight are the quartenary, and next sixteen, if they develop, are the quintary flowers.

The most important climactic factors, as far as they affect the strawberry plant, are those of temperature and daily light period (13). In the winter and early spring, if the temperature inside the cultivated strawberry plant reaches 16°F, injury may occur, with the killing point at 10°F. With a rise in temperature above 32°F, plant functions increase rapidly.

Different cultivars of all species of strawberries react differently to photo periods. Fall-bearing types are long-day plants that form fruit buds under long days of summer in northern regions (32). The more common types are the short-day plants that form the flower buds when the days become short and the temperature mild. This latter type, often referred to as "June" or "spring" bearing, is the type most adapted to Oklahoma production.

The strawberry is not a true fruit. The aggregate fruit of the strawberry is made up of the conical receptacle of the flower that supports numerous pistils, each with one carpel from which the true botanical fruits or achenes, as they are termed, are formed. These multiple achenes make up the berry that we eat. When the achene contains a fertilized seed it stimulates growth of that part of the receptacle. If several achenes do not set seed, that part of the receptacle may be deformed (27,28). Improperly shaped berries are termed nubbins.

Commercial strawberry beds are usually abandoned after one to three years as a result of either disease or serious weed infestation (24). Appropriate use of herbicides can considerably extend the production life of many plantings, especially as more effective disease resistance and control methods become available. Varieties may vary considerably in their tolerance to herbicides, emphasizing the need for research to establish tolerance levels as new varieties are developed and recommended.

Currently only a few herbicides are registered for use in newly planted strawberries. There are also limitations on the weed species controlled by these chemicals. The results then may not be as effective as a commercial grower desires. The need for minimizing the weed problem through the use of chemical treatment is rapidly increasing. In the long run herbicides will save many hours of hand cultivation and help produce a higher quality and higher yielding crop.

The value of substitution of chemical methods of weed control for conventional manual methods as a production procedure for strawberries has not been fully determined. This study will help try to accomplish a part of the continuing weed control investigation. With the development of new and better herbicides, continual studies are needed to compare these new products with standardly used chemicals.

The purpose of this study was to determine the effectiveness of selected preemergence and postemergence herbicides on weed control in first year establishment of 'Cardinal' strawberries. The 'Cardinal' strawberry was chosen for this study because of its popularity and widespread use among Oklahoma growers.

Objectives

The objectives of this study were to evaluate the effectiveness of herbicides as to:

1. Weed species controlled.
2. Overall effectiveness of weed control.
3. Effect the herbicides and weed growth had on runner formation.
4. To determine herbicide phytotoxicity to the 'Cardinal' strawberry plant and runners.

CHAPTER II

LITERATURE REVIEW

History

Antoine Nicholas Duchesne in 1766, at the age of 19, completed the first conclusive treatise on the genus Fragaria, the strawberry. In it he described 10 major species of strawberries. The origin of the modern cultivated strawberry, Fragaria x ananassa Duch., was also described in his work. This variety was named for its flavor resemblance to the pineapple (Ananas comosus). It was found that F. ananassa Duch. was a cross between F. chiloensis (the Chilean strawberry) and F. virginiana (the scarlet or Virginia strawberry) (33).

The genus Fragaria is credited to Linnaeus (4). L. H. Bailey (4), in his Manual of Cultivated Plants, describes the genus Fragaria as a low growing perennial herb in the Western Hemisphere in high regions of the tropics. Plants are stemless but make long runners. Flowers are borne on radical peduncles or scapes, these flowers are white or reddish in raceme-like clusters, sometimes nearly or quite unisexual. The Latin word Fragaria means fragrance from the odor of the fruit (4).

Effect of Cultural Practice on Strawberry Stand Establishment

It has been found that many cultural practices help in the establishment and production of strawberry stands (8, 10, 18, 26, 32, 33).

Runner formation represents the vegetative phase of reproduction (4, 8, 26). Since these runners form the next season's fruiting plants it is important to maximize runner formation (4, 8).

Shoemaker (32) points out that first season flower removal from newly set plants has shown to be beneficial in stand establishment. This may be a remedy preventing a severe drain on the plant vitality from untimely fruiting, aids in toleration of heat and drought, and increases runner formation (32). Other studies have indicated that flower removal helps to increase first year runner formation (7, 26).

Choma (11) found that blossom removal in strawberries decreased net photosynthesis while dark respiration was not affected. Inflorescence removal in strawberry plants increased leaf production rate, total leaf area and numbers of runners (11, 22, 24, 26, 31).

Fertility is shown to play a major part in runner formation (8, 10, 22, 32). Carlson (8) found that stable manure alone, at the rate of 32 tons per acre, gave an increase in the number of runners formed during the growth season. Irrigation or proper soil moisture plays another major part in plant establishment (7, 8, 10, 32). It has been shown that one inch of water should be applied or enough water to wet the soil to the 12 inch depth when the soil becomes dry. This should be done during the dry season, about once a week to once every two weeks (8, 10, 32).

Effect of Weeds on Plant Growth

Weeds are a problem to many types of plants (4, 5, 8, 20, 27, 24, 34, 38). Weeds have shown to compete with crops for light, water, space and nutrients (10, 17, 24, 32, 34, 38). In strawberries weed competition has been shown to decrease runner formation (2, 9, 18, 32).

Weed competition was first described in early religious writings (the Bible). Two passages have been found. Genesis 3:17,18 states, "Cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life; thorns and thistles shall it bring forth to thee; and thou shalt eat of the herb of the field." Another passage, Matthew 13:7, notes that "Some fell among thorns; and the thorns sprang up, and choked them."(38).

Darwin regarded competition between plants as only one of the components of the struggle for existence, but possibly the most important one (38). Brenchley in conducting studies of various weeds in cultivated crops, observed that some weeds were found in association with some crops and other species were found in relation to cultivated crops. She hypothesized that factors determining the abundance and scarcity of weeds in a crop was its ability to withstand competition (38).

Zimdahl says weed density can be expressed in a curvilinear relationship when expressed as crop yield over weed density. This is to say a few weeds may not affect crop yield but many weeds will start to decrease crop yields and when maximum weed density is reached crop yield can be zero (38).

The Farm Chemicals Handbook (15) defines a weed as "any plant which grows where not wanted." Weed Science (24) defines a weed as a plant growing where it is not desired or a plant out of place. Weeds encompass all types of undesirable plants. Trees, broadleafed plants, grasses, sedges, rushes, aquatic plants and parasitic flowering plants (dodder, mistletoe, witchweed) are considered weeds at some time.

Studies have shown that the cultivated layer of soil in fields usually contains large quantities of viable seeds of many annual weeds (24, 29, 38). Roberts (29) found viable seeds ranging from 1,270 to $65{,}580/m^2$ in soil 10 cm deep. The median was $9{,}500/m^2$, 10 cm deep. In Minnesota, 98 to 3,068 viable weed seeds/Ft^2 of soil six inches deep were reported (24).

Some weed seeds can live for many years while some will only stay viable for a few weeks or less (24). Seeds can germinate from many depths including up to six to eight inches deep (24, 29).

Seeds of redroot pigweed, prostrate pigweed and evening primrose have shown to live and still be viable after 40 years (24).

Weed Control in Strawberries

Cultivation soon after plants are set and at frequent intervals thereafter helps to control weeds and conserve moisture. Hoeing during the strawberry runner formation will help encourage runner rooting.

Childers (10) states that hand weeding and machine cultivation of strawberries are expensive.

Ahrens (2) reported that 183 hours per acre per weeding was required in strawberry production. Shoemaker suggests that at least seven hoeings per season may be needed (32). Childers in 1976 reported that a cost of \$100-\$500 per acre can be added to the cost of production (10).

Herbicides can be used in strawberry production to help control weeds (7, 10, 17, 19). Hughes (19) suggests that with the use of herbicides, less cultivation can be expected, less weed growth, thus more moisture conservation, and less damage to roots, plants and runners, due to less cultivation, ~~can~~ also be expected. This may help strawberries yield better.

Herbicides

The commercial grower has rapidly grasped the value of herbicides (19). Ahrens 1982 (2) found that in strawberries, herbicides have been shown to reduce weeding time by 96 to 99 percent. The number of herbicides registered for weed control in strawberries is very limited (3, 17).

Ahrens 1980 (3) found that oxadiazon and oryzalin injured or reduced yields while napropamide gave only slight injury. Agamalian (1) found that napropamide and diphenamid did not affect growth or yield on strawberries in a weed free environment. Beste, et al. (6) reported that napropamide was injurious to strawberry plants when applied from planting until about ten weeks after planting. Weller (37) reported no injury with napropamide applied immediately after planting fifteen strawberry cultivars in a higher organic matter soil.

Schubert (30) found that in West Virginia with 'Midway' strawberries that diphenamid gave adequate control of weeds, did not affect yield but did not control common ragweed, black nightshade and ladiesthumb. Lay (25) found that diphenamid in combinations with other herbicides gave better control in transplanted strawberries than diphenamid alone. Walker (36) found that diphenamid at 4 lbs. A.I/acre gave excellent control of annual grasses but poor control of certain annual broadleaf weeds in sweet potatoes.

The mode of action of diphenamid appears to let seeds germinate, but kills the seedling plant before it emerges from the soil. In established plants diphenamid translocates to the top of the plant accumulating in the leaves. Studies with tomatoes and strawberries that diphenamid is metabolized in higher plants yielding N-methyl -2,2 diphenamid as a major metabolite. In studies it appears that diphenamid inhibits the uptake of inorganic ions by roots and influences the distribution of calcium within the plant (24).

Studies have shown napropamide inhibits the growth and development of the roots of grassy weeds and grass seedlings. In established plants napropamide is rapidly metabolized to water-soluable metabolites (24).

Jachetta (20) found that napropamide controlled redroot pigweed better than prostrate pigweed. Ahrens 1980 (20) found that crabgrass, red stem filaree, lambsquarters and purslane control was better with napropamide than with diphenamid. He also noted that napropamide did not affect strawberry vigor as much as diphenamide did. Bailey (5) found oxadiazon gave good control of common groundsel but gave poor control of common chickweed in container plant production.

Kennedy (23) found that under field conditions oryzalin is the least affected dinitroaniline herbicide when left for two days on the soil surface before incorporation. Jacques (21) states that evidence indicates that organic surfaces are responsible for most dinitroaniline adsorption to soil. The dinitroaniline herbicides have low solubility in water, are relatively non-polar, and with the exception of oryzalin, are essentially non-ionic. Adsorption/desorption of herbicides in soil is a physicochemical process which controls the quantity of herbicides in the soil solution and thus its biological activity, mobility in soil water, and volatility. Jacques (21) in his work found that oryzalin is the least adsorbed or diffused in the soil out of the dinitroaniline herbicides.

In studies with trifluralin dinitroaniline herbicide like oryzalin studies have shown the chemical inhibits growth of roots. Characteristically, the root increases in diameter or swells in the active meristematic region near the root tip. Lateral or secondary root development is also inhibited. Trifluralin disrupts cell division causing multinucleate cells or polyploids and probably prevents microtubule development. Trifluralin seems to be absorbed by the grass shoot as it passes through the treated soil. Some root absorbtion may also occur. No significant translocation of trifluralin into the stems, leaves or crop seeds has been found.

