CONTROL OF ONION MAGGOT BY SEED PELLETING WITH INSECTICIDES

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Robert Doak Harrison

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THESIS

This is to certify that the

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The Control of Onion Maggot,
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Seed Pelleting with Insecticides

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CONTROL OF ONION MAGGOT BY SEED PELLETING WITH INSECTICIDES

by

ROBERT DOAK HARRISON

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INTRODUCTION

One of the important crops of the northern part of the United States and of southern Canada is the onion. Many acres are devoted to its culture and it provides one of the main sources of income to certain areas of the country. The onion, like most other crops grown in large acreages of pure stands of one type of plant, is attacked by various plant diseases and insect predators. Two widely distributed insect pests on onions are the onion thrips Thrips tabaci Lind., which draws the sap from the leaves and the onion maggot Hylemya antiqua Meig., which feeds in the bulbs. Hylemya antiqua is the insect with which this work is concerned. It is generally considered that the onion maggot is the more destructive, although under certain conditions an infestation of thrips is capable of seriously damaging an entire crop of onions. The onion maggot, though, seems to cause more damage year after year. Whereas the thrips damage is to the leaves only and its effect on the onion bulb is secondary, the maggot damage comes from the direct feeding on the onion bulb and from the subsequent rotting of the damaged tissue. This rotting of the bulbs may not show up on very slightly damaged onions until they have been in storage for some time.

The onion maggot is a pest to be considered by the

onion grower almost every year. The "Insect Pest Survey Bulletin" from 1922 to 1933, reported that the maggot had caused severe damage many places in the United States and Canada every year (15). In 1930, Compton reported that for the first time in ten years the onion maggot had not caused commercial damage in Cook County, Illinois (6). At the same time, also, serious damage was being reported from British Columbia, Alberta, North Dakota, Utah, Montana, Minnesota, Indiana, New York and in southern Wisconsin a short distance north of Cook County.

This insect is another of the many imported insects, which have caused so much damage to North American agriculture. It is indigenous to northern Europe, where it was first described under the name Hylemya antiqua by Meigen. This insect is similar to many other insects and plant disease organisms in that it seems to be of as great or greater importance in its new environment than in its original habitat. In Europe it is confined primarily to northern parts, including the British Isles.

Distribution in North America

In North America this fly is mostly confined to northern United States and southern Canada wherever onions are grown. It has been reported from all onion growing areas from New Brunswick and Nova Scotia to British Columbia and from Maine to Washington. In the southern United States the maggot is not the serious pest it is in the north, but at times does cause considerable damage in certain areas. In 1926 Grimes reported that onions in Mississippi were 75 percent infested (11). Although it may be serious in the south, it is not the causal agent of high loss year after year as it is in the northern states and Canada.

Economic Importance

Metcalf and Flint state that in 1936 when the damage to the onion crop by insects was 20 percent the loss in income to the country was $2,487,400 (22). Since the onion maggot is the most destructive of the onion pests, its importance is obvious. In some years the damage runs much higher than 20 percent of the crop. As high as 95 percent damage has been reported in certain parts of the country. Severin reported in 1915 that in some parts of Wisconsin growers had to give up onion growing because of the maggot (25).

With the nature of this pest in mind, it is no wonder that ever since the advent of the serious depredations of this insect in North America, some method of control has

been sought. Although much time and money have been devoted to this one insect since the turn of the century, no real progress has been made until recent years, when the advent of new organic insecticides has brought new hope in the battle against this pest.

Synonomy

The accepted scientific name for the common onion maggot is now Hylemya antiqua Meigen. It was described in 1826. Over the past one-hundred years other names have been used, which now are considered as synonymous. These are Phorbia ceparum Meig., Phorbia cepetorum Meig., Anthomyia ceparum Bouche', Pegomyia ceparum Bouche'. The generic name has been found spelled three ways: Hylemyia, Hylemia, and Hylemya. The latter is the accepted form.

In referring to the work of various authors the name given in their publications will be used.

Description and Life Cycle

The following description of the adult onion maggot is taken from Meade's "Annotated List of British Anthomyiidae" (19). He uses the name Phorbia cepetorum for the species described and states that all specimens were taken from onions. He compared flies brought from the United States and stated that they were the same as those in Europe.

> Head: Face slightly prominent; epistome flat; eyes of male contiguous; antennae of moderate length, with the arista thickened and pubescent at its base, but nearly bare in the middle extremity.
>
> Thorax: With the scutellum of a light yellowish-gray colour; the former marked with four indistinct pale brown stripes, and with four rows of black bristles.
>
> Abdomen: Oblong and rather narrow, cinereous, clothed with black hairs, and showing silvery-white reflections when viewed from behind; it is marked down the dorsum with a row of elongated, narrow triangular black spots, which form a sub-continuous stripe; the anal segment is grey, small and rather pointed; the sub-anal male appendages are large and hairy.
>
> Wings: Hyaline, with the third and fourth longitudinal veins nearly parallel to each other, and the external transverse ones straight, and a little oblique; calyptra and halteres both pale yellow; legs some times piceous; hind femora almost bare of hairs or bristles at the base of their undersurfaces; hind tibiae of the males furnished with a few short bristles along the middle and upper part of their inner sides. The female is very similar in colour to the male; the eyes are widely separated, the intervening space being red at its front part; the abdomen is dull grey, mostly immaculate, conical and pointed at the apex; the calyptra are white and the halteres yellow.

The maggot is nearly one-third inch long and dull whitish in color. The flattened posterior end of the body is surrounded by a row of twelve fleshy tubercles, of which the middle lower pair are single-pointed. In addition to the two tubercles just back of the vent, there are two smaller ones on the ventral side just in front of the two large ventral marginal tubercles; they aid the larva in crawling (7).

A knowledge of the life cycle is important in attempts to control the onion maggot. Being an insect with complete metamorphosis, it goes through the four stages, egg, larva, pupa and adult. Controls have been devised for each of these stages, but the majority have been directed toward the larval stage.

The usual method of overwintering of this fly is in the pupal stage. It has been reported that the maggots and even the adults have overwintered, but these are exceptions, at least in the north (25). The pupae in the field are found from one-half to six inches deep, though the majority found have been only two or three inches under the surface near the infested onion. In the spring about the time when onions are planted, the last of April through the 20th of May, adult flies emerge from the puparia and make their way to the surface. Emergence of this first brood of flies extends over several weeks.

After emerging the adult fly feeds one or two weeks before mating and laying eggs on the young seedling onions. The adults have been found to feed on the common dandelion Taraxacum officinale Weber. This plant serves as food only for the adult and only the nectar and pollen are eaten (3). In this work, flies were reared in cages for experimental purposes. They were found to feed on molasses, table syrup, honey and sugarwater. Honey was preferred. Besides feeding on the dandelion, they also fed upon the pollen of corn, Zea mais, golden rod, Solidago sp., and wild carrot, Daucus carota. The latter was preferred.

The eggs are placed either on the plant at the base of the seedling or on the ground near the plant. They are white and smooth, elongat-oval in shape with a slight groove on one side. The egg is visible to the naked eye, being about four-hundredths of an inch long and about one-hundredth broad. These eggs usually hatch within a week, the time depending upon the temperature.

When the egg hatches, the young larva migrates down the seedling inside the sheath. It feeds in the roots and hollows out the base of the plant leaving only the outer skin. When the onion begins to form the bulb, several maggots may be found feeding together in one plant. When the roots of the young seedling have been consumed, the maggot migrates to another and in this way may destroy several

plants before it reaches full size and pupates. The length of time required to reach pupation is determined somewhat by the kind of onion being fed upon, green onions favoring a more rapid growth than second year onions (6). Two weeks are required when feeding on green onions.

When the maggot has finished feeding it almost invariably leaves the onion before pupating. It moves out of the onion and may migrate three or four inches into the soil. It becomes quiescent, and forms the puparium from its outer skin. The pupa takes from three to four weeks to reach maturity, when the adult emerges. These flies also have a preoviposition period of one or two weeks. The eggs are laid as in the spring, but since the onions are larger, more maggots are able to exist on them. One female may lay as many as six eggs on one plant and more than one female may use the same plant for oviposition. The females seem to prefer onions which are rotting from previous maggot attacks or onions infested with smut (2). The peak of egg laying by the second brood is generally in August according to Canadian observations. However, the egg laying by later broods seemingly depends on conditions especially temperatures and moisture(12). In this work onions with as many as 75 maggots in them were found. The maggots leave the onion as do the first brood maggots and pupate in the soil. They usually pupate at a greater depth than those of the

first brood (27). Many of the second brood pupae remain in the soil until the following spring, but some do emerge to start a third brood. In some regions of the country the third brood may complete its growth and pupate in the field, but in many instances the onions are harvested before the larvae have finished feeding. When the onions are sorted and the infested onions discarded, they may finish feeding and pupate in the cull pile. An undisturbed cull pile is a potent sources of infestation the following year.

