A STUDY OF SELECTIVE CHEMICAL WEED CONTROL POSSIBILITIES FOR ONION SET PRODUCTION

by

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INTRODUCTION

The production of onio n sets has long been of importance as a vegetable crop in the Winnipeg area. The total production in some years has exceeded four million pounds (IO), which is approximately 65 per cent of the total Canadian production. Control of weeds is a major item of expense (15, 19) in the production of this crop. Onions grown for sets are planted relatively close together, both with respect to distance between the rows and to distance between the plants in the rows, and for this reason mechanical and hand weeding is often difficult and costly. In view of these facts, the possibilities of chemical weed control have received much attention from research workers. The discovery or development of a suitable chemical which would cause no significant reduction in yield or storage capacity of onions, and yet control or aid in the control of weeds, would be a boon to the onion set grower.

This thesis presents a report of studies of several phases of weed control in onions. Potassium cyanate has been in fairly general use as a post-emergent weed control in the Eastern United States and Canada for several years. In order to establish rates of potassium cyanate which could be used safely under Winnipeg conditions, the chemical was applied at

several rates in experiments carried out in two consecutive years. The effect of the spray treatments upon both onions and weeds is reported in considerable detail.

A study was also made to determine what effects the factors of climate, such as temperature and relative humidity, might have upon the degree of injury caused by post-emergence spray treatments of potassium cyanate. This was an attempt to provide information as to the most desirable time for application from the standpoint of effect on weeds and possible injury to onions.

The effects of pre-emergence application of calcium cyanamid, monosodium cyanamide, potassium cyanate, and 2,4-D were also studied.

REVIEW OF LITERATURE

Considerable research work has been done on chemical weed control in onions during the last 10 years. This work has included studies of many chemicals. Those showing most promise and most widely studied are: dilute sulphuric acid (H_2SO_4), cyanamids and cyanates, 2,4-dichlorophenoxy acetic acid (2,4-D), and various dinitro compounds.

Dilute sulphuric acid, as a selective herbicide in growing crops, has been used for about 50 years. In the more recent years it has been used commercially on onion fields with a considerable amount of success. Lee and Ellis (20) state that of all the chemicals used on onions in their experiments in Indiana, dilute sulphuric acid was the only effective one which showed sufficient selectivity. They recommend that the onion plants should have two true leaves and that the foliage be dry at the time of spraying. They also found that temperatures ~~of~~ above 70 degrees F. and a high relative humidity are desirable in order to obtain maximum effectiveness from sulphuric acid, and that low spraying pressures (below 50 pounds) should be employed to avoid excessive wetting of the onion plants. Warren (29) also found that sulphuric acid in 3 per cent solution was one of the best chemicals tested on onions as a selective post-emergent spray. Chappell (6) used dilute sulphuric acid (2 per cent) and controlled weeds

effectively without significant reduction in the yield of onions. There was no significant difference in the number or weight of bulbs, nor any effect upon the amount of sprouting in storage. Lachman (17) obtained no control of purslane, lamb's quarters, or grass weeds with the use of sulphuric acid, and considered the use of the chemical to be of questionable value. He suggested that environmental conditions may play an important part in the success of this method. Most research workers agree, however, that because of its highly corrosive ~~chemical~~ nature there is little hope that it will be developed for extensive use as an herbicide.

Sinox and other dinitro compounds have been used with considerable success in the control of weeds in onions, especially in the western part of the United States. In California, Westgate and Raynor (33) reported that sinox at the rate of 1 gallon in 160 gallons of solution per acre proved satisfactory for weed control in transplanted onions, providing they were healthy, and not over 10 inches high. Good control of various species of mustard and pigweed was obtained with no control of purslane and many grasses. Crafts and Raynor (9) in 1944 found that sinox could be safely used on onions during the first to third true-leaf stage. Sinox has been used on a commercial scale in California onion fields. Warren (29) working in Wisconsin found that spray concentrations of sinox strong enough to

give good control of weeds resulted in considerable burning and a small amount of killing of the onion plants. Sinox was therefore not considered satisfactory under conditions existing in that state.