Kennedy (23) found that under field conditions oryzalin can be successfully used as a preemergence control without incorporation but adequate water-in gave better herbicidal activity.

Corbin (12) states that organic matter and pH have been shown to be among the soil properties highly and positively correlated with herbicide toxicity. Eshel (14) notes that organic matter content of the soil appears to be the most consistent factor affecting the herbicide movement because of its high capacity to inactivate herbicides in the soil.

CHAPTER III

METHODS AND MATERIALS

A study to determine the effectiveness of selected herbicides on weed control in 'Cardinal' strawberry (Fragaria ananassa) was conducted during the 1983 growing season at two locations. One study was located at the Perkins Fruit Research station in Central Oklahoma on a Tellar loam soil. This soil has 46.1% sand, 40.7% silt, 13.2% clay and 1.07% O. M. The other study was located at the Bixby Vegetable Research station in Northeastern Oklahoma on a Severn very fine sandy loam soil. This soil has 65% sand, 24.2% silt, 10% clay and .8% O. M. A randomized complete block design was used with each treatment replicated five times at Perkins and four times at Bixby.

In the fall of 1982, the soil was disked, harrowed and subsoiled according to recommended practices. In the late winter of 1983 prior to planting the soil was again plowed and diazinon granulars were applied at 2.242 kg/ha for control of soil insects. A complete analysis fertilizer (12-12-12) was applied at 336.3 kg/ha for the summer fertility requirement. Rows were bedded and prepared about one week before planting.

Plant Stand Establishment

Healthy dormant plants were set on March 23, 1983 at Perkins in rows 1.2 meters apart and 46 cm between plants and on April 13, 1983 at

Bixby in rows with spacing 1.5 meters between rows and 46 cm within the row. The plants were watered with a starter solution of Peters 20-20-20 fertilizer mixed at .45 kg per 378.5 liters of water. 236.6 cc of this solution was then poured around the base of each plant. Supplemental water was then supplied to the plants throughout the summer to supply at least 2.5 cm of water per week.

Flowers were removed from the plants at both locations during the flowering period. This is a cultural practice aimed at increasing total runner count per plant (11, 12, 32). A list of herbicides used are listed in Table I and the treatment rates listed in Table II. A weedy control was used for a reference to how plants would perform without any weed control and for a check of weed species at the location. A clean control with no herbicides applied was kept by hoeing. This hoeing was once every two weeks to keep the plot clean of all weed growth.

Herbicide Application

The preemergence chemical treatments were applied within two days after the plants were set. Applications were made with a CO_2 compressed air tank sprayer, with a .914 meter wide 2 nozzle boom held one meter high off the ground. The granular oxadiazon was applied uniformly using a specially prepared hand applicator. Complete and even coverage was obtained. No weeds were present at this time.

The postemergence products were applied using the same CO_2 sprayer. Sethoxydim and fluozifop-butyl were applied at two separate times, and two separate rates each. Acifluorfen was applied at two treatment rates. The early June applications of sethoxydim and fluozifop-butyl were applied at Bixby on June 8, 1983 and the higher

TABLE I

CHEMICALS USED

Trade Name	Common Chemical Name	Chemical Name
Devrinol WP	napropamide	2-(a-napthoxy)- N,N-diethylpropionamide
Enide WP	diphenamid	N,N-dimethyl1-2,2- diphenylacetamide
Ronstar G	oxadiazon	2-tert--butyl-4-(2,4$_2$dich loro-5-isopropoxyphenyl1)-4^2 -1,3,4-oxydiazolin-5-one
Surflan WP	oryzalin	3,5-dinitro-N^4- dipropyl- sulfanilamide
Poast EC	sethoxydim	2-[1-(ethoxyimino)-buty]-3 hydroxy-2-cyclohexen-1-one
Fusilade EC	fluozifop-butyl	butyl 2-[4-(5-trifluormethyl -2-pyridinyloxy) phenoxy] proponate
Blazer	acifluorfen	sodium 5-[2-chloro-4- (trifluoromethyl)-phenoxy] -2-nitrobenzoate

TABLE II

TREATMENTS AND RATES USED

Product	Rate
	Preemergence at Bixby and Perkins
Devrinol	4.484 kg ai/ha
Enide	6.726 kg ai/ha
Ronstar 1X	.56 kg ai/ha
Ronstar 2X	1.121 kg ai/ha
Surflan	2.242 kg ai/ha
	Postemergence at Bixby
Poast Early June application	1 l/ha
Post Mid-June application	1.75 l/ha
Fusilade Early June application	.56 kg ai/ha
Fusilade Mids-June application	1.121 kg ai/ha
Blazer 1X	1.121 kg ai/ha
Blazer 2X	2.242 kg ai/ha
	Controls at Bixby and Perkins
Weedy Control	
Clean Control	

rates applied at mid-June on June 14, 1983. The grassy weeds were about 3-5 inches tall for the first application and about 8-12 inches tall for the later application. Acifluorfin was applied June 21, 1983. The broadleaf weeds, mainly pigweeds and lambsquarters, were approximately 8-18 tall at the time of application of acifluorfin. Ortho 77 crop oil was mixed in the tank to obtain 2% oil to total volume of liquid in the tank with the postemergence products.

One inch of rain was received within two days after the preemergence products were applied. No overhead water was given to the area for five days after the postemergence treatments were applied.

Data Collection

Data was collected periodically from May 25 to July 20. All later reference to data collected will be listed in a numerical sequence according to corresponding dates on which data was collected. Dates on which data was collected are as follows:

Perkins Trial	Bixby Trial
Date 1 - May 25	Date 1 - May 27
Date 2 - June 15	Date 2 - June 14
Date 3 - June 24	Date 3 - June 28
Date 4 - July 7	Date 4 - July 8
Date 5 - July 20	Date 5 - July 18

Data collection included:

1. Percent weed control by species in which the species of weeds in the area were identified and each plot was then observed. Each species of weed was rated on a percent scale, 1-100 as to percent control given by the chemical, 100% being complete control, or no weeds present.

2. This same percent scale was used for a general weed control category. This was the percent effectiveness of the chemical overall.

This was a general assessment of how effective the herbicide was relative to weed control in that area expressed as a percent.

3. Runner counts were also taken. This was done by counting into each replication three plants, then counting the number of runners on the next seven plants. This was not always possible because in some treatments many plants died so runners were counted on as many plants that remained up to seven.

4. Strawberry plant phytotoxicity was also recorded. This was on a scale of 0-3. 0 was no symptoms, 1--slight injury, 2--major damage with leaf loss, stunting and runner loss, and 3--plant death. General notes about plant vigor and growth were also made.

5. Hoeing times for the clean control treatments were recorded each time hoed. At the end of the experiment all plots were hoed and the time it took was recorded. This was an indication of the labor involved to keep the weeds out of the clean control and also the time involved in hoeing out weeds at the end of a season if an herbicide is used. This time was also an indication of plant runners and also weed density.

6. For the postemergence applications a general grass kill and a general broadleaf kill category were used. This was a percent effectiveness rating for overall control of the grass or broadleaf growth. Many species of weeds were found, both grassy and broadleafed weeds. A list of weeds present at each location is included in Appendix A.

All data collected was analyzed using the general linear models procedure and the Duncan's Multiple Range Test was used to identify pairs of means which were statistically different to each other at the .05 level.

CHAPTER IV

RESULTS AND DISCUSSION

During the course of the study all the weed species were identified at Perkins and Bixby. The results and discussion presented in this chapter are limited to those weed species considered as major problem weeds to the establishment of strawberry plantings in local areas. A complete analysis of the data for all treatments and all weed species at both locations is contained in Appendix B.

Perkins Location

Tables III and IV show the overall effectiveness of each herbicide at Perkins, as to the general percent control of weeds. This is an overall rating and is not species specific. The final date 5 is of the greatest importance, since this date is at the end of the study and is an indication of the overall length of herbicide effectiveness.

Oxadiazon, at either rate was not statistically different from each other but did not perform as well as did the other herbicide treatments. Oxadiazon gave better early season control but broke down rapidly and allowed considerable grassy weed growth to enter. Napropanide, diphenamid and oryzalin by dates 4 and 5 appeared to give good control upon observation, but no statistical difference can be noted between them. The control was still close to 90% which can be considered good weed control as shown on dates 4 and 5.

TABLE III

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT OF OVERALL WEED CONTROL, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropramide	97.6A	93.6B	95.4A	95.2A	91.8A
Diphenamid	96.4A	95.0AB	93.0B	90.2A	89.8A
Oxadiazon 1X	96.0A	96.2AB	89.0C	82.6B	71.4B
Oxadiazon 2X	96.4A	95.2AB	88.6C	68.0C	68.0B
Oryzalin	98.0A	97.8A	96.0A	92.6A	88.6A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE IV

LENGTH OF PREEMERGENCE HERBICIDE EFFECTIVENESS FOLLOWING APPLICATION DATE EXPRESSED AS PERCENT OF OVERALL WEED CONTROL, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	97.6A	93.6CB	95.4AB	95.2AB	91.8C
Diphenamid	96.4A	95.0A	93.0AB	90.2B	89.8B
Oxadiazon 1X	96.0A	95.0A	93.0AB	90.2B	89.8B
Oxadiazon 2X	96.4A	95.2A	88.6A	68.0B	68.0B
Oryzalin	98.0A	97.8A	96.0A	92.6B	88.6C

Means within rows of each treatment with the same letter(s) are not significantly different at the .05 level.

The length of effectiveness of the preemergence herbicides is shown in Table IV. The length of effectiveness of both rates of oxadiazon was poor shown by good control (96.0%) at dates 1 and 2 but by date 5 had little residual effectiveness with only 82.0% and 68.0% control. Napropamide, diphemanid and oryzalin are slower to break down and therefore more persistent in the soil showing a control of 91.8%, 89.8% and 88.6% respectively at the end of the study.

Tables V, VI and VII show the effect of herbicides on controlling dallisgrass, crabgrass, and barnyardgrass at Perkins. The herbicides used were fairly specific as to their effectiveness in controlling either grassy weeds or broadleaf weeds. Oxadiazon was the least effective at controlling the grassy weeds and especially by the last two dates of data collection. Barnyardgrass, dallisgrass, and crabgrass were all controlled more effectively with napropamide, diphenamid and oryzalin. There was no statistical difference between these compounds by the last two dates of data collection, however, all were significantly more effective than both rates of Ronstar as shown (Tables V, VI, VII).

Henbit control had varied results as to the effectiveness of each herbicide. Henbit is a cool season annual weed that appeared early in the study and by the third date of data collection had died as a result of high temperatures. All the herbicides except napropamide were effective at controlling henbit. Napropamide gave little control of henbit early with only 67.6% control but as the summer temperature increased, henbit died shown by the absence of data after date 2 in Table VIII.