Related species

The cabbage maggot Hylemya brassicae Bouche' and the seed-corn maggot Hylemya cilicrura Rondani are discussed here because of their close relationship and similarity to the onion maggot.

Cabbage maggot

Adult. The adult female is similar to the adult female of the onion maggot in size, shape and color. They are very difficult to distinguish. The males can be separated by the presence of a tuft of hair on the base of the hind femur. The femur is immaculate in the onion maggot.

Larva. The maggots are similar in size, color and shape to the onion maggot. Both have eight lateral marginal tubercles, but two of the ventral tubercles are bifid on the cabbage maggot.

Seed-corn maggot

Adult. The adult females are a trifle smaller than those of the onion and cabbage maggot, but are very difficult to distinguish except when associated with the males of the species. The adult males are distinguished by a row of bristles on the inside of the hind tibia.

Larva. The larva is about one-fifth inch in length, but otherwise very similar to the onion maggot. The maggots

do not have the bifid tubercles as do the cabbage maggots.

As the name implies the cabbage maggot is a pest of the cabbage plant and its relatives, feeding on the roots. The seed-corn maggot infests the germinating seeds of corn and beans.

REVIEW OF LITERATURE

The Onion Maggot

The earliest mention of the onion maggot as a serious pest in the United States was found in a treatise submitted to the Massachusetts legislature by T.W. Harris in 1852 (13). He stated that failure of onions in the United States might be caused by Anthomyia ceparum as in Europe, but no one at that time had investigated to make sure.

Another early report of the damage caused by this insect in the United States was published by J.A. Lintner in 1882 in the "First annual report of the Injurious and other Insects of the State of New York" (17). It was described under the name Anthomyia ceparum and mentioned under the title of "The Importation of Injurious Insects". He stated that its ravages had been noticed and recorded both in this country and in Europe long before Bouche', in the year 1834, described it as infesting onions and gave to it the scientific name of Anthomyia ceparum. It could have been brought to this country either as larvae or as pupae, since its pupal transformation often takes place within the bulb in stored onions. Sanderson and Peairs state that the onion maggot probably was imported in colonial times. They mention it under the name Pegomyia ceparum Bouche' (24).

It is of interest to note some of the control methods

advocated over the years since the onion maggot first became prominent in our onion growing areas.

Harris stated that a crop could be preserved from attack by sowing onions on ground on which a quantity of straw had been burned (13).

Lintner in 1882 listed the following recommendations for the control of the onion maggot (17):

(a) Strewing the onion-bed with powdered charcoal, leaving small portions without the application, where the flies may deposit their eggs. The infested onions were taken up and destroyed by burning or deep burying.

(b) Scattering dry, unleached ashes over the beds as soon as the plants were up to prevent deposition of the eggs.

(c) Scattering pulverized gas-lime among the onions to repel the insects.

(d) Watering with the liquid from pigsties.

(e) Applying a heavy application of animal fertilizer to prevent attack. Poultry manure was recommended because of its high ammonia content.

Severin in 1915 recommended a poison bait made of one-fourth ounce sodium arsenite mixed with a gallon of water. This was sprinkled over the field at intervals of about a week (25).

Dudley in 1925 recommended the planting of cull onions

as a trap crop and destroying them with oil after infestation (9).

In 1925 Flint and Compton recommended a control, which is still considered good on small plots, but too costly for large onion fields (10). One ounce of corrosive sublimate was mixed in ten gallons of water and applied along the row of onions. A bordeaux-oil emulsion was also suggested and was a standard spray for many years. It did not injure set onions, but did cause trouble on onions grown from seed. This spray was made by mixing 97 gallons of 8-12-100 Bordeaux with three gallons of lubricating oil emulsion. The spray was applied along the row of the onions during time of oviposition.

The use of sanitary methods in the control of the onion maggot was advocated at an early date and continues to be of importance at the present time. The most important of these is the disposal of cull onions and refuse remaining after sorting. These culls and refuse should be destroyed by burying at least one foot under the ground, by burning, by boiling or by steam (14).

In the past, most of the attempts to control the onion maggot have been directed at the control of the maggot or larval form. Recently an attempt has been made to control the adult fly, thus cutting down the oviposition and subsequent injury by the maggots. This has been accomplished

quite successfully by use of a five percent chlordane dust (16). It is applied at five-day intervals over a period of four or five weeks during oviposition.

McLeod attempted to control the onion maggot by coating onion seeds with insecticides (20). This was done by moistening the seeds in sugar water and mixing them with insecticides. He found that 20 percent gypsum and hexachlorocyclohexane prevented the growth of the seedlings (21). McLeod's work resembles the work described in this paper.

Seed pelleting

Even though the use of pelleted seed has been prominent for only seven years, it is not a new idea. The United States Patent Office issued its first patent relating to seed coating in 1868. Since that time a number of patents have been issued, most of them dealing with the coating of seeds with fertilizers or other growth-promoting substances (26).

The first experimental work on modern pelleting was begun in 1943. This was occasioned by a shortage of labor during the war and the development of segmented sugar beet seed. In 1942, Bainer had devised a machine to segment the beet seed balls into single germ seed units (4). This process reduced the hand labor of thinning the beets, because

it eliminated the crowded conditions caused by the germination of many plants from one seed ball. This saved labor, but at that time the available planting equipment was not accurate enough to "precision plant" the small germ pieces. Also because of the small size and the lightness of the beet-seed pieces, they did not feed well in the planters then available. It was suggested that the seeds be increased in size to give them more weight and to make them an even size so that precision planting would be possible.

One method which was devised on the west coast does not use a sticker. A volcanic ash known as montmorillonite, which becomes sticky upon being moistened is used (4). It is claimed that the use of a sticker will decrease germination because of the exclusion of air from the seed on hardening of the sticker.

In this work the term pelleted seed is used to designate a single seed, which has been coated with an inert material. Some workers in the field make a distinction between the terms "pelleting" and "coating". In such cases "pelleted" refers to seed pellets made from a mixture of inert material and seeds and shaped by some mechanical means. The number of seeds in the pellet is variable, depending on the ratio of seeds to pelleting mixture from which the seeds are formed. This type of process has been used in the reclamation of over grazed pasture land in the west. The

pellet carries fertilizer for the germinating seed. Seeds which are coated singly with some material are called "coated seed" by those who make a distinction between the two types. With the common usage of the term, no distinction is made between the two and "pelleted seed" refers to seed, which has been coated with any material to increase its size, to improve its shape or to carry some special chemical (4).

Soon after the idea of coating seeds was developed, there were suggestions as to adding other materials in the pellets, which might affect the germination of the seed or vigor of the seedling. The materials included in this work have been insecticides for the control of the onion maggot.

THEORY

The theory behind this work was that the control of the larva attacking the young seedling onions could be accomplished by the inclusion of insecticides in the pellet surrounding the seed. The control with pelleted seeds was directed at the first brood maggots right after the germination of the seeds. Due to the migrating of these maggots from one seedling to another, it was surmised that sufficient insecticide would be present in the soil surrounding the seedling to kill the maggot before much damage was done. No control of the second brood was expected because by the time the second brood appeared, the insecticide probably would have been leached out of the soil surrounding the plant and because the second brood larva bores into the onion at the surface and migrates down to the bulb through the sheath. It does not come in contact with the surrounding soil. By this time, due to the size of the bulb, the maggot can complete its growth in one onion and therefore would not come in contact with the poison.

EXPERIMENTAL WORK

Materials

The pellet covering the seed in these tests was made up of three different materials. These coatings consisted of fly-ash, feldspar and a sticker, methylcellulose[1], which is a water-soluble plastic.

The methylcellulose was mixed with water to form an eight percent solution and was kept refrigerated to retain its proper consistency. When kept at room temperature, it jells.