Considerable work has been done to discover the possibilities of using various forms of 2,4-D as a pre-emergence treatment on onions. Warren, et al., (30) concluded that to be effective, 2,4-D must be present in toxic concentrations at the time weed seeds are germinating. Several workers (2, 30, 16, 20, 19) reported that 2,4-D at rates high enough to effect practical weed control seriously injured the onion plants. This was found especially true when 2,4-D was applied before seeding, and even more evident if applied before seeding and mixed into the soil. Warren and Hernandez (32) found that in onions grown from sets, a pre-planting treatment of 2 to 4 pounds per acre delayed emergence from 10 days to 2 weeks. It was concluded that 2,4-D soil treatments offer little promise as a method of controlling weeds in Golden Globe onions grown from sets. Taylor (24) on the other hand, found that ½, 1, and 1½ pounds of sodium salt of 2,4-D on onions grown from sets gave significant weed control without reduction in yield or change in the average weight per bulb.

Warren and Hernandez (32) applied several formulations of 2,4-D to onions grown from seed and reported that the only ones which did not reduce yield were the sodium and amine salts. These formulations at 2, 3, and 4 pounds per acre were found to give generally good control of pigweed, lamb's quarters, purslane, shepherds purse, witch-grass, and foxtail for a period of from 4 to 6 weeks. They found that crop injury increased almost directly with the rate of application, and suggest that the lowest rate of 2,4-D which will give good weed control should be used. The amine salt of 2,4-D was also found to be effective for weed control by Denisen et al. (11), but significant reductions in yield were obtained at rates above $\frac{1}{2}$ pound per acre. Grigsby (13) found that of several chemicals, the amine salt of 2,4-D, potassium cyanate, and sodium 2,4-dichlorophenoxy-ethyl sulphate (EH-1) caused the least reduction in yield.

Taylor (28) made several treatments on onions in the greenhouse, using the sodium salt of 2,4-D. He reported that the stand was better and the seedling injury was less when applied just before emergence than when applied earlier. Percentage weed control was also higher at the later date. Rates as high as 2 pounds per acre seemed satisfactory on onions grown from seed. These results were generally verified in outdoor trials by Taylor (23).

Taylor (26) found that in pre-emergence treatment of onions grown from sets, there was no significant reduction in set yield from treatments of ½ to 1½ pounds of the sodium salt of 2,4-D per acre. The stand, however, was reduced which resulted in larger sets being produced. Pre-emergence applications of 2 pounds of amine and 2 pounds of the ester formulation of 2,4-D per acre were made by Bakke and Staniforth (4), and gave good control of weeds in onions for about three weeks after the onions emerged.

The alkyl ester of 2,4-D was applied to onions as a pre-emergence treatment by Alban (1). Excellent weed control was obtained for a period of several weeks. All other 2,4-D treatments caused severe damage to all onion varieties.

Hedlin (15) carried out work using calcium cyanamide as a pre-emergent dust treatment on onions. He found that 100 and 200 pounds per acre of this chemical delayed the emergence of the onions by 24 to 48 hours. Weeds were reduced about 50 per cent by pre-emergent treatment, but crop yields were not reduced. Plots which received an additional post-emergence treatment of calcium cyanamide at 50 and 100 pounds per acre, showed a reduction in yield of onions, and eliminated about 90 per cent of the hand weeding.

Potassium cyanate has proven to date to be one of the most promising of post-emergent selective chemicals which can be used safely on onions. Experimental workers in various

parts of the continent have obtained results which differ widely. In general, higher rates have been found necessary in the inland regions than in coastal regions. Work carried out at the University of Manitoba in 1949 (3) indicated that 72 pounds per acre, applied in two applications of 36 pounds, did not produce any apparent injury to onions grown for sets. Such rates are far in excess of those in use in Eastern United States at the present time.

Potassium cyanate was applied by Hedlin (15) as a post-emergent treatment in an effort to control late germinating purslane. When the spray was applied during hot and dry weather and the weeds were in very small stages, purslane and lamb's quarters were readily killed. He found that when the weeds were small, there was no need to go above a 2 per cent solution at 80 gallons per acre. Lachman (19) and Nylund (22) found that of several chemicals used, potassium cyanate was the most effective, but that it was not sufficiently selective to permit direct application to the onion plants without some reduction in yield. Cockrum and Warden (8) applied potassium cyanate to onions at 20 pounds per acre and produced a slight burning of the onion leaves.

Denisen, et al. (11) obtained significant yield reductions using potassium cyanate at 1 and 1½ per cent as a post-emergent treatment, and obtained also, a good measure of weed control. Grigsby (13) used several chemicals in pre-emergence

treatments of onions, and found that least reduction in yield was caused by potassium cyanate and 2,4-D. Nylund (21) found that potassium cyanate applied pre-emergently gave from 90 to 100 per cent weed control.