There was no significant difference in the control of lambsquarters with any treatments except napropamide on the final 2 dates as shown on

TABLE V

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF DALLISGRASS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	99.6A	98.2A	94.2A	97.8A	97.4A
Diphenamid	96.2AB	94.6A	94.4A	94.6A	94.2A
Oxadiazon 1X	87.0BC	80.6B	77.6B	85.6B	74.0B
Oxadiazon 2X	77.0C	76.0B	75.0B	74.0C	68.2C
Oryzalin	94.4AB	95.8A	95.6A	95.6A	93.0A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE VI

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF CRABGRASS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	99.6A	99.2A	97.8A	97.8A	97.8A
Diphenamid	98.0AB	98.0A	94.8B	96.6A	94.2A
Oxadiazon 1X	94.0C	94.0B	89.0C	87.6B	74.0B
Oxadiazon 2X	96.8B	93.6B	92.6B	87.0B	68.2C
Oryzalin	97.8AB	98.2A	99.2A	97.4A	93.6A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE VII

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF BARNYARDGRASS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	---	98.2A	99.0A	97.8A	97.8A
Diphenamid	---	967.2A	95.2A	95.2A	95.2A
Oxadiazon 1X	---	80.6B	78.4B	86.6B	86.6B
Oxadiazon 2X	---	75.0B	72.6B	74.0C	74.0C
Oryzalin	---	94.0A	94.6A	95.6A	95.6A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE VIII

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF HENBIT, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Naprapamide	67.6B	84.6B	---	---	---
Diphenamid	92.6A	94.2AB	---	---	---
Oxadiazon 1X	96.0A	95.4AB	---	---	---
Oxadiazon 2X	96.6A	96.6AB	---	---	---
Oryzalin	99.6A	98.6A	---	---	---

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

Table IX. All herbicides gave acceptable control, over 95%, except napropamide which was significantly less by dates 4 and 5. The control by napropamide, however, was still good when compared to the weedy control.

Runner formation other than percent weed control was another important variable in this experiment. An herbicide may be good at controlling weeds but if it is phytotoxic to the strawberry plant or affected runner formation in a detrimental way the herbicide would be inappropriate for the use in first year establishment of strawberries. Table X shows the means for runner counts per seven plants for each treatment. The weedy control had the least number of runners with only 13.0 per seven plants at the last date and there was no statistical increase in runners from date 1 as shown in Table XI. The clean control showed a steady increase in runners as shown in Table XI and had the highest number of runners by date 5 out of all the other treatments with 62.6 runners per seven plants as shown in Tables X and XI. All the herbicide treatments showed varying degrees of effect on runner formation. Napropamide and diphenamid had the least effect on preventing runner formation while oxadiazon appeared to be the most harmful.

As was previously stated if the treatment did harm or was phytotoxic to the strawberry plant it could possibly be considered nonsuitable for use in the first year establishment of strawberries. Tables XII and XIII show that diphenamid no observed phytotoxicity effect on the plants. Napropamide gave early signs of phytotoxicity but by the fourth and fifth dates the phytotoxic symptoms not apparent. This was not statistically different however from the earlier dates as shown on Table XIII. The weedy control, after date 2 began to show some

TABLE IX

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF LAMBSQUARTERS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	97.2A	95.6A	99.6A	90.4B	90.4B
Diphenamid	97.2A	99.0A	97.2A	96.6A	96.6A
Oxadiazon 1X	99.0A	98.0A	92.2A	97.6A	97.6A
Oxadiazon 2X	97.0A	99.0A	99.0A	98.2A	98.2A
Oryzalin	99.2A	98.6A	98.6A	98.6A	98.6A

Means with columns followed by the same letter(s) are not statistically different at the .05 level.

TABLE X

THE EFFECT OF PREEMERGENCE HERBICIDES ON RUNNER DEVELOPMENT EXPRESSED AS MEAN RUNNER COUNTS PER 7 PLANTS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	9.0B	19.2BC	21.6B	32.4BC	41.8B
Diphenamid	9.2B	20.6B	22.4B	35.4B	35.2BC
Oxadiazon 1X	8.2B	15.4CD	18.6BC	26.2BCD	30.0BCD
Oxydiazon 2X	7.4BC	17.2BC	21.8B	21.0CD	25.2CD
Oryzalin	4.2C	10.0E	14.0C	17.0D	21.8CD
Weedy Control	9.0B	12.2DE	15.8C	15.4D	13.0D
Clean Control	13.6A	28.4A	31.0A	63.2A	62.6A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XI

DEVELOPMENT OF RUNNERS BY DATE FOLLOWING HERBICIDE TREATMENTS EXPRESSED AS MEAN RUNNERS PER 7 PLANTS, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	9.0A	19.2C	21.6C	32.4B	41.8A
Diphenamid	9.2B	20.6AB	22.4AB	35.2A	35.4A
Oxadiazon 1X	8.2D	15.4CD	18.6CB	26.2AB	30.0A
Oxadiazon 2X	7.4C	17.2B	21.8AB	21.0B	25.2A
Oryzalin	4.2B	10.0AB	14.0AB	17.0A	21.8A
Weedy Control	9.0A	12.2A	13.8A	15.4A	13.0A
Clean Control	13.6C	28.0B	31.0B	63.2B	62.6A

Means within rows of each treatment with the same letter(s) are not significantly different at the .05 level.

TABLE XII

THE EFFECT OF PREEMERGENCE HERBICIDES ON PLANT PHYTOTOXICITY, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	0.2AB	0.4AB	0.2AB	0.0C	0.0C
Diphenamid	0.0B	0.0B	0.0B	0.0C	0.0C
Oxadiazon 1X	0.6AB	0.8A	0.2AB	0.4BC	0.4BC
Oxadiazon 2X	0.6AB	0.4AB	0.4AB	0.8AB	0.8AB
Oryzalin	0.8A	0.8A	0.8A	1.2A	1.2A
Weedy Control	0.0B	0.0B	0.6AB	0.4BC	0.4BC

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XIII

THE EFFECT OF PREEMERGENCE HERBICIDES ON PLANT PHYTOTOXICITY FOLLOWING DATE OF APPLICATION, PERKINS FRUIT RESEARCH STATION

Treatment	Date				
	1	2	3	4	5
Napropamide	0.2A	0.4A	0.2A	0.0A	0.0A
Diphenamid	0.0A	0.0A	0.0A	0.0A	0.0A
Oxadiazon 1X	0.6A	0.8A	0.2A	0.4A	0.4A
Oxadiazon 2X	0.6A	0.4A	0.4A	0.8A	0.8A
Oryzalin	0.8A	0.8A	0.8A	1.2A	1.2A
Weedy Control	0.0A	0.0A	0.6AB	.4AB	1.0AB

Means within rows of each treatment with the same letter(s) are not significantly different at the .05 level.

damage to the plants due to competition between weeds and the strawberry plants, oryzalin was the most phytotoxic to the plants and showed a statistically significant increase when compared to all treatments except oxadiazon 2X and the weedy control.

Preemergence Control at Bixby

Table XIV shows overall percent effectiveness of all the herbicide treatments by date at Bixby. For overall control the date 5 is of the most importance. This is the final date and helps to indicate total weed growth. Table XV shows the resistance to breakdown or persistence of the herbicide in the soil. Oryzalin and napropamide appeared to be the most effective herbicides for general weed control (Table XIV) with 90.25% and 95% control respectively by date 5. As shown in Table XV napropamide was the least effective on date 1 with only 50% general control mainly due to its lack of ability to control henbit. However, later when the henbit died because of high temperature good general control of other weeds was noted. Diphenamid was the second effective herbicide showing a 70% control of weeds by date 5. Oxadiazon at both rates was least effective with only 47% and 49% control of weeds neither being statistically different from each other shown on Table XIV.

Goosegrass and crabgrass control was similar with each of the herbicides. Table XVI shows goosegrass control and Table XVII shows crabgrass control. Goosegrass, a late season grass, appears later in June. Napropanide and oryzalin showed significantly better control of these two grasses than the other treatments with diphenamide being the third most effective treatment. Oxadiazon showed the least percent control with under 50% control for both of these species and there was no

TABLE XIV

EFFECT OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON PERCENT OF OVERALL WEED CONTROL, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	50.0B	98.5AB	93.2AB	90.2AB	90.2AB
Diphenamid	97.7A	96.7BC	87.7B	83.0ABC	70.7C
Oxadiazon 1X	97.5A	99.0A	77.0C	72.7CDE	47.5DE
Oxadiazon 2X	98.0A	96.0C	74.5C	70.0CDE	49.2DE
Oryzalin	100.0A	99.5A	98.0A	96.5A	95.2A
Sethoxydim E. J.	---	---	50.0DE	43.7F	75.7BC
Sethoxydim M. J.	---	---	42.5EF	61.7D	88.2AB
Fluozifop-butyl E. J.	---	---	53.7D	64.0E	60.0CD
Fluozifop-butyl M. J.	---	---	37.5F	58.7E	73.7BC
Acifluorfen 1X	---	---	---	66.2DE	42.5E
Acifluorfen 2X	---	---	---	80.0BCD	73.7BC

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XV

LENGTH OF EFFECTIVENESS OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES FOLLOWING DATES EXPRESSED AS PERCENT OF OVERALL WEED CONTROL, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	50.0C	98.5A	93.2B	90.2B	90.2B
Diphenamid	97.7A	96.7A	87.7AB	83.0B	70.7C
Oxadiazon 1X	97.5A	99.0A	77.0B	72.7B	47.5C
Oxadiazon 2X	98.0A	96.0A	74.5B	70.0B	49.2C
Oryzalin	100.0A	99.5A	98.0AB	96.5BC	95.2C
Sethoxydim E. J.	---	---	50.0B	43.7B	75.7A
Sethoxydim M. J.	---	---	42.5C	61.7B	88.2A
Fluozifop-butyl E. J.	---	---	53.7A	64.0A	60.0A
Fluozifop-butyl M. J.	---	---	37.5B	58.7A	73.7A
Acifluorfen 1X	---	---	---	66.2A	42.5B
Acifluorfen 2X	---	---	---	80.0A	73.7A

Means within rows across with same letter(s) are not significantly different at the .05 level.

TABLE XVI

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF GOOSEGRASS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	---	---	98.0A	97.2AB	87.0A
Diphenamid	---	---	85.2B	82.0BC	72.5B
Oxadiazon 1X	---	---	87.5B	81.2BC	50.0C
Ozadiazon 2X	---	---	78.5B	75.0(B)	48.7C
Oryzalin	---	---	99.5A	99.5A	98.0A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XVII

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF CRABGRASS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	100.0A	99.0A	95.5A	94.5A	87.0A
Diphenamid	98.2A	90.0B	79.5B	73.7B	70.0B
Oxadiazon 1X	94.5B	93.2B	78.2B	72.5B	41.2C
Oxadiazon 2X	97.7A	93.2B	76.0B	72.5B	38.2C
Oryzalin	100.0A	100.0	99.5A	99.5A	98.0A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

difference between the two different rates used, but was significantly less than all other treatments.

Broadleaf signalgrass was another grass that appeared later in June as did goosegrass. Oryzalin and napropanide gave the best control with 95.5% and 85.5% control respectively as shown on date 5, Table XVIII. Diphenamid's control was similar to that of napropamide and both rates of oxadiazon. Oxadiazon at both rates and diphenamid all appeared to have no significant difference in control of this species.