The fly-ash and feldspar were dry powders and were thoroughly mixed together before using. The ratio used was 30 percent feldspar to 70 percent fly-ash.

The methylcellulose sticker was applied by a standard paint spray outfit. It consisted of an adjustable gun, air pump, motor and container for the solution to be sprayed (Plate A).

The pellets were formed in a revolving copper drum. The drum was turned by a motor attached to a set of reduction gears to revolve the drum at the desired speed. This type of machine is used by pharmacists for coating pills and by confectioners in making coated nuts and fruits (Plate B).

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[1]Methocel. 15 cps. technical grade. Dow Chemical Co. Midland, Michigan.

The following insecticides and fungicide were used in the pellets in this work.

1. Parathion 25 percent wettable powder.[1]
2. Lindane 25 percent wettable powder.[2]
3. Chlordane 40 percent wettable powder.[3]
4. DDT 75 percent wettable powder.[4]
5. Arasan.[5]

A household electric heater containing a blower was used to dry the pellets.

Downing yellow globe and Michigan Sweet Spanish onion seeds were used.

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[1]American Cyanamid Co., New York, N.Y.
[2]Dow Chemical Co., Midland, Michigan.
[3]Julius Hyman and Co., Denver, Colorado.
[4]Dow Chemical Co., Midland, Michigan
[5]E.I. Du Pont de NeMours Co., Wilmington, Del.

Methods

The experimental work was done in the spring and summer of 1949 and in the spring and summer of 1950. The same process was used both years, but with progressive variations. The process used in 1949 will be given and an enumeration of the changes in 1950 added.

1949. The seeds were weighed out in 100 gram amounts. These were put in the revolving drum and lightly sprayed with the sticker. Just enough of the fly-ash, feldspar mixture was added to adhere to the moistened seeds. Through successive additions of sticker and pelleting material, the pellets were brought up to the desired size. Practice is needed to acquire facility.

Parathion was the only insecticide used in the pellets. It was included in amounts of 1.5 percent, 2.5 percent and 5 percent by weight of the dry unpelleted seed. For example, to make the 5 percent batch, five grams of parathion was included in the pellets made from 100 grams of seed. Separate batches were made at the above concentrations, with both the Downing Yellow Globe and the Sweet Spanish varieties and a check pellet for each. All pellets contained five percent Arasan based on the weight of the seed. The parathion and Arasan were added to the pellets at the beginning of the process by mixing them with a small amount of the pelleting material.

After the pellets had reached the desired size, they were given a coating of pure feldspar (Plate C). This was done to improve the appearance of the finished pellet. These pellets were put in trays with a screen bottom and dried by means of an electric heater.

The following pellets were planted May 20, 1949:

1.	Check pellet	Michigan Sweet Spanish
2.	1.5% parathion	" " "
3.	2.5% "	" " "
4.	5% "	" " "
5.	Check seed	" " "
6.	Check pellet	Downing Yellow Globe
7.	1.5% parathion	" " "
8.	2.5% "	" " "
9.	5% "	" " "
10.	Check seed	" " "

Space for the experimental plots was obtained at the Michigan State College Experimental Muck Farm. Seven replicate plots were laid out. Each consisted of ten 25-foot rows. A three foot space was left between plots (Table 1).

The seeds were planted by means of a Planet Jr. seed drill using a 5/16 inch opening on the disk for the pelleted seed and a 5/32 inch opening for the unpelleted seed. This was done in an attempt to get as even seeding as possible.

TABLE I

REPLICATED ONION PLOTS PLANTED MAY 20, 1949

I	II	III	IV	V	VI	VII
1_____	5_____	6_____	9_____	1_____	5_____	6_____
2_____	7_____	4_____	10_____	2_____	7_____	4_____
3_____	10_____	2_____	7_____	3_____	10_____	2_____
4_____	9_____	3_____	8_____	4_____	9_____	3_____
5_____	1_____	10_____	6_____	5_____	1_____	10_____
6_____	8_____	9_____	5_____	6_____	8_____	9_____
7_____	2_____	1_____	3_____	7_____	2_____	1_____
8_____	3_____	5_____	4_____	8_____	3_____	5_____
9_____	4_____	7_____	1_____	9_____	4_____	7_____
10_____	6_____	8_____	2_____	10_____	6_____	8_____

1. Check pellet Michigan Sweet Spanish
2. 1.5% parathion " " "
3. 2.5% " " " " "
4. 5% " " " " "
5. Unpelleted seed " " "

6. Check pellet Downing Yellow Globe
7. 1.5% parathion " " "
8. 2.5% " " " " "
9. 5% " " " " "
10. Unpelleted seed " " "

All pelleted seeds contain 5% Arasan

1950. Two batches of pellets were made in 1950, the first in May and the second in July. Those made in May were similar to those made the year before, except that different insecticides were used, the insecticide was not added until the pellet was nearly completed, and the pellets were not dried by heat.

In July, another batch was made containing the same insecticides, but instead of processing each insecticide concentration separately, one large batch of pellets was built up to nearly the desired size and then removed from the drum. These pellets were divided into equal portions and returned to the drum separately. The insecticide was added and a thin coat of the pelleting material applied. A final feldspar coating was put on as in the previous year. These pellets were not dried over the heater. They were put in trays and allowed to dry at room temperature.

Only Downing Yellow Globe seed was used. Five percent Arasan was included in all pellets in 1950.

The following pellets were planted in 1950:

1.	Check pellet	Downing	Yellow	Globe
2.	1% DDT	"	"	"
3.	10% DDT	"	"	"
4.	1% Lindane	"	"	"
5.	10% Lindane	"	"	"
6.	1% Chlordane	"	"	"

7.	10% Chlordane	Downing	Yellow	Globe
8.	0.1% Parathion	"	"	"
9.	1% Parathion	"	"	"
10.	5% Parathion	"	"	"
11.	Unpelleted seed	"	"	"

Space for planting the onions was again obtained at the Michigan State College Muck Farm in 1950. Six replicated plots were planted May 15. These plots were the same size as those planted the previous year. These seeds were not planted with a mechanical seeder, but were planted by hand. Five-hundred seeds were planted in each 25-foot row (Table 2).

On July 20, a plot was planted using seeds from the same batch as those planted in May. This plot was made up of 20-foot rows with 300 seeds to the row. This plot was for germination data.

The pellets made in July were planted in flats in the greenhouse to test germination.

TABLE 2

REPLICATED ONION PLOTS PLANTED MAY 15, 1950

I	II	III	IV	V	VI
11	2	6	9	1	4
10	8	4	5	3	7
9	6	2	1	2	5
8	4	10	7	4	6
7	11	5	11	5	3
6	10	8	3	6	2
5	1	11	10	8	9
4	3	7	6	7	10
3	5	9	2	9	1
2	7	1	8	10	11
1	9	3	4	11	8

1. Check pellet
2. 1% DDT
3. 10% DDT
4. 1% lindane
5. 10% lindane
6. 1% chlordane
7. 10% chlordane
8. 0.1% parathion
9. 1% parathion
10. 5% parathion
11. Unpelleted seed

EFFECT ON GERMINATION

Results and discussion

1949. After pelleting the seeds, a check on germination was made in the greenhouse (Table 3). It was found that all seeds were affected by the process, but whether it was by the insecticide or by the pelleting was not clear. The Sweet Spanish seed was affected to a much greater extent than the Downing Yellow Globe. This was thought to be a varietal affect or due to the lower vigor of the particular Sweet Spanish seed used. It can not be said, though, that these are entirely valid conclusions because of the fairly high germination of the Sweet Spanish seed containing five percent parathion. Another possibility is that the parathion had a stimulatory effect on the seed. All pellets showed a decided decrease in germination compared with unpelleted seed. The germination of the seeds planted in July showed a very decided decrease in germination compared to those planted in May. It has been suggested that the presence of a sticker excludes oxygen and causes the death of the seed. The results tended to support this conclusion. However, each group of pellets was made individually and pelleting times, drying times, amounts of sticker and various other factors were not equal.