Several other chemicals have been used with varying amounts of success. Lachman (18) obtained good control of grass weeds with isopropyl n-phenyl carbamate (IPPC), and found that it possessed good selectivity for beans, beets, spinach, and onion sets. IPPC supplemented with 2,4-D was found to be valuable in the prevention of weed growth in fields of onion sets. Crafts and Raynor (9) indicate that good pre-emergent control of weeds, including grasses, can be obtained by the use of either diesel oil or stove oil at rates of 60 to 75 gallons per acre. Alban (1) found that 8 pounds of sodium pentachlorophenate (Na PCP) per acre applied when the onions were 2 inches high gave excellent weed control for three weeks. Sodium isopropyl xanthate used at 8 pounds per acre by Grigsby (12) caused a 16 per cent stand reduction, with no reduction in yield. Barnard and Warden (5) found that pre-emergence treatments of 15 pounds of sodium isopropyl xanthate per acre produced onion stands approximating those of check plots.

MATERIALS AND METHODS

Two main experiments were conducted. (1) Potassium cyanate was used post-emergently in experiments which were repeated for the two years, 1950 and 1951. Observations were made on the amount of weed control obtained and on the effect of this control on the yield of onion sets. (2) A study was made in 1951 to determine the effect of the stage of growth, temperature, and relative humidity upon the amount of injury caused to the onion plants with various rates of potassium cyanate. (3) A small pre-emergence study was carried out in 1950 and 1951 using 2,4-D, monosodium cyanamide, calcium cyanamid, and potassium cyanate.

The Red River flood in May of 1950 necessitated the moving of all plots to Headingly, Manitoba, for that year. In 1951, all trials were conducted at the University of Manitoba, Fort Garry.

In all tests, Yellow Ebenezer onions were used. A knapsack sprayer to which a brass auxiliary side tank had been attached was used for all applications. A measured amount of chemical and volume of solution were placed in the auxiliary tank sufficient to cover the plot area. The side tank was connected to the main knapsack sprayer tank by a hose line in which was located a stopcock. This made

it possible to fill the side tank without losing pressure in the main tank. The nozzle used was a "Teejet" 8007, at a pressure of 30 pounds per square inch.

1. Post-emergence experiments.

In 1950, the onions were sown on May 27 into fairly wet soil. Row spacing used in this experiment was 14 inches and plots consisted of 5 rows, 12 feet long. Planting depth was 1½ inches. A randomized block with four replicates was used.

On June 11, 1950, potassium cyanate was applied at rates of 8, 16, 24, and 32 pounds per acre, in 60 gallons of solution per acre. On this date the onions were in the crook stage and about ½ to 3/4 inches high. The soil was wet at the time of application. Applications were made both with the addition of a wetting agent (Nonic 218, Sharples Chemicals, Inc.) at 0.05 per cent and without a wetting agent. Weeds present at this time were wild mustard (Brassica arvensis), stinkweed (Thlaspi arvense), wild buckwheat (Polygonum convolvulus), red root pigweed (Amaranthus retroflexus), wild oats (Avena fatua), perennial sow thistle (Sonchus arvensis), and giant ragweed (Ambrosia trifida). Not until after planting was it discovered that the land was heavily infested with wild oats and perennial sow thistle. Because these two weeds are not normally a problem in onion fields and because no control of these weeds was obtained, they were removed manually on July 10 - 12. Weed counts were

made on 3 square feet out of each plot. The number of mustard, stinkweed, ragweed, spotted spurge, and wild buckwheat were counted separately and totalled. There was no other hand weeding or cultivation.

Since no observable differences could be detected between those plots which earlier had received a wetting agent and those which did not, it was decided to use these plots in a further experiment to obtain additional information. By the middle of July, a new crop of weeds was emerging and on July 21, 1950, a duplicate set of treatments was made to those plots which received the potassium cyanate and the wetting agent of June 11. A high temperature of 71° F. and a low relative humidity of 57 per cent was recorded on the day of the application.

The onions were pulled on September 5 and allowed to dry on the ground. They were then removed to the dryer, thoroughly dried, screened, and the plot weight recorded.

In 1951, wild mustard seed was mixed with the onion seed and sown on May 7. The plots consisted or 5 rows, 12 feet long, as in 1950, but with a row spacing of 12 inches. The same rates were used. Potassium cyanate was applied on May 26 when the onions were in the flag stage and from 1½ to 2 inches high. No wetting agent was used. The temperature at the time of spraying was 62° F. with a high of 71° for the day. The low during the following night was