Henbit was a major early season weed problem at Bixby as well as at Perkins. Napropamide was the least effective in control of henbit with only 21.75% control shown on date 1 (Table XIX) but by date 2 gave better control (82.5%), statistically comparable to that of diphenamid. Oryzalin and both rates of oxadiazon gave the best control of henbit with no statistical difference between either of these treatments.

Oryzalin and either rate of oxadiazon was significantly more effective in controlling lambsquarters than any of the other treatments with 100% control as shown in Table XX. Napropamide and diphenamid also showed acceptable control, however at 94% or 95% effectiveness by the end of the study.

All treatments were effective in controlling redroot pigweed except diphenamid as shown in Table XXI. Diphenamid, with 89% control was significantly less effective than all other treatments.

Oryzalin, either rate of oxadiazon and napropamide gave the best season long control with 100% effectiveness for primrose. Although diphenamid was least effective there was no significant difference with napropamide by date 5, Table XXII.

Mean runner count shows the clean control as having statistically

TABLE XVIII

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF BROADLEAF SIGNALGRASS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	---	---	95.5AB	92.5AB	85.5AB
Diphenamid	---	---	82.5C	77.5BC	68.7CB
Oxadiazon 1X	---	---	86.0CB	77.5BC	61.2C
Oxadiazon 2X	---	---	77.0C	73.7C	62.5C
Oryzalin	---	---	99.0A	97.7A	95.5A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XIX

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF HENBIT, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	21.7C	82.5B	---	---	---
Diphenamid	86.5B	83.7B	---	---	---
Oxadiazon 1X	96.0A	97.2A	---	---	---
Oxadiazon 2X	95.2A	96.5A	---	---	---
Oryzalin	100.0A	100.0A	---	---	---

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XX

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF LAMBSQUARTERS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	99.0B	97.5B	96.5B	95.0B	94.0B
Diphenamid	100.0A	100.0A	99.0A	98.7B	95.7B
Oxadiazon 1X	100.0A	100.0A	100.0A	100.0A	100.0A
Oxadiazon 2X	100.0A	100.0A	100.0A	100.0A	100.0A
Oryzalin	100.0A	100.0A	100.0A	100.0A	100.0A

Means within columns with the same letter(s) are not significantly different at the .05 level.

TABLE XXI

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF REDROOT PIGWEED, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	98.7A	100.0A	99.0AB	98.5A	98.7A
Diphenamid	99.5A	99.0B	94.7B	91.2B	89.0B
Oxadiazon 1X	100.0A	100.0A	100.0A	100.0A	100.0A
Oxadiazon 2X	100.0A	100.0A	99.5A	99.5A	100.0A
Oryzalin	100.0A	100.0	100.0A	100.0A	100.0A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XXII

EFFECT OF PREEMERGENCE HERBICIDES ON PERCENT CONTROL OF PRIMROSE, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	100.0A	99.5A	100.0A	100.0A	96.2AB
Diphenamid	98.2A	100.0A	96.0B	95.0B	94.0B
Oxadiazon 1X	100.0A	100.0A	100.0A	100.0A	100.0A
Oxadiazon 2X	100.0	100.0A	10.00A	100.0A	100.0A
Oryzalin	97.5A	100.0A	100.0A	100.0A	100.0A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

the most runners per seven plants shown date 5, Table XXIII, with 68 runners per seven plants. The weedy control had the fewest number of runners, date 5, with only 19.25 per seven plants, this statistically is the same as the postemergence treatments and the oxadiazon 1X and diphenamid preemergence treatments. Oxadiazon and diphenamid are shown to have statistically the fewest number of runners, date 5, out of the preemergence treatments.

Oxadiazon 1X shows decrease of runners (44.5 to 27.25) from date 4 to date 5, Table XXIV. This is probably due to competition with the strawberry plants from the grassy weed growth that occurred at this time, due to the poor performance and breakdown of oxadiazon.

Table XXVI shows the amount of the herbicide phytotocity with oryzalin increased within weeks after the application was made. Plant death and slow-growing plants were common. Once the runners began to form, however, they were equal the runners per plant (with about 10) to that of the clean control. The overall runner count per seven plants (Table XXIII) shows fewer runners than the control. This is a result of less than seven plants to count runners on in each treatment rep of oryzalin due to plant death.

Oryzalin, all the postemergence treatments, and the weedy control treatment were all harmful to the plants or showed herbicide phytotoxicity to the strawberry plants by date 5 shown on Table XXV. All preemergence herbicides showed phytotoxicity signs during the first few weeks after application except diphenamid, however with napropamide and both rates of oxadiazon, the plants recovered from the initial herbicide phytotoxicity, as shown in Table XXVI.

TABLE XXIII

EFFECT OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON RUNNER DEVELOPMENT EXPRESSED AS MEAN RUNNERS PER 7 PLANTS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	9.7B	26.7B	37.0B	45.5B	46.0B
Diphenamid	4.2B	18.2B	27.0BC	33.2BC	30.7BCD
Oxadiazon 1X	5.5B	25.7B	36.2BC	44.5BC	27.2CD
Oxadiazon 2X	5.7B	23.5B	30.2BC	37.7B	37.7BC
Oryzalin	6.0B	16.0B	28.0BC	36.0BC	39.2BC
Sethoxydim E. J.	---	---	31.2BC	37.7B	35.2BCD
Sethoxydim M. J.	---	---	22.5CD	29.5BC	29.5BC
Fluozifop-butyl E. J.	---	---	35.2BC	43.5B	34.0BCD
Fluozifop-butyl M. J.	---	---	31.0BC	39.7B	28.7BCD
Acifluorfen 1X	---	---	---	21.0C	28.7BCD
Acifluorfen 2X	---	---	---	34.0BC	22.2CD
Clean Control	18.0A	43.5A	54.5A	73.5A	68.0A
Weedy Control	9.0B	15.0B	13.2D	20.2C	19.2A

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

TABLE XXIV

DEVELOPMENT OF RUNNERS BY DATES FOLLOWING HERBICIDE TREATMENTS EXPRESSED AS MEAN RUNNER COUNTS PER 7 PLANTS, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	9.7B	26.7AB	37.0AB	25.5AB	46.0A
Diphenamid	4.2C	18.2B	27.0AB	33.2A	30.7AB
Oxadiazon 1X	5.5D	25.7C	36.2B	44.5A	27.2C
Oxadiazon 2X	5.7C	23.5B	30.2AB	37.7A	37.7A
Oryzalin	6.0C	16.0BC	28.0AB	36.0A	39.2A
Sethoxydim E. J.	---	---	31.2A	37.7A	35.2A
Sethoxydim M. J.	---	---	22.2A	29.5A	29.5A
Fluozifop-butyl E. J.	---	---	35.2A	43.5A	34.0A
Fluozifop-butyl M. J.	---	---	31.0B	39.7A	28.2A
Acifluoren 1X	---	---	---	21.0A	28.7A
Aciflurен 2X	---	---	53.0A	34.0B	22.2C
Weedy Control	9.0B	15.0AB	13.2AB	20.2AB	19.2
Clean Control	18.0D	43.5C	54.5B	68.0A	73.5A

Means within rows across with same letter(s) are not significantly different at the .05 level.

TABLE XXV

EFFECT OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON PLANT PHYTOTOXICITY, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	0.0B	0.0B	0.0B	0.0B	0.0B
Diphenamid	0.5AB	0.7B	0.0C	0.0B	0.0B
Oxadiazon 1X	1.0A	1.0B	0.5BC	0.0B	0.0B
Oxadiazon 2X	0.7A	2.0B	0.5BC	0.0B	0.0B
Oryzalin	1.2A	2.5A	1.2A	1.7A	1.5A
Sethoxydim E. J.	---	---	0.0C	0.0B	1.0AB
Sethoxydim M. J.	---	---	1.0AB	1.0A	1.25A
Fluozifop-butyl E. J.	---	---	1.5A	1.5A	1.2A
Fluozifop-butyl M. J.	---	---	1.2A	1.5A	1.2A
Acifluorfen 1X	---	---	---	1.2A	1.0AB
Acifluorfen 2X	---	---	---	1.5A	1.5A
Weedy Control	0.0B	1.0AB	1.0AB	1.7A	1.5A

0 = None　　2 = Burn and Foliage Die Back
1 = Slight Burn　　3 = Major Damage and Plant Death

Means within columns followed by different letter(s) are significantly different at the .05 level.

TABLE XXVI

EFFECT OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES ON PLANT PHYTOTOXICITY FOLLOWING DATES OF APPLICATION, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Date				
	1	2	3	4	5
Napropamide	0.5A	0.7A	0.0A	0.0A	0.0A
Diphenamid	0.0A	0.0A	0.0A	0.0A	0.0A
Oxadiazon 1X	1.0A	1.0A	0.5B	0.0C	0.0C
Oxadiazon 2X	0.7A	1.0A	0.5B	0.0B	0.0B
Oryzalin	1.25B	2.5A	1.2B	1.7AB	1.5AB
Sethoxydim E. J.	---	---	0.0B	0.0B	1.0A
Sethoxydim M. J.	---	---	1.0A	1.0A	1.5A
Fluozifop-butyl E. J.	---	---	1.5A	1.5A	1.5A
Fluozifop-butyl M. J.	---	---	1.2A	1.5A	1.2A
Acifluorfen 1X	---	---	---	1.2A	1.0A
Acifluorfen 2X	---	---	1.0A	1.5A	2.0A
Weedy Control	0.0A	1.0A	1.0A	1.7A	1.5A

Means within rows of each treatment with the same letter(s) are not significantly different at the .05 level.

Postemergence Control at Bixby

Acifluorfen at 1.11 kg/ha gave the least percent effectiveness to general weed control of the postemergence treatments (Table XXIV). Sethoxydim at 1.75 l/ha as a mid-June application gave the best general control but was statistically no better than sethoxydim applied in early June at 1.46l/ha, fluozifop-butyl at 1.121 kg/ha when applied in mid-June and the acifluorfen 2X rate application. Table XV shows that Blazer 1X, at the lowest rate by date 4 of data collection, had good control but this control decreased by date 5. This decrease in activity is mainly due to when first sprayed, the weeds showed signs of death but because of the lower rate used and a slightly later spray the weeds recovered and did not die. This may have been due to the weeds being large at the time and more resistant to the herbicide.

General control and the percent effectiveness of the postemergence herbicides are shown as general percent control of grassy weeds, and the general percent control of the broadleaf weeds in Table XXVII.