TABLE 3

GERMINATION OF PELLETED SEEDS IN THE GREENHOUSE IN 1949
PELLETS PLANTED MAY 20 AND JULY 8
COUNTS TAKEN JUNE 6 AND JULY 26

Seed	Variety	Germination	
		June 6	July 26
1. Unpelleted seed	Sweet Spanish	72%	75%
2. Check pellet	" "	11%	3%
3. 1.5% parathion	" "	5%	1%
4. 2.5% parathion	" "	9%	4%
5. 5% parathion	" "	59%	41%
6. Unpelleted seed	Downing	86%	85%
7. Check pellets	"	68%	53%
8. 1.5% parathion	"	70%	57%
9. 2.5% parathion	"	82%	71%
10. 5% parathion	"	29%	11%

All pelleted seeds contained 5% Arasan

The unpelleted seeds did not contain a fungicide

The seeds planted in the field were put in by a seed drill and therefore no accurate counts were made. Since there was no infestation of the maggot in this plot during the year, yield data taken in September reflect in a general way the germination in the various plots. Table 4 shows the data as obtained from the field. Table 5 lists the pounds of onions in the rows of each concentration in the seven replicates and their averages. Figure I shows these averages graphically. The averages showed a marked difference in the yields of the two varieties of unpelleted seeds. The check pellet of each showed a pronounced drop in yield, but the Spanish seed showed the more pronounced drop. As the concentration of parathion was increased in the pellets the Sweet Spanish yields increased until at five percent the yield was considerably higher than the unpelleted seed. The Downing yields also increased with increase of insecticide up to 2.5 percent, where yield is greater than with the unpelleted seed. A very sharp drop in yield occured though, when five percent parathion was included in the pellet. Again, this may have been due to the pellet and not the insecticide. The decrease in germination of the unpelleted seeds in comparison with the germination in the greenhouse may have been due to the absence of a fungicide.

TABLE 4

YIELD IN POUNDS OF ONIONS IN REPLICATED PLOTS
SEPTEMBER 17, 1949

I		II		III		IV		V		VI		VII	
1	1.3	5	9.4	6	12.2	9	2.3	1	0.8	5	10.4	6	18.5
2	2.0	7	19.5	4	22.2	10	28.8	2	2.7	7	16.5	4	18.0
3	5.8	10	20.4	2	2.0	7	19.0	3	3.5	10	19.4	2	2.1
4	26.4	9	10.4	3	5.3	8	28.0	4	19.4	9	5.4	3	7.0
5	10.3	1	1.5	10	28.5	6	17.7	5	11.3	1	1.9	10	20.0
6	21.5	8	20.7	9	7.1	5	10.8	6	16.3	8	30.2	9	9.7
7	22.2	2	2.7	1	10.5	3	4.9	7	20.5	2	1.3	1	9.6
8	30.5	3	4.6	5	18.8	4	24.9	8	24.8	3	5.2	5	9.8
9	6.0	4	18.6	7	20.5	1	0.8	9	4.3	4	16.0	7	17.5
10	25.8	6	13.3	8	28.0	2	1.5	10	22.4	6	13.8	8	33.0

1. Check pellet Michigan Sweet Spanish
2. 1.5% parathion " " "
3. 2.5% " " " "
4. 5% " " " "
5. Unpelleted seed " " "

6. Check pellet Downing Yellow Globe
7. 1.5% parathion " " "
8. 2.5% " " " "
9. 5% " " " "
10. Unpelleted seed " " "

TABLE 5

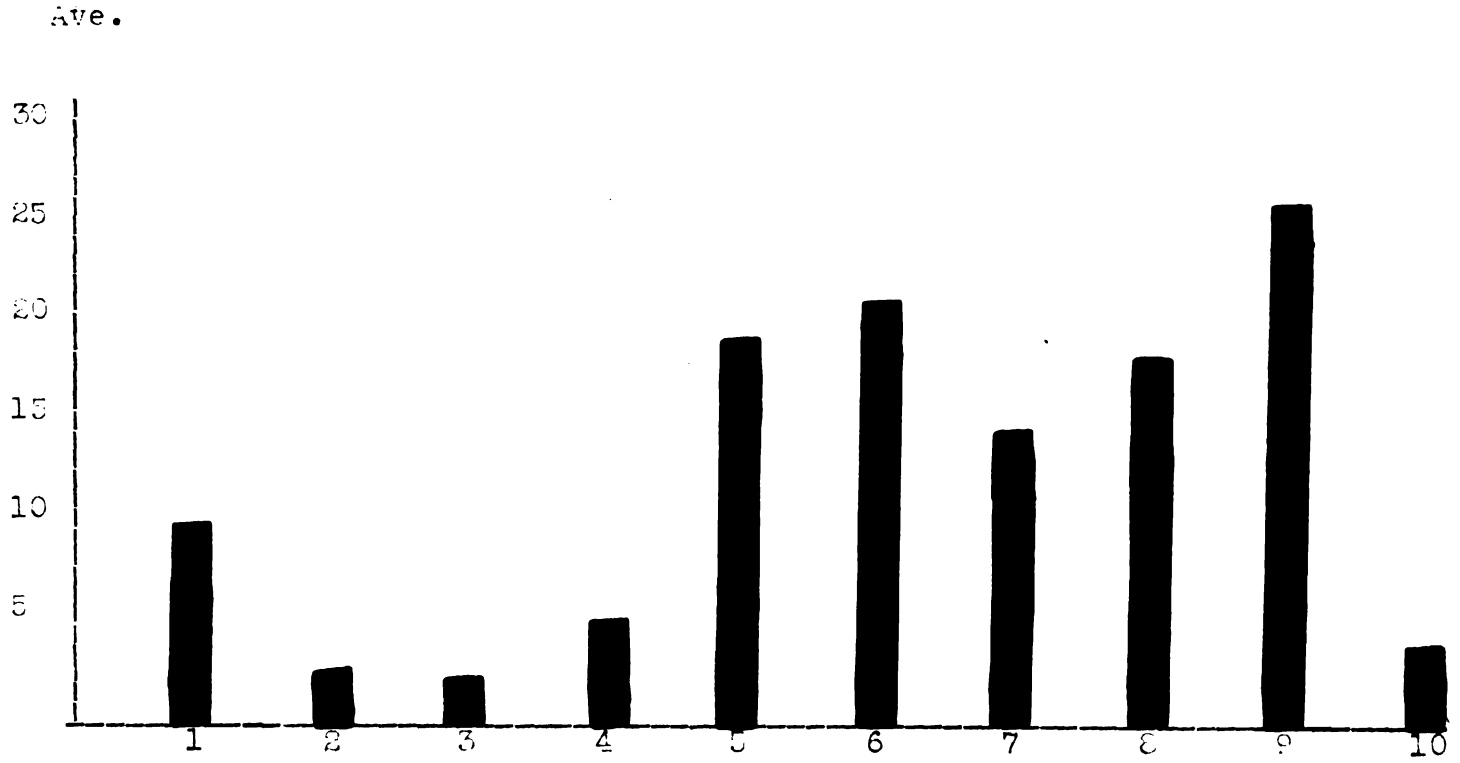
YIELD OF ONIONS FROM REPLICATE PLOTS

	Unpelleted	Check pellet	1.5% parathion	2.5% parathion	5% parathion
			Michigan Sweet Spanish		
1	10.3 *	1.3	2.0	5.8	26.4
2	9.4	1.5	2.7	4.6	18.6
3	18.8	10.5	2.0	5.3	22.2
4	10.8	0.8	1.5	4.9	24.9
5	11.3	0.8	2.7	3.5	19.4
6	10.4	1.9	1.3	5.4	16.0
7	9.8	9.6	2.1	7.0	18.0
Ave	11.5	3.8	2.0	5.2	20.8
			Downing Yellow Globe		
1	25.8	21.5	22.9	30.5	6.0
2	20.4	13.3	19.5	20.7	10.4
3	28.5	12.6	20.5	28.0	7.1
4	28.8	17.7	19.0	24.0	2.3
5	22.4	16.3	20.5	24.8	4.3
6	19.4	13.8	16.5	30.2	5.4
7	20.0	18.5	17.5	33.0	9.7
Ave	23.6	16.2	19.4	27.9	6.5

* pounds of onions

FIGURE I

AVERAGE YIELD IN POUNDS OF ONIONS IN 1949



1. Unpelleted seed Michigan Sweet Spanish
2. Check pellet " " "
3. 1.5% parathion " " "
4. 2.5% " " " "
5. 5% " " " "
6. Unpelleted seed Downing Yellow Globe
7. Check pellet " " "
8. 1.5% parathion " " "
9. 2.5% " " " "
10. 5% " " " "

1950. No germination tests were made in the greenhouse because all seeds planted in the field were counted and planted by hand. A check on germination was obtained by counts in the field. A great variation was noted in germination of the various pellets (Table 6). The seed used was claimed by the producer to have a germination of 90 percent, but in the field, it had only 72.4 percent germination. This was lower than the germination of some of the pelleted seeds. The unpelleted seed did not contain a fungicide and may have been hit by disease. The pellets with lowest germination were those containing ten percent lindane. In contrast to the results of the previous year, the high concentration of parathion decreased the germination of the seeds planted in May. The high germination of the chlordane treated seed may have indicated a stimulation by the chemical. Also a difference in the hardness of the pellet may have had an influence on these seeds. On July 11, a plot was planted using seeds from the same batch as those planted in May. This plot consisted of rows 20 feet long with 300 seeds to the row. Germination tests showed a very marked reduction in germination compared with the earlier planting (Table 6). This is the same effect as found 1949 and probably was caused by the exclusion of air from the seed by the sticker. Striking exceptions to this, however, are one percent chlordane, one percent parathion and five percent parathion.

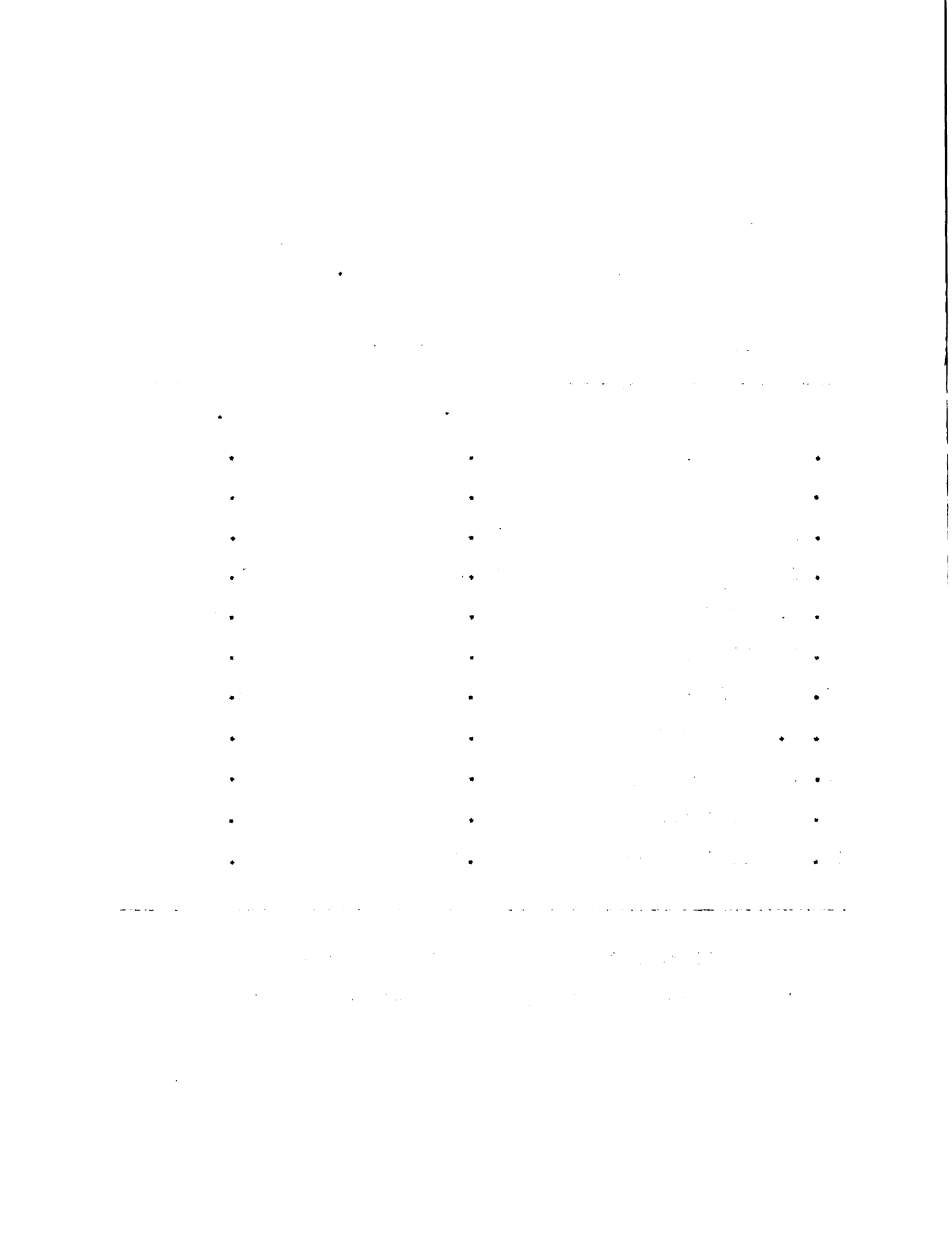
TABLE 6

GERMINATION OF PELLETED SEED IN THE FIELD IN 1950
PELLETS PLANTED ON MAY 15 AND JULY 11
COUNTS TAKEN JUNE 10 AND AUG. 4

Seed	Germination	
	June 10	Aug. 4
1. Check pellets	79.2%	16.6%
2. 1% DDT	73.0%	20.6%
3. 10% DDT	72.4%	27.3%
4. 1% lindane	52.0%	37.6%
5. 10% lindane	11.6%	2.0%
6. 1% chlordane	57.2%	59.3%
7. 10% chlordane	84.4%	42.6%
8. 0.1% parathion	49.4%	39.0%
9. 1% parathion	43.6%	50.3%
10. 5% parathion	31.4%	43.6%
11. Unpelleted seed	72.4%	69.6%

All pelleted seeds contained 5% Arasan

The unpelleted seeds did not contain a fungicide



These chemicals might have had a stimulatory effect on the seed. This was thought to occur in 1949 with seeds pelleted with parathion and showed up again in this test, although it was not apparent in those seeds planted in May. These pellets were processed in separate batches and therefore the germination results may have been affected by the particular conditions occuring during the individual pelleting processes.

To find the true effect of the insecticide on the germinating seed another group of seeds was pelleted in July. As stated earlier, these pellets were made in one large batch. The pellets were removed and divided into ten equal amounts. These were returned to the drum separately and the insecticides added. In this way, the pelleting was as nearly identical as possible. Only the insecticides were different and therefore should be the major cause of differences in germination. These pellets were planted in flats in the greenhouse. Sterilized muck soil was used. Germination counts were taken from September 5 to October 6. The data obtained are presented in Table 7 and in Figures II, III and IV. The results of this work show that the process of pelleting is one of the major factors in the reduction in germination of the onion seed. The pelleted seeds showed both a marked decrease in germination and a retardation of germination. The maximum germination of the unpelleted seed was reached in 13 days after planting.

TABLE 7

PERCENTAGE OF GERMINATION OF PELLETED SEED PROCESSED IN JULY 1950

Pellets *	Days after planting																					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22 - 37
1.	0	0	0	0	0	0	4	11	18	22		32	43	44	47	48	49	49	49	49		50 50
2.	0	0	0	0	0	0	8	21	32	42		45	45	46	46	46	48	49	50	50		54 64
3.	0	0	0	0	0	0	5	9	10	13		15	15	15	16	16	16	16	17	18		18 21
4.	0	0	0	0	0	0	0	8	14	20		26	32	35	36	38	38	38	38	38		38 42
5.	0	0	0	0	0	0	9	14	20	28		37	39	41	43	43	43	43	43	43		43 49
6.	0	0	0	0	0	5	11	18	24	29		43	45	48	51	51	52	52	53	53		56 58
7.	0	0	0	0	0	0	0	0	1	1		1	4	4	5	5	5	5	6	6		7 10
8.	0	0	0	0	0	2	3	6	8	10		17	17	19	22	24	25	26	29	29		31 37
9.	0	0	0	0	0	0	0	13	19	27		37	41	42	42	42	42	42	42	42		42 48
10.	0	0	0	0	0	9	21	41	53	62		64	68	68	68	68	68	69	69	69		69 69