Sethoxydim and fluozifop-butyl gave good control of the grassy weeds but no control of broadleaf weeds as shown in Table XXVII. Acifluorfen gave good control of broadleaf weeds and some control of the grassy weeds with the double rate being statistically more significant than the single rate by date 5, Table XXVII. By date 5, Table XXVII, there is shown no statistical difference between the herbicide treatments except that of acifluorfen 1X and the lower rate early June application of fluozifop-butyl. Acufluorfen, date 5, Table XXVII, shows that the double rate was more effective at killing the broadleaf weeds with 45% control. The lower rate gave fair control on the fourth date but

TABLE XXVII

EFFECT OF POSTEMERGENCE HERBICIDES ON PERCENT OVERALL WEED CONTROL, VEGETABLE RESEARCH STATION, BIXBY

Treatment	% Grass Kill				% Broadleaf Kill		
	2	3	4	5	3	4	5
Sethoxydim E. J.	80.0B	18.0C	17.7C	35.0A	0.0A	0.0A	0.0A
Sethoxydim M. J.	---	33.7B	51.7AB	50.0A	0.0A	0.0A	3.7A
Fluozifop-butyl E. J.	97.2	50.0A	65.5A	17.5A	0.0A	0.0A	1.2A
Fluozifop-butyl M. J.	---	30.0BC	36.2CB	51.2	0.0A	0.0A	2.5A
Acifluorfen 1X	---	---	17.5C	17.5C	---	61.2B	43.7B
Acifluorfen 2X	---	---	35.0CB	45.0CB	---	75.0B	82.5C

Means within columns followed by the same letter(s) are not significantly different at the .05 level.

these effects did not persist to the end of the study.

By date 5, Table XXIII, (page 44) no statistical difference is shown between any of the postemergence herbicides and the weedy control treatments as to mean runners per seven plants. Table XXIV, (page 45) shows that with the use of acifluorfen 2X a statistical decrease (34.0-22.25) in runners was noted from date 4 to date 5, this mainly due to the phytotoxicity of this higher rate. Tables XXV and XXVI show that there was some herbicide phytotototoxicity to the strawberry plants with the use of the postemergence herbicides but that there was no statistical difference between those that were still phytotoxic by date 5, Tables XXVI.

Table XXVIII shows the effect that the herbicides had on the time it takes to remove weeds by hand hoeing at the end of the season. The clean control was hoed once every two weeks for the entire season. This completed hoeing was 907.5 man hours of cumulative time. Based on a minimum wage rate of $3.50 per man hour of labor in 1983 it would cost a grower $3,176.25 to hoe one acre of weeds for one season without the use of herbicides. With the use of herbicides this cost can be considerably reduced. An 85% reduction in hoeing time can be obtained with the use of oryzalin and a cost of only $476.46 per acre. A 72.5% decrease in weeding time can be obtained with the use of napropamide with an average cost of $873.46 per acre at the end of the season. Oryzalin and napropamide were statistically the same in man hours of hoeing shown on Table XXVIII. Napropamide was no better than the early June application of fluozifop-butyl at reducing hoeing times and all the other herbicide treatments were statistically the same and were all better than the weedy control of 685.15 man hours at the end of the season one time over.

TABLE XXVIII

HOEING TIME REQUIRED TO CONTROL WEEDS IN FIRST YEAR STRAWBERRY ESTABLISHMENT EXPRESSED AS MAN HOURS PER ACRE, VEGETABLE RESEARCH STATION, BIXBY

Treatment	Means
Napropamide	249.56CE
Diphenamid	394.76BC
Oxadiazon 1X	449.21B
Oxadiazon 2X	421.99B
Oryzalin	136.13
Sethoxydim E. J.	453.75B
Sethoxydim M. J.	440.14B
Fluozifop-butyl E. J.	285.86CD
Fluozifop-butyl M. J.	476.44B
Acifluorfen 1X	399.30BC
Acifluorfen 2X	381.15BC
Weedy Control	685.16A
Clean Control	907.50 man hours per season

Means with same letter(s) are not significantly different at the .05 level.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the effectiveness of selected preemergence and postemergence herbicides on weed control in first year establishment of 'Cardinal' strawberries. The major objectives highlighted in this study were the effect these herbicides had on: a) weed species controlled; b) overall effectiveness of weed control; c) strawberry plant runner formation; and d) herbicide phytotoxicity to the 'Cardinal' strawberry plant and runners.

Napropamide and diphenamid still continue to be the most acceptable herbicides for first-year establishment of strawberry plants. They allow the plants to grow well and do not affect runner formation severely. They are effective herbicides for controlling grassy weeds but not as effective on a wide species range in broadleaf weeds.

Oxadiazon at either rate appeared to have potential for early season use where broadleaf weeds are a problem. Oxadiazon controlled most of these weeds with a minimum amount of phytotoxicity to the 'Cardinal' variety of strawberry plants.

Oryzalin may have had the greatest potential for broad spectrum weed control. Rates and time of application need to be determined more specifically to reduce the phytotoxic effect of oryzalin to the plants. Oryzalin was the most effective overall control of both grassy and broadleaf weeds. The initiation of runners was delayed but once the plants began runner formation the runners per plant were not significantly less than strawberry plant runner formation with the use of napropamide or diphenamid.

The postemergence herbicides, sethoxydim, fluozifop-butyl and acifluorfen may have potential. Rates used and the specific times of application need to be researched further before recommendations can be made for use of these herbicides. Since two of these postemergence herbicides control primarily grasses and the other one controls primarily broadleaf weeds, mixtures should be considered in future research.

The amount of time required to control weeds mechanically in first-year establishment of strawberries can be significantly reduced with the use of herbicides, resulting in a substantial savings in establishment cost to the producer.

Additional research with herbicides in strawberries needs to be considered.

Additional herbicides that show promise on strawberry establishment need to be researched. Dates and timing of application should be studied very closely. The consideration of combining preemergence materials such as oxadiazon for broadleaf weed control with diphenamid or napropamide for grassy weed control may also be one area of further research.

Further studies need to be conducted with the tank mixing or successive applications of a preemergence product with a postemergence product, the postemergence chemical for cleaning up an area that has become infested with weeds and the preemergence chemical to stop the germination of new weeds.

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APPENDIX A

WEEDS PRESENT AT SITE LOCATIONS

WEEDS PRESENT AT BIXBY

Goosegrass	Eleusine indica L. Gaetn.
Broadleaf Signalgrass	Brachiaria platypylla Grieseb.
Crabgrass	Digitaria sanquinalis L.
Sandburr	Cenchrusincertus M.A. Curtis
Lambsquarters	Chenopodium album L.
Spiney Pigweed	Amaranthus spinosus L.
Horsenettle	Solanum carolinense L.
Buffalobur	Solanum rostratun Dunal
Primrose	Oenothera biennis L.
Puncturevine	Tribulus terrestris L.
Carpetweed	Mollugo verticillata L.
Henbit	Lanium amplexicaule L.
Pepperweed	Lepidium verginicum L.
Spurge	Euphorbia supina Raf
Redroot Pigweed	Amaranthus retroflexux L.

WEEDS PRESENT AT PERKINS

Crabgrass	Digitaria sanquinalis L.
Dallisgrass	Paspalumdilatatum L.
Barnyardgrass	Echinochloa crusgalli L.
Yellow Foxtail	Setavia lutescens Weigel
Lambsquarters	Chenopodium album L.
Henbit	Lanium amplexicaule L.
Pepperweed	Lepidium virginicum L.

Ragweed	*Ambrosia psilostachya* L.
Redroot Pigweed	*Amaranthus retroflexus* L.
Spiney Pigweed	*Amaranthus spinosus* L.
Spurge	*Euphorbia supina* Raf.
Carpetweed	*Mollugo verticillata* L.
Woodsorrel	*Oxalis stricta* L.
Smartweed	*Polygonum pensylvanicum* L.
Horsenettle	*Solanum carolinense* L.
Wild Lettuce	*Lactuca canadensis* L.
Hemp Sesbaine	*Sesbania exaltata* Raf.
Knotweed	*Polygonum aviculase* L.

APPENDIX B

COMPUTER PRINTOUTS

KEY TO COMPUTER PRINTOUTS

Date	Corresponding Data Date
TRT	Treatments
CC	Clean Control
DV	Napropamide
EN	Diphenamid
RA	Oxadiazon 1X
RB	Oxadiazon 2X
SR	Oryzalin
WC	Weedy Control
BA	Acifluorfen 1X
BB	Aciflurfen 2X
FA	Fluozifop-butyl E. J. app.
FB	Fluozifop-butyl M. J. app.
PA	Sethoxydim E. J. app.
PB	Sethoxydim M. J. app.
PLOTNO	Plot Number
CRA	Crabgrass
GOO	Goosegrass
SAN	Sandburr
SIG	Broadleaf Signalgrass
CAR	Carpetweed
HEN	Henbit
HOR	Horsenettle
LAM	Lambsquarters
PEP	Pepperweed
PRI	Primrose
PUN	Puncturevine
RED	Redroot Pigweed
SPI	Spiney Pigweed
SPU	Spurge
GRA	% General Grass Control
PHY	Plant & Runner Phytotoxicity
RUN	Number of Runners per 7 Plants
HOE	Hoeing time in man minutes per plot
BAR	Barnyardgrass
DAL	Dallisgrass
FOX	Foxtail
GRO	Ground Ivy
HEM	Hemp Sesbain
KNO	Knot Weed
LET	Wild Lettuce
RAG	Ragweed

SMA Smartweed
WOO Wood Sorrel

Note: All numbers in body under weeds are expressed as percent control of weeds

COMPUTER PRINTOUTS AT BIXBY

OBS	DATE	TRT	PLOTNO	CRA	GOO	SAN	SIG	CAR	HEN	HOR	LAM	PEP	PRI	PUN	RED	SPI	SPU	GRA	BRO	GEN	PHY	RUN	HOE
1	1	CC	2																		0	17	
2	1	CC	25																		0	17	
3	1	CC	42																		0	15	
4	1	CC	52																		0	23	
5	1	DV	7	100					27		98	100	100	98	97					50	2	0	26
6	1	DV	19	100					25		98	100	100	100	98					50	0	13	32
7	1	DV	23	100					20		100	100	100	100	100					45	0	11	22
8	1	DV	46	100					15		100	100	100	100	100					55	0	15	30
9	1	EN	12	100					80		100	100	98	100	100					98	0	1	44
10	1	EN	20	100					88		100	100	100	100	100					100	0	1	50
11	1	EN	28	98					85		100	100	100	100	100					98	0	4	50
12	1	EN	39	95					93		100	100	95	100	98					95	0	11	30
13	1	RA	10	90					90		100	100	100	100	100					98	1	7	52
14	1	RA	14	98					98		100	100	100	100	100					96	1	4	50
15	1	RA	24	95					98		100	100	100	100	100					98	1	5	40
16	1	RA	35	95					98		100	100	100	100	100					98	1	6	56
17	1	RB	17	98					95		100	100	100	98	100					96	1	5	60
18	1	RB	37	100					98		100	100	100	100	100					100	0	4	41
19	1	RB	43	95					90		100	100	100	98	100					98	1	5	45
20	1	RB	47	98					98		100	100	100	100	100					98	1	9	40
21	1	SR	6	100					100		100	100	100	95	100					100	1	6	20
22	1	SR	38	100					100		100	100	90	100	100					100	1	6	14
23	1	SR	44	100					100		100	100	100	100	100					100	1	7	10
24	1	SR	51	100					100		100	100	100	100	100					100	2	5	16
25	1	WC	27																		1	5	65
26	1	WC	29																		1	11	75
27	1	WC	36																		1	10	72
28	1	WC	41																		1	10	90
29	2	BA	13																				34
30	2	BA	26																				32
31	2	BA	40																				60
32	2	BA	48																				50
33																							
34	2	BB	16																				56
35	2	BB	21																				44
36	2	BB	33																				46
37	2	BB	50																				22
38	2	CC	2																		0	35	
39	2	CC	25																		0	48	
40	2	CC	42																		0	38	
41	2	CC	52																		0	53	
42	2	DV	7	100				100	85		100		100	100	100	98	100			100	0	32	
43	2	DV	19	100				100	85		100		100	100	100	100	100			100	0	32	
44	2	DV	23	98				100	80		95		100	100	100	100	100			98	0	39	
45	2	DV	46	98				100	80		95		98	90	100	98	100			96	3	4	
46	2	EN	12	90				80	85		100		100	85	100	95	100			95	0	11	

COMPUTER PRINTOUTS AT BIXBY (continued)

OBS	DATE	TRT	PLOTNO	CRA	GOO	SAN	SIG	CAR	HEN	HOR	LAM	PEP	PRI	PUN	RED	SPI	SPU	GRA	BRO	GEN	PHY	RUN	HOE
47	2	EN	20	90				95	80		100		100	100	98	90	98			98	0	20	
48	2	EN	28	85				75	80		100		100	90	98	100	100			98	0	14	
49	2	EN	39	95				90	90		100		100	85	100	98	100			96	0	28	
50	2	FA	9	98	98		98											98	0				36
51	2	FA	34	98	98		98											98	0				14
52	2	FA	45	95	95		95											95	0				40
53	2	FA	49	98	98		98											98	0				36
54	2	FB																					50
55	2	FB	3																				60
56	2	FB	4																				40
57	2	FB	30																				60
58	2	PA	5	80	80		80											80	0				44
59	2	PA	15	80	80		80											80	0				50
60	2	PA	31	85	85		85											85	0				46
61	2	PA	32	75	75		75											75	0				60
62	2	PB	8																				50
63	2	PB	9																				50
64	2	PB	18																				42
65	2	PB	22																				52
66	2	RA	10	98				100	98		100		100	100	100	100	100			100	1	23	
67	2	RA	14	90				100	98		100		100	100	100	100	100			98	1	28	
68	2	RA	24	95				100	98		100		100	100	100	100	100			98	1	27	
69	2	RA	35	90				100	95		100		100	100	100	100	100			100	1	25	
70	2	RB	17	90				100	98		100		100	100	100	100	100			96	1	25	
71	2	RB	37	98				100	95		100		100	100	100	100	100			96	1	26	
72	2	RB	43	95				100	98		100		100	100	100	100	100			96	1	17	
73	2	RB	47	90				100	95		100		100	90	100	100	100			96	1	26	
74	2	SR	6	100				100	100		100		100	98	100	100	100			100	2	17	
75	2	SR	38	100				100	100		100		100	100	100	100	100			100	3	14	
76	2	SR	44	100				100	100		100		100	98	100	100	100			98	2	15	
77	2	SR	51	100				100	100		100		100	98	100	100	100			100	3	18	
78	2	WC	27																			12	
79	2	WC	29																			17	
80	2	WC	36																			11	
81	2	WC	41																			20	
82	3	CC	2																		0	60	
83	3	CC	25																		0	48	
84	3	CC	42																		0	50	
85	3	CC	52																		0	60	
86	3	DV	7	96	100	100	98	95		100	97		100	100	98	100				95	0	48	
87	3	DV	19	96	98	98	93	90		100	96		100	95	100	95				93	0	50	
88	3	DV	23	95	96	100	93	90		100	100		100	100	98	98				90	0	40	
89	3	DV	46	94	98	100	98	98		100	93		100	70	100	100				95	0	10	
90	3	EN	12	80	90	100	90	90		100	100		97	100	98	95				90	0	18	
91	3	EN	20	88	86	98	90	95		100	100		96	100	85	95				88	0	40	
92	3	EN	28	75	85	90	80	95		95	96		96	100	98	100				88	0	20	

COMPUTER PRINTOUTS AT BIXBY (continued)

OBS	DATE	TRT	PLOTNO	CRA	GOO	SAN	SIG	CAR	HEN	HOR	LAM	PEP	PRI	PUN	RED	SPI	SPU	GRA	BRO	GEN	PHY	RUN	HOE
93	3	EN	39	75	80	100	70	90		100	100		95	88	98	95				85	0	30	
94	3	FA	9	50	50		50											50	0	55	2	31	
95	3	FA	34	50	50		50											50	0	50	1	40	
96	3	FA	45	30	30		30											30	0	60	1	40	
97	3	FA	49	70	70		70											70	0	50	2	30	
98	3	FB	3	20	20		20											20	0	20	1	31	
99	3	FB	4	35	35		35											35	0	50	2	30	
100	3	FB	11	30	30		30											30	0	45	1	30	
101	3	FB	30	35	35		35											35	0	35	1	33	
102	3	PA	5	15	15		15											15	0	50	0	40	
103	3	PA	15	12	12		12											12	0	50	0	25	
104	3	PA	31	20	20		20											20	0	60	0	30	
105	3	PA	32	25	25		25											25	0	40	0	30	
106	3	PB	1	40	40		40											40	0	30	1	20	
107	3	PB	8	30	30		30											30	0	45	1	20	
108	3	PB	18	30	30		30											30	0	50	1	25	
109	3	PB	22	35	35		35											35	0	45	1	25	
110	3	RA	10	80	95	100	80	100		100	100		100	100	100	100				80	1	35	
111	3	RA	14	78	85	100	96	100		100	100		100	100	100	100				78	0	30	
112	3	RA	24	80	78	100	75	100		100	100		100	100	100	100				75	0	40	
113	3	RA	35	75	92	100	93	100		100	100		100	100	100	100				75	1	40	
114	3	RB	17	78	78	98	78	100		100	100		100	100	100	100				80	1	38	
115	3	RB	37	73	78	100	75	100		100	100		100	100	98	100				70	0	30	
116	3	RB	43	75	78	98	75	100		100	100		100	75	100	100				75	1	20	
117	3	RB	47	78	80	95	80	100		100	100		100	75	100	100				73	0	33	
118	3	SR	6	98	98	100	98	100		100	100		100	100	100	100				98	1	40	
119	3	SR	38	100	100	100	100	100		98	100		100	98	100	100				96	1	14	
120	3	SR	44	100	100	100	98	100		100	100		100	96	100	100				98	2	30	
121	3	SR	51	100	100	100	100	100		100	100		100	93	100	100				100	1	28	
122	3	WC	27																		2	8	
123	3	WC	29																		0	20	
124	3	WC	36																		1	15	
125	3	WC	41																		1	10	
126	4	BA	13															20	40	70	1	15	
127	4	BA	26															20	50	50	3	15	
128	4	BA	40															10	80	75	1	25	
129	4	BA	48															20	75	70	0	29	
130	4	BB	16															20	50	75	3	33	
131	4	BB	21															40	80	80	1	30	
132	4	BB	33															40	90	80	1	35	
133	4	BB	50															40	80	85	1	38	
134	4	CC	2																		0	67	
135	4	CC	25																		0	74	
136	4	CC	42																		0	73	
137	4	CC	52																		0	80	
138	4	DV	7	95	98	100	95	93		100	95		100	100	98	98				93	0	56	

COMPUTER PRINTOUTS AT BIXBY (continued)

OBS	DATE	TRT	PLOTNO	CRA	GOO	SAN	SIG	CAR	HEN	HOR	LAM	PEP	PRI	PUN	RED	SPI	SPU	GRA	BRO	GEN	PHY	RUN	HOE
139	4	DV	19	95	98	98	90	88		98	95		100	94	100	93				90	0	58	
140	4	DV	23	93	95	100	95	85		100	100		100	100	98	98				88	0	56	
141	4	DV	46	95	98	100	90	96		100	90		100	40	98	98				90	0	12	
142	4	EN	12	75	88	100	85	88		100	100		95	100	95	95				85	0	21	
143	4	EN	20	85	85	95	85	93		100	100		95	100	80	80				87	0	49	
144	4	EN	28	70	80	85	75	93		93	95		95	100	95	95				85	0	25	
145	4	EN	39	65	75	100	65	85		100	100		95	85	95	93				75	0	38	
146	4	FA	9	80	80		80											80	0	75	2	39	
147	4	FA	34	75	75		75											75	0	75	2	51	
148	4	FA	45	20	20		20											20	0	30	1	46	
149	4	FA	49	75	75		75											75	0	76	1	38	
150	4	FB	3	40	40		40											40	0	60	1	38	
151	4	FB	4	25	25		25											25	0	50	1	36	
152	4	FB	11	50	50		50											50	0	75	2	43	
153	4	FB	30	30	30		30											30	0	50	2	42	
154	4	PA	5	18	18		18											18	0	45	0	46	
155	4	PA	15	8	8		8											8	0	40	0	31	
156	4	PA	31	25	25		25											25	0	50	0	35	
157	4	PA	32	20	20		20											20	0	40	0	39	
158	4	PB	1	50	50		50											50	0	60	1	22	
159	4	PB	8	50	50		50											50	0	60	1	28	
160	4	PB	18	55	55		55											55	0	64	1	33	
161	4	PB	22	52	52		52											52	0	63	1	35	
162	4	RA	10	75	80	98	75	100		100	100		100	100	100	100				76	0	43	
163	4	RA	14	75	80	100	90	100		100	100		100	100	100	100				75	0	38	
164	4	RA	24	70	75	100	70	100		100	100		100	100	100	100				70	0	45	
165	4	RA	35	70	90	100	75	100		100	100		100	100	100	100				70	0	52	
166	4	RB	17	75	75	95	75	100		100	100		100	100	100	100				75	0	48	
167	4	RB	37	70	75	100	70	100		100	100		100	100	98	100				65	0	40	
168	4	RB	43	70	75	95	75	100		100	100		100	70	100	100				70	0	26	
169	4	RB	47	75	75	94	75	100		100	100		100	70	100	100				70	0	37	
170	4	SR	6	98	98	100	96	100		100	100		100	95	100	100				95	1	50	
171	4	SR	38	100	100	100	100	100		95	100		100	95	100	100				98	2	19	
172	4	SR	44	100	100	100	95	100		100	100		95	100	100	100				95	2	43	
173	4	SR	51	100	100	100	100	100		100	100		100	90	100	100				98	2	32	
174	4	WC	27																		3	10	
175	4	WC	29																		1	30	
176	4	WC	36																		1	23	
177	4	WC	41																		2	18	
178	5	BA	13															30	40	45	2	31	
179	5	BA	28															20	40	35	1	29	
180	5	BA	40															10	40	40	1	32	
181	5	BA	48															10	55	50	0	23	
182	5	BB	16															20	80	80	3	20	
183	5	BB	21															60	85	75	2	23	
184	5	BB	33															50	85	70	2	22	

COMPUTER PRINTOUTS AT BIXBY (continued)