Pellets *

1. Check pellet
2. 1% DDT
3. 10% DDT
4. 1% lindane
5. 10% lindane
6. 1% chlordane
7. 1% parathion
8. 5% parathion
9. 10% parathion
10. Unpelleted seed

FIGURE II

PERCENTAGE OF GERMINATION OF PELLETED SEED PROCESSED IN JULY 1950

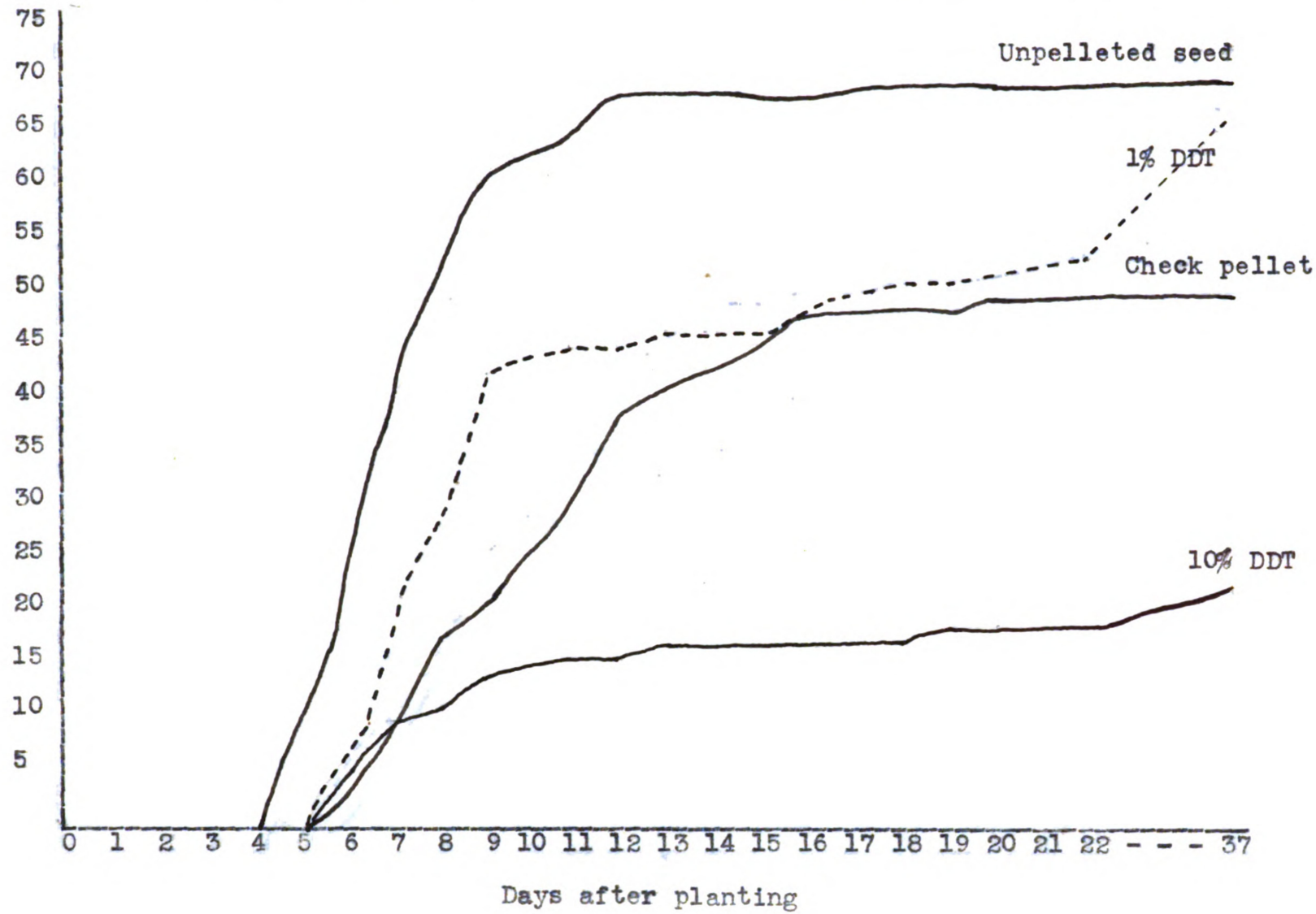


FIGURE III

PERCENTAGE OF GERMINATION OF PELLETED SEED PROCESSED IN JULY 1950

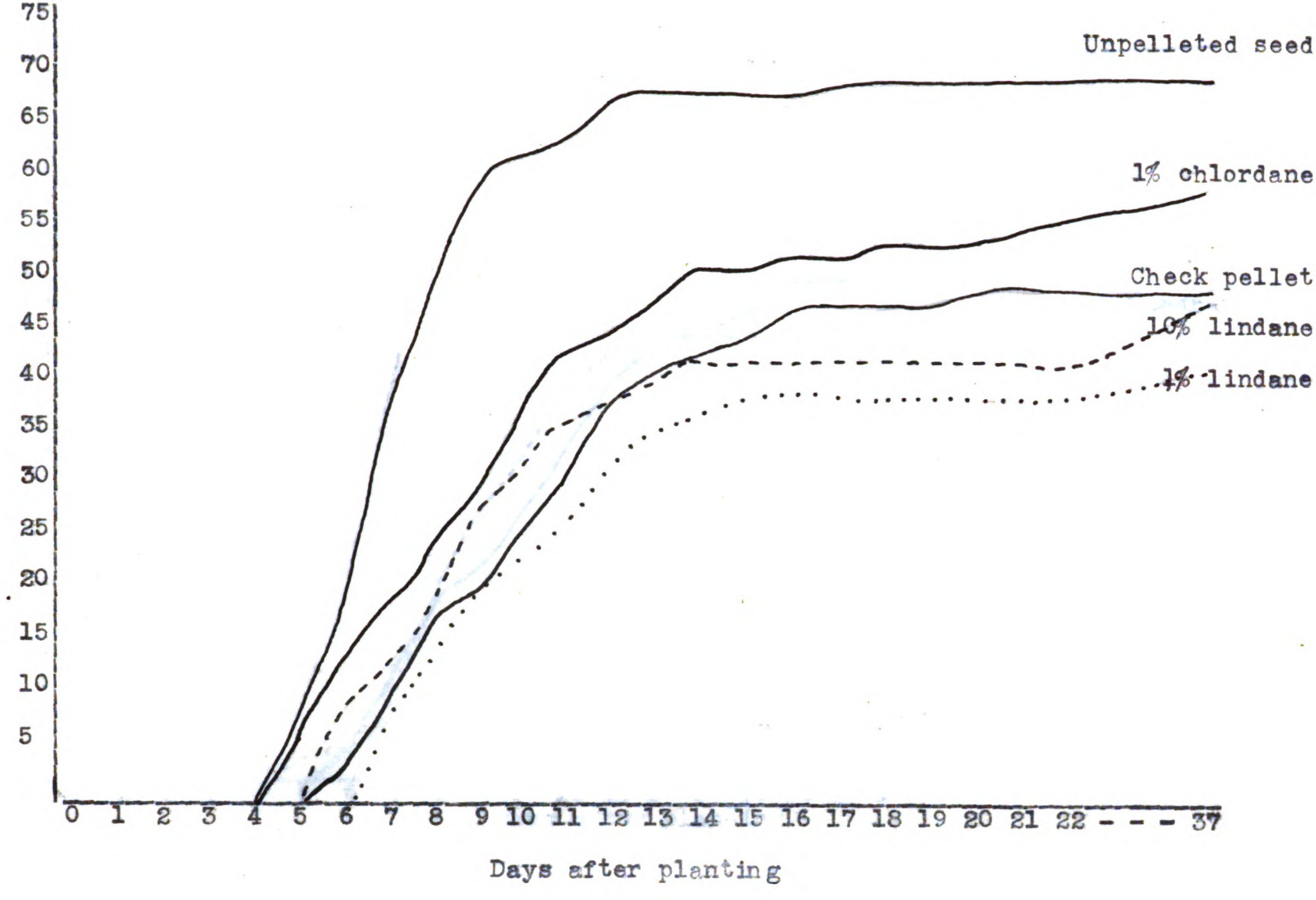
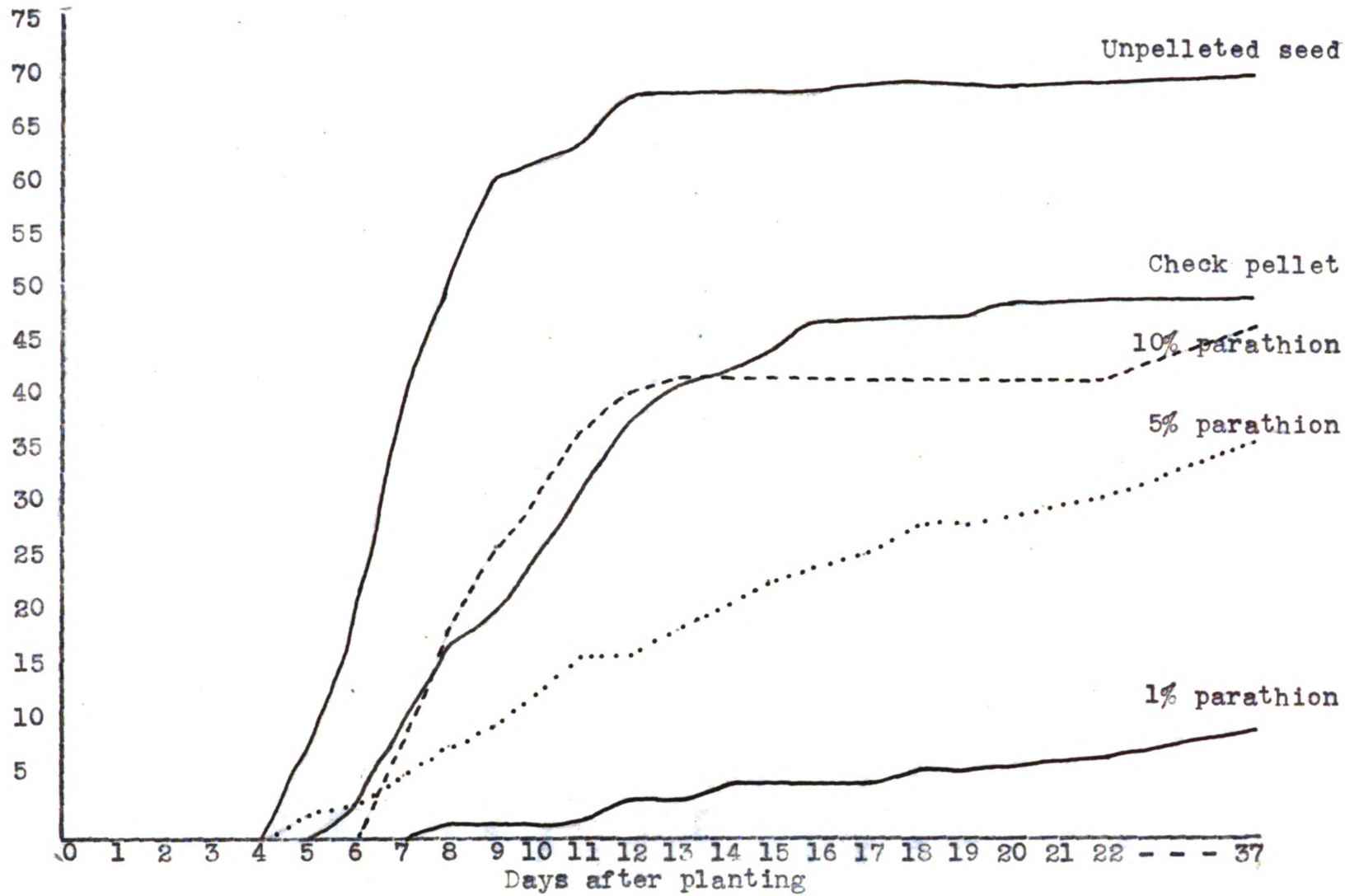