OBS	DATE	TRT	PLOTNO	CRA	GOO	SAN	SIG	CAR	HEN	HOR	LAM	PEP	PRI	PUN	RED	SPI	SPU	GRA	BRO	GEN	PHY	RUN	HOE
185	5	BB	50															50	80	70	1	24	
186	5	CC	2																			67	
187	5	CC	25																			68	
188	5	CC	42																			63	
189	5	CC	52																			74	
190	5	DV	7	88	85	98	90	86		100	95		100	95	95	98				90	0	52	
191	5	DV	19	88	88	98	87	85		95	95		100	98	100	98				90	0	65	
192	5	DV	22	87	90	98	90	80		96	93		95	90	100	90				88	0	53	
193	5	DV	46	88	85	100	75	88		93	93		90	80	100	95				93	0	14	
194	5	EN	12	75	80	95	75	100		100	93		98	95	85	95				80	0	35	
195	5	EN	20	85	80	98	80	95		98	100		95	93	83	85				78	0	38	
196	5	EN	28	80	80	95	80	100		100	95		93	90	95	95				75	0	25	
197	5	EN	39	40	50	95	40	100		100	95		90	80	93	95				50	0	25	
198	5	FA																10	0	40	1	33	
199	5	FA																15	0	85	3	44	
200	5	FA																10	0	30	1	38	
201	5	FA																35	5	85	1	21	
202	5	FB																50	0	75	1	21	
203	5	FB																60	5	75	0	23	
204	5	FB																45	5	70	3	31	
205	5	FB																50	0	75	1	38	
206	5	PA																25	0	70	1	42	
207	5	PA																40	0	75	1	31	
208	5	PA																45	0	88	1	30	
209	5	PA																30	0	70	1	38	
210	5	PB																60	0	90	1	28	
211	5	PB																40	5	83	2	30	
212	5	PB																50	5	90	2	35	
213	5	PB	1															50	5	90	1	25	
214	5	RA	5	40	50	100	65	100		100	100		100	100	100	100				50	0	38	
215	5	RA	10	45	55	100	80	100		100	100		100	85	100	100				45	0	23	
216	5	RA	24	40	45	100	40	100		100	100		100	100	100	100				40	0	23	
217	5	RA	35	40	50	98	60	100		100	100		100	100	100	100				55	0	25	
218	5	RB	17	40	50	98	60	100		100	100		100	100	100	98				55	0	32	
219	5	RB	37	40	50	100	60	100		100	100		100	100	100	100				52	0	49	
220	5	RB	43	35	40	100	50	100		100	100		100	75	100	100				45	0	25	
221	5	RB	47	40	55	100	80	100		100	100		100	85	100	100				45	0	45	
222	5	SR	6	98	98	98	96	100		100	100		100	95	100	100				95	0	68	
223	5	SR	38	98	98	100	95	100		100	100		100	95	100	100				93	2	25	
224	5	SR	44	98	98	100	95	100		100	100		100	100	100	100				98	2	37	
225	5	SR	51	98	98	100	96	100		100	100		100	98	100	100				95	2	27	
226	5	WC	26																		1	25	
227	5	WC	27																		3	7	
228	5	WC	29																		1	23	
229	5	WC	41																		1	22	

COMPUTER PRINTOUTS FOR PERKINS

OBS	DATE	TRT	PLOTNO	BAR	CRA	DAL	FOX	CAR	GRO	HEM	HEN	HOR	KNO	LAM	LET	PEP	PRI	RAG	RED	SMA	SPI	SPU	WOO	GRA	BRO	GEN	PHY	RUN
1	1	CC	6																								0	12
2	1	CC	13																								0	16
3	1	CC	20																								0	14
4	1	CC	27																								0	11
5	1	CC	33																								0	15
6	1	DV	5		100	100		100	100	100	98	100		100	98	90	100	98		95			90			95	0	6
7	1	DV	9		100	100		100	100	100	95	100		100	98	90	100	100		98			98			97	0	10
8	1	DV	15		100	100		98	100	98	85	100		90	100	90	100	95		98			90			98	0	11
9	1	DV	22		100	100		98	100	98	10	100		98	100	85	100	100		98			96			100	1	11
10	1	DV	29		98	98		98	100	100	50	90		98	100	80	95	100		96			90			98	0	7
11	1	EN	1		94	95		100	100	100	100	100		100	90	98	100	100		98			98			98	0	7
12	1	EN	12		100	98		100	100	100	95	100		90	98	95	90	100		95			93			96	0	8
13	1	EN	17		98	95		100	100	100	98	100		98	98	90	95	95		96			95			95	0	12
14	1	EN	26		100	95		95	98	100	85	100		98	98	98	100	100		98			93			95	0	8
15	1	EN	35		98	98		98	100	100	85	100		100	100	95	98	98		100			90			98	0	11
16	1	RA	2		95	85		100	100	100	100	100		100	98	98	100	98		100			100			98	1	9
17	1	RA	10		95	90		100	98	100	95	98		100	100	98	98	96		100			100			96	1	8
18	1	RA	16		90	90		100	100	100	95	100		95	100	90	98	98		98			100			96	0	13
19	1	RA	23		95	80		100	100	100	95	100		100	100	95	98	100		95			100			95	1	7
20	1	RA	31		95	90		90	100	100	95	100		100	100	98	98	98		100			100			95	0	4
21	1	RB	4		98	80		100	100	100	100	100		100	100	100	100	98		100			100			96	0	5
22	1	RB	8		95	50		100	100	100	100	100		100	100	98	100	98		100			100			95	0	10
23	1	RB	18		98	80		100	100	100	98	100		100	98	95	98	98		98			100			98	1	9
24	1	RB	25		98	85		90	98	100	95	98		95	98	90	98	98		98			100			96	2	4
25	1	RB	34		95	90		98	95	100	90	100		100	98	98	98	100		98			100			97	0	9
26	1	SR	7		98	90		100	98	100	100	100		100	98	90	95	100		98			100			98	1	3
27	1	SR	11		98	95		96	97	98	100	100		100	98	90	98	100		98			98			98	1	2
28	1	SR	19		96	95		100	97	100	100	100		98	95	98	98	100		95			98			98	0	3
29	1	SR	28		100	95		98	100	100	98	100		98	100	90	95	100		95			100			98	0	2
30	1	SR	30		97	97		90	100	98	100	100		100	100	95	95	98		95			100			98	2	11
31	1	WC	3																								0	9
32	1	WC	14																								0	11
33	1	WC	21																								0	5
34	1	WC	24																								0	10
35	1	WC	32																								0	10
36	2	CC	6																								0	29
37	2	CC	13																								0	27
38	2	CC	20																								0	30
39	2	CC	27																								0	24
40	2	CC	33																								0	32
41	2	DV	5	98	100	98		100	100	100	98	100		100	98	85	100	100	95	95		98	95			92	1	19
42	2	DV	9	95	100	95		100	100	100	95	100		100	100	85	98	100	98	95		95	93			95	0	22
43	2	DV	15	100	98	100		100	100	100	90	100		88	100	88	100	95	100	98		100	92			90	1	21
44	2	DV	22	100	100	100		95	100	95	50	98		90	100	85	100	100	100	98		100	95			96	0	18
45	2	DV	29	98	98	98		100	100	98	90	90		100	98	85	93	100	100	93		100	95			95	0	16
46	2	EN	1	100	98	90		100	100	100	100	100		100	95	98	100	100	100	98		98	95			98	0	17

COMPUTER PRINTOUTS AT PERKINS (continued)

OBS	DATE	TRT	PLOTNO	BAR	CRA	DAL	FOX	CAR	GRO	HEM	HEN	HOR	KNO	LAM	LET	PEP	PRI	RAG	RED	SMA	SPI	SPU	WOO	GRA	BRO	GEN	PHY	RUN
47	2	EN	12	90	98	93		100	100	100	98	100		100	98	95	95	100	95	95		100	93			96	0	16
48	2	EN	17	96	98	96		100	100	100	95	100		95	100	90	100	95	100	94		100	95			96	0	25
49	2	EN	26	97	98	96		95	98	100	90	100		100	100	95	100	100	100	93		100	95			93	0	27
50	2	EN	35	98	98	98		95	100	100	88	93		100	100	90	95	98	100	95		100	93			92	0	18
51	2	FA	80																					95	5	80	1	25
52	2	FA	90																					90	10	83	1	12
53	2	PA	60																					90	0	80	0	20
54	2	PA	70																					20	0	40	0	10
55	2	RA	2	85	90	85		98	100	100	100	100		100	100	98	98	98	100	100		100	100			97	1	13
56	2	RA	10	75	95	75		100	100	100	98	100		100	90	95	100	95	100	100		100	100			93	0	15
57	2	RA	16	75	90	75		100	95	100	95	100		92	93	85	98	98	100	96		100	100			98	0	21
58	2	RA	23	80	95	80		90	100	100	95	100		98	100	90	98	100	100	92		100	100			98	1	18
59	2	RA	31	88	100	88		85	100	100	95	100		100	100	88	95	96	98	100		100	100			95	2	10
60	2	RB	4	80	95	80		100	100	100	95	100		100	100	95	95	95	100	100		100	100			97	0	14
61	2	RB	8	50	95	50		100	100	100	100	100		100	100	93	93	95	100	100		100	100			95	0	16
62	2	RB	18	80	90	80		95	98	100	95	100		100	95	90	90	95	100	95		100	100			96	0	25
63	2	RB	25	80	90	80		100	100	100	95	100		95	93	85	100	95	100	95		100	100			93	1	14
64	2	RB	34	85	98	90		90	98	100	92	90		100	100	96	98	98	100	98		100	100			95	1	17
65	2	SR	30	95	98	100		95	100	95	100	95		100	100	90	93	100	100	98		100	100			98	2	9
66	2	SR	7	95	100	95		100	98	100	100	100		100	96	95	95	100	90	98		100	100			98	0	7
67	2	SR	11	90	97	92		100	100	100	100	100		100	100	90	90	98	95	98		100	98			98	0	14
68	2	SR	19	95	98	97		100	95	100	98	100		100	95	98	95	100	93	90		100	98			97	1	11
69	2	SR	28	95	98	95		100	100	100	95	100		93	100	95	93	100	93	93		100	100			98	1	9
70	2	WC	3																								0	12
71	2	WC	14																								0	15
72	2	WC	21																								0	8
73	2	WC	24																								0	16
74	2	WC	32																								0	10
75	3	CC	6																								0	32
76	3	CC	13																								0	30
77	3	CC	20																								0	30
78	3	CC	27																								0	28
79	3	CC	33																								0	35
80	3	DV	5	97	98	98		98	100	100		98	98	98	100	84	100	95	98	93			96			96	0	21
81	3	DV	9	98	95	98		98	100	98		98	100	100	100	86	98	98	100	95			93			97	0	24
82	3	DV	15	100	98	100		98	100	95		98	95	85	100	88	100	95	100	96			90			95	0	22
83	3	DV	22	100	98	95		94	100	100		97	100	90	100	85	100	98	100	96			95			96	1	22
84	3	DV	29	100	100	80		98	100	98		90	96	100	100	84	95	93	100	92			96			93	0	19
85	3	EN	1	100	98	90		98	100	100		100	100	98	95	95	100	98	100	96			95			95	0	18
86	3	EN	12	88	95	94		98	98	98		100	98	98	98	96	95	95	95	93			93			92	0	18
87	3	EN	17	95	96	94		98	100	98		98	98	94	98	92	100	95	100	93			95			93	0	28
88	3	EN	26	95	93	96		94	100	100		100	95	98	98	92	98	98	98	90			95			95	0	28
89	3	EN	35	98	92	98		94	98	100		93	96	98	95	88	95	95	98	93			93			90	0	20
90	3	FA	80																					90	0	80	0	30
91	3	FA	90																					90	0	85	1	15
92	3	FB	65																					90	10	85	1	28