FIGURE IV

PERCENTAGE OF GERMINATION OF PELLETED SEED PROCESSED IN JULY 1950



Maximum germination of the check pellets was not reached until 17 days after planting. All the pellets except one percent DDT and ten percent parathion have a much more gradual germination curve than the unpelleted seed. These two show a definite leveling off of the germination curve after about the same amount of time as that shown for the unpelleted seed although at a much lower germination level. These two however show another upward surge in germination after 23 days indicating a definite retarding effect on the seed. The seeds showing the slowest germination were those containing 1 percent and 5 percent parathion. The germination was very low and extended over a long period of time. Time did not allow an extension of the test to find if germination would continue with these pellets, but the germination was still increasing when the test was stopped. Pellets with 10 percent DDT also showed very retarded and poor germination. It was increasing slowly at the end of the test.

To the onion grower, this retardation of germination would be very undesirable since it would spread the harvest over an extended period causing a loss of time and an increase of labor.

EFFECT ON INFESTATION

Results and discussion

1949. No infestation of maggots was noted from the first brood of flies. A very few were noted later in the season, but they had no appreciable affect on the yield. This experimental planting of onions was situated between two large fields of onions, which were dusted during the period of oviposition with 5 percent chlordane dust. It was thought that due to the presence of the dust on both sides of the plots the population of flies was depleted to the extent that even on the undusted plots no flies were present to lay eggs. The only extensive damage due to the first brood flies at the muck farm was in a field of onions planted very early in the season. All other fields of onions were dusted with 5 percent chlordane and showed very little infestation of onion maggot.

1950. The second year the pelleted seed plots were removed as far possible from other onion fields at the farm. Complete isolation was impossible, but the experimental area was bounded on one side by sugar beets and on the other by table beets and the nearest dusted onions were about 30 yards away. Even with these precautions no first brood infestation occured in this group of replicates, the infestation by the first brood was very light throughout the farm.

About 1 percent infestation was estimated.

The only plot infested by the onion maggot was the one planted July 11 (Table 8). This had been planted to test the difference in germination between those seeds planted immediately after pelleting and those stored over a length of time. This plot was infested heavily by the second brood. By this time, the germination had been seriously affected, especially by the 10 percent lindane. Also the check pellets, 1 percent DDT pellets and 10 percent DDT pellets were low enough in germination to impair the validity of control data. The check pellets showed a lower infestation than the pellets containing 10 percent DDT, 1 percent lindane and 10 percent lindane (Figure V). The germination of the remaining pellets was considerably higher and there was some indication of control. The pellets containing 5 percent parathion showed the most control, followed by 1 percent parathion, 10 percent chlordane, 0.1 percent parathion and 1 percent chlordane. The infestation of the unpelleted seed was very marked, but this was probably partly due to the higher germination and therefore the closer proximity of the onions in the row. In this row, the maggots were more apt to migrate from one plant to another.