COMPUTER PRINTOUTS AT PERKINS (continued)

OBS	DATE	TRT	PLOTNO	BAR	CRA	DAL	FOX	CAR	GRO	HEM	HEN	HOR	KNO	LAM	LET	PEP	PRI	RAG	RED	SMA	SPI	SPU	WOO	GRA	BRO	GEN	PHY	RUN
93	3	FB	75																					20	5	20	1	16
94	3	PA	60																					90	0	88	0	25
95	3	PA	70																					10	0	10	0	15
96	3	PB	85																					95	0	90	0	23
97	3	PB	95																					12	5	10	1	10
98	3	RA	2	83	90	83		95	98	100		100	98	98	98	96	98	95	100	98			100			88	1	17
99	3	RA	10	70	88	75		100	98	100		100	100	100	93	94	100	93	100	98			100			88	0	20
100	3	RA	16	74	92	75		98	95	100		100	96	90	98	85	98	95	100	95			100			90	0	21
101	3	RA	23	80	90	70		90	96	100		98	98	98	100	90	98	96	100	90			100			92	0	23
102	3	RA	31	85	85	85		100	100	100		100	100	100	100	88	100	95	100	100			49			87	0	12
103	3	RB	4	75	92	75		94	98	100		100	98	100	95	93	90	100	100	100			100			88	1	18
104	3	RB	8	50	90	50		95	100	100		100	96	100	100	92	95	95	100	100			100			88	0	23
105	3	RB	18	75	98	80		90	98	100		98	96	95	93	88	98	95	100	95			100			92	1	27
106	3	RB	25	80	95	80		100	100	100		98	95	100	100	85	92	95	98	95			100			90	0	18
107	3	RB	34	83	88	90		95	100	100		90	100	100	100	94	94	98	100	98			100			85	0	23
108	3	SR	7	98	100	95		100	98	100		100	97	100	100	98	95	100	90	98			98			96	0	10
109	3	SR	11	90	98	92		100	100	100		100	98	100	100	90	95	100	95	100			100			95	0	18
110	3	SR	19	95	100	95		100	95	100		100	96	100	100	95	90	98	95	100			98			98	1	15
111	3	SR	28	95	98	96		100	100	100		100	100	93	100	96	93	100	95	100			100			98	1	14
112	3	SR	30	95	100	100		100	98	95		95	100	100	100	88	98	100	100	98			100			93	2	13
113	3	WC	3																								1	14
114	3	WC	14																								0	20
115	3	WC	21																								1	12
116	3	WC	24																								0	18
117	3	WC	32																								1	15
118	4	CC	6																								0	65
119	4	CC	13																								0	62
120	4	CC	20																								0	68
121	4	CC	27																								0	44
122	4	CC	33																								0	77
123	4	DV	5	95	95	95	100			100		95	100		95	88	100	90	90	88			95			98		38
124	4	DV	9	98	98	98	100			100		100	93		100	83	90	98	100	90			85			95		36
125	4	DV	15	98	98	98	100			100		100	95		100	90	100	100	100	95			90			95		29
126	4	DV	22	100	100	100	100			98		98	98		100	88	100	100	100	98			90			95		29
127	4	DV	29	98	98	98	100			95		90	93		95	85	93	100	100	93			95			93		30
128	4	EN	1	95	100	95	100			100		100	100		90	100	100	98	100	98			100			80		17
129	4	EN	12	93	95	93	100			100		100	100		93	98	95	100	90	95			95			93		29
130	4	EN	17	98	95	95	100			100		100	95		100	95	95	95	95	95			80			95		52
131	4	EN	26	95	98	95	100			100		100	90		100	93	98	100	98	95			90			93		54
132	4	EN	35	95	95	95	100			100		85	85		100	95	95	95	88	95			85			90		25
133	4	FA	80																					94	0	92	0	46
134	4	FA	90																					98	5	95	0	11
135	4	FB	65																					90	0	90	1	35
136	4	FB	75																					20	0	15	0	15
137	4	PA	60																					95	0	90	0	28
138	4	PA	70																					5	0	10	0	15

COMPUTER PRINTOUTS AT PERKINS (continued)

OBS	DATE	TRT	PLOTNO	BAR	CRA	DAL	FOX	CAR	GRO	HEM	HEN	HOR	KNO	LAM	LET	PEP	PRI	RAG	RED	SMA	SPI	SPU	WOO	GRA	BRO	GEN	PHY	RUN
139	4	PB	85																					98	0	90	1	28
140	4	PB	95																					5	0	10	0	12
141	4	RA	2	90	90	90	98			100		100	98		100	100	100	98	98	100			100			85		24
142	4	RA	10	85	85	80	95			100		100	100		95	95	95	95	98	100			100			80		26
143	4	RA	16	85	85	85	90			100		100	100		95	95	98	98	100	98			100			80		37
144	4	RA	23	93	93	93	100			100		100	95		100	95	93	98	100	90			98			88		26
145	4	RA	31	80	85	80	100			100		95	90		100	90	90	95	100	100			100			80		18
146	4	RB	4	75	90	75	100			100		100	95		100	100	100	98	100	100			100			50		20
147	4	RB	8	70	80	70	100			95		100	100		100	95	100	88	100	100			100			70		15
148	4	RB	18	75	85	75	100			100		100	100		98	95	95	90	100	98			100			75		29
149	4	RB	25	75	90	75	100			100		100	95		88	90	90	98	100	95			100			75		20
150	4	RB	34	75	90	75	100			100		90	95		100	90	90	100	98	100			100			70		21
151	4	SR	7	95	98	95	100			100		100	100		95	90	90	100	90	95			100			88		7
152	4	SR	11	95	98	95	100			100		100	100		100	90	90	100	90	98			100			95		19
153	4	SR	19	95	98	95	100			100		100	100		95	95	90	100	88	85			100			95		33
154	4	SR	28	95	95	95	100			100		100	95		100	88	93	100	85	90			100			93		17
155	4	SR	30	98	98	98	100			95		95	95		100	95	88	98	100	98			100			92		9
156	4	WC	3																								2	8
157	4	WC	14																								0	19
158	4	WC	21																								2	8
159	4	WC	24																								0	25
160	4	WC	32																								1	17
161	5	CC	6																								0	58
162	5	CC	13																								0	61
163	5	CC	20																								0	58
164	5	CC	27																								0	65
165	5	CC	33																								0	71
166	5	DV	5		98	98	100			95		93	98	100	88	85	95	98	100	88		95	93			95	0	64
167	5	DV	9		98	98	98			90		100	95	100	100	90	90	100	96	85		95	98			95	0	43
168	5	DV	15		98	98	100			100		100	95	80	100	90	100	85	97	93		95	95			93	0	30
169	5	DV	22		100	98	100			95		95	93	82	100	90	100	95	95	96		100	93			88	0	28
170	5	DV	29		95	95	100			90		90	98	90	95	90	93	100	95	88		100	95			88	0	44
171	5	EN	1		88	88	100			100		100	100	100	93	100	100	100	100	95		100	100			90	0	20
172	5	EN	12		95	95	98			95		100	98	100	90	100	95	100	100	93		100	100			90	0	24
173	5	EN	17		95	95	100			95		100	100	90	100	88	90	88	100	85		100	90			90	0	63
174	5	EN	26		95	98	100			100		100	88	95	100	90	100	100	100	90		95	85			91	0	38
175	5	EN	35		98	95	100			90		95	95	98	100	98	93	95	98	95		100	90			88	0	31
176	5	FA	80																					15	0		1	40
177	5	FA	90																					10	0		2	4
178	5	FB	65																					98	0		0	34
179	5	FB	75																					80	0		0	25
180	5	PA	60																					100	0		1	38
181	5	PA	70																					0	0		0	15
182	5	PB	85																					100	0		1	31
183	5	PB	95																					75	0		0	25
184	5	RA	2		80	80	100			100		100	100	100	100	98	100	98	100	100		100	100			82	1	19

COMPUTER PRINTOUTS AT PERKINS (continued)

OBS	DATE	TRT	PLOTNO	BAR	CRA	DAL	FOX	CAR	GRO	HEM	HEN	HOR	KNO	LAM	LET	PEP	PRI	RAG	RED	SMA	SPI	SPU	WOO	GRA	BRO	GEN	PHY	RUN
185	5	RA	10		65	65	95			98		100	100	100	98	98	95	95	100	100		100	100			60	0	20
186	5	RA	16		70	70	90			100		100	95	95	98	95	95	98	100	96		100	100			65	0	35
187	5	RA	23		80	80	93			100		100	93	100	100	100	93	100	100	93		100	100			75	1	48
188	5	RA	31		75	75	100			95		95	85	93	100	98	95	93	100	100		100	100			75	0	28
189	5	RB	4		65	65	95			100		100	100	100	100	100	100	95	100	100		100	100			60	0	21
190	5	RB	8		70	70	95			100		100	95	100	100	90	100	86	100	100		100	100			88	2	23
191	5	RB	18		68	68	95			100		100	95	96	92	95	100	96	100	93		100	100			72	0	25
192	5	RB	25		70	70	100			100		100	88	95	93	98	98	95	100	98		100	100			70	1	25
193	5	RB	34		68	68	100			100		98	88	100	98	90	95	100	100	95		100	100			50	1	32
194	5	SR	7		95	95	100			95		100	100	100	93	88	90	100	100	95		100	100			90	2	10
195	5	SR	11		90	90	100			100		100	95	100	100	95	95	100	100	95		100	100			90	0	10
196	5	SR	19		98	95	100			90		100	100	98	98	93	93	98	100	85		100	100			88	1	30
197	5	SR	28		90	90	100			90		95	90	95	100	85	93	100	100	88		100	100			88	2	14
198	5	SR	30		95	95	98			93		93	85	100	100	88	93	98	95	95		100	95			87	1	45
199	5	WC	3																								0	14
200	5	WC	14																								0	13
201	5	WC	21																								1	5
202	5	WC	24																								1	17
203	5	WC	32																								0	20

VITA 2

James Ronald Grimm, Jr.

Candidate for the Degree of

Master of Science

Thesis: A PRELIMINARY EVALUATION OF SELECTED PREEMERGENCE AND POSTEMERGENCE HERBICIDES FOR USE IN FIRST YEAR ESTABLISHMENT OF 'CARDINAL' STRAWBERRY

Major Field: Horticulture

Biographical:

Personal Data: Born in Phoenix, Arizona, July 22, 1958, the son of Mr. and Mrs. J. R. Grimm.

Education: Graduated from Birmingham High School, Van Nuys, California in 1976; received the Associate of Science degree in Horticulture from Pierce Junior College in June, 1979; received the Bachelor of Science degree in Agriculture from the Oklahoma State University in December, 1982; completed the requirements for the Master of Science degree in Horticulture at Oklahoma State University in May, 1984.

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