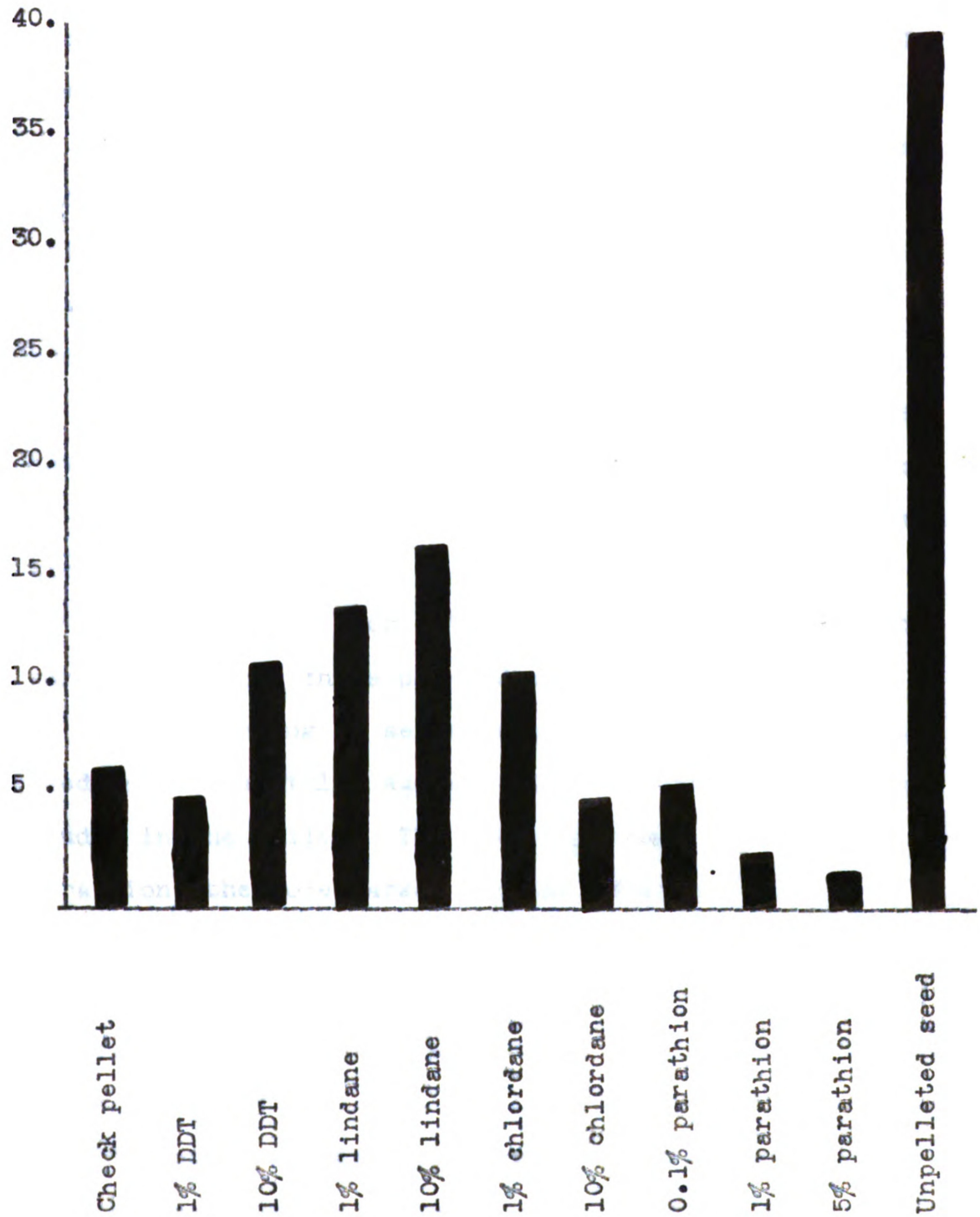
TABLE 8

GERMINATION AND INFESTATION OF ONIONS PLANTED JULY 11, 1950
THREE HUNDRED SEEDS WERE PLANTED IN EACH ROW. COUNTS WERE MADE AUG. 4, 1950

Row	Pellet	No. germinated	No. of plants infested	Percent germinated	Percent infested
1.	Check pellet	50	3	16.6	6.0
2.	1% DDT	62	3	20.6	4.8
3.	10% DDT	82	9	27.3	10.9
4.	1% lindane	113	15	37.6	13.3
5.	10% lindane	6	1	2.0	16.6
6.	1% chlordane	178	18	59.3	10.1
7.	10% chlordane	128	6	42.6	4.6
8.	0.1% parathion	117	6	39.0	5.1
9.	1% parathion	151	4	50.3	2.8
10.	5% parathion	137	2	43.6	1.5
11.	Unpelleted seed	229	78	69.6	39.7

FIGURE V

PERCENT OF PLANTS INFESTED WITH MAGGOTS
ONIONS PLANTED JULY 11, 1950
COUNTS TAKEN AUG. 4, 1950



SUMMARY

In this work a varietal difference was noticed in the severity of seed damage caused by the pelleting process. Michigan Sweet Spanish seed germination was considerably lower than that of Downing Yellow Globe.

The pelleting process varies so much from one batch to another that an accurate check on the effect of the pelleting and on the inclusion of insecticides is not feasible unless various concentrations of insecticides are added to pellets processed at one time.

The 1949 pellets which contained parathion appeared to have been stimulated in comparison to the check pellets.

Pelleting always had an adverse effect on the germination of the seed.

Seeds planted soon after pelleting had a much higher germination than those planted a month later.

The pelleting of seeds retarded the emergence of the seedlings. Parathion aggravated this further when it was included in the pellet. The lower the concentration of parathion, the more marked was the effect.

Parathion and chlordane when included in the pellets, controlled the onion maggot, but until ways of pelleting are perfected which will not effect the germination so drastically, this method of control is not practical. The loss in germination caused by pelleting may be more serious than the damage caused by the maggots.

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PLATE A

PELLETING EQUIPMENT

COMPRESSOR, GUN AND SPRAY CONTAINER

PLATE B

PELLETING EQUIPMENT

MOTOR AND DRUM

PLATE C

UNPELLETED AND PELLETED ONION SEED

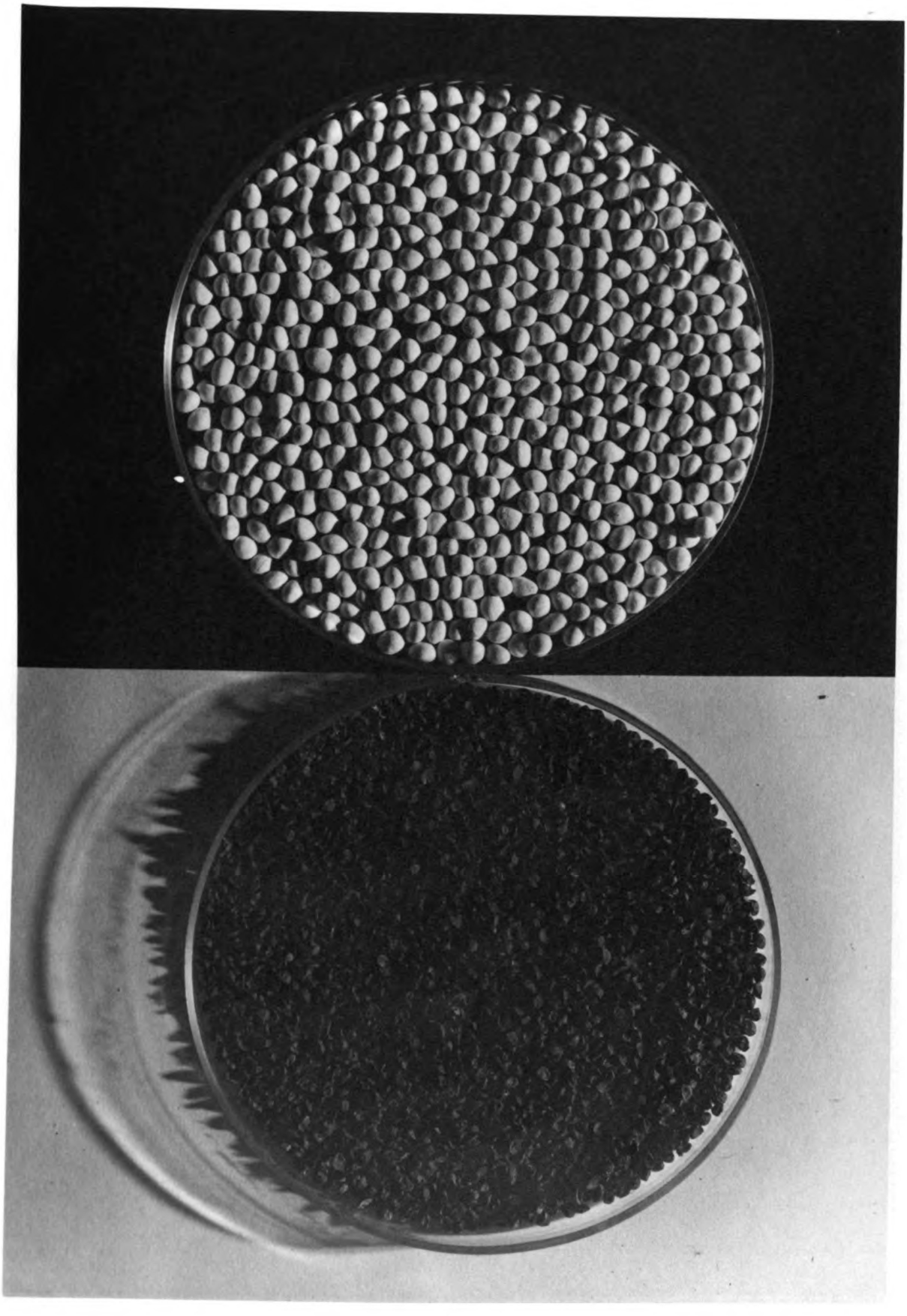

PLATE D

ONION MAGGOT DAMAGE IN THE FIELD

ROOM USE ONLY