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The Effect of Different Methods of Handling Chicken Manure on the Viability of Weed Seed

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THE EFFECT OF DIFFERENT METHODS OF HAND-LIME CHICKEN MANURE ON THE VIABILITY OF WEED SEEDS.

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INTRODUCTION

It is well known that weeds spread and are perpetuated by means of seed and vegetative reproduction. The seeds in turn are spread by various agencies, such as wind, snow, water, animals, and man. These agencies are aided by especially adapted seed mechanisms for dissemination.

As vegetative reproduction can take place only after the plant has become established, the most logical means of eliminating this type of reproduction is to prevent the seed from germinating. Thousands of dollars have been spent in the eradication of weeds from the fields and waste lands of Utah, with varying degrees of success. In spite of the great amount of effort exerted and money spent in eradicating noxious weeds, it is now a very serious problem, confronting the people of Utah.

No doubt, there are many weed seeds carried in hay, straw and grain feeds which find their way into manure and are later hauled to the land. Especially is this true in the case of the poultry manure, because the grain is fed largely as scratch feed in the litter and the weed seeds are not eaten by the poultry. With the growth of the poultry industry in Utah in recent years, there is considerably more chicken manure produced, there-by increasing the hazards of spreading weed seeds—providing the manure is spread on the land. This increased production of manure is a valuable source of fertilizer. Many farmers hesitate to use this manure because of the likelyhood of it carrying weed seeds. It has been a common practice among some farmers to allow the chicken manure to be wasted, and at the same time their land to become lacking in organic matter necessary to make it highly productive. The importance of adding organic matter to the soil is well known and the amount is usually limited on most farms. If the chicken manure

could be handled in any way such as to destroy the viability of the seeds and give the farmer fairly good assurance against such a hazard, much valuable organic matter could be returned to the soil. This experiment was conducted to determine to what extent (weed seeds retain their viability in poultry manure and if some practical method of handling manure could be used to destroy the viability of such seeds carried in it.

REVIEW OF LITERATURE

Several experiments have been conducted to determine the viability of seeds under various conditions and during various periods of time. Some workers have been chiefly interested in the longevity of stored seeds and the factors influencing it. Others have been concerned with a study of organic and inorganic substances as a means of maintaining or destroying the viability.

Dalton (1) has found that the longevity of seeds is affected by the humidity and storage conditions, the degree of maturity and weather conditions at time of harvest, and the methods of harvesting and storing.

Seeds were submerged for a period of seven years and some were found to be still viable at the end of this period. (2). Barton (3) thinks that the capacity for germination is not destroyed by long-continued soaking in sterile media. Morinaga (4) germinated seeds under water. Of the 73 genera in 24 families, 45 germinated. Of the 45 germinating, 13 showed no decided difference between the germination in water and on filter paper, and 2 germinated better in water.

Organic substances such as alfalfa, casein, peptone and sugar, were added to a silt loam soil in which seeds of alfalfa, buck wheat castor bean, red clover, corn, cotton, flax, hemp, white lupine, mustard, oats, serradella, soybean, sunflower, sweet pea and wheat were planted. (6). It was found that nitrogenous substances, such as alfalfa powder, casein, and peptone did not seriously injure germination unless used in very large amounts. Sugar increased bacterial growth and retarded the rate of germination and in large amounts, it decreased the percentage of germination.

The viability of many seeds were destroyed after being burried in a silage. (6). A large number of seeds of grain, grasses, legumes and weeds were distributed in a silo as it was being filled and remained in the silo for periods ranging from 2 to 22 months. The germination tests, made upon removing the seeds from the silo, showed the seeds to be dead in nearly every case. In a few cases alsike clover, crab grass, sorghum, red clover, alfalfa, wormseed, mustard and amaranthus showed a one percentage germination. (6). Similar results were obtained at Kansas. (7). Only three of eleven species of weed seeds germinated after being in a silo. These were: Field bindweed, Morning-glory and Velvet Leaf. Morning-glory and Velvet Leaf gave a higher germination than the check.

Seeds have been buried in the soil to determine how long they would remain dormant and yet germinate under favorable conditions. Dr. Beal (2, 3) was the first to obtain specific data on this subject. In 1879 at East Lansing, Michigan, 20 inverted-open mouth bottles, each containing 50 seeds of each of 23 species were buried in sand at a depth of about twenty inches. One of these bottles was taken up

every 5 years. At the end of 40 years ten of the 23 species produced sprouts. (10). In 1902 Duval (11) set up an experiment using the general plan of Dr. Beal. He used 100 species, representing 94 genera and 54 families. These seeds were buried in well-baked earthen pots at three different depths. This work was continued by Goss (9) and at the end of twenty years the results showed that the depth at which they were buried had little effect on their vitality. He concludes that seeds of most weeds when plowed under will not perish, during the period of a normal crop rotation, and that weed seeds survive better than crop seeds. Experiments at Rothamsted (12) show that certain seeds appear to lie dormant in the soil for long periods and germinate under favorable conditions. Similar results were obtained at Iowa.(13).

Green manure may also injure the germination of certain seeds. (14).

The effect of fermentation of manure on the germination of weed seeds has been studied at Iowa (15) and Maryland (16). At both stations horse manure, cow manure and horse and cow manure mixed in equal parts were used. At Maryland 52 varieties of seeds were placed in the manure for periods of one month and six months and all the seeds failed to germinate after the one month and six month period. Iowa station obtained the same results in 1907 for the 60-day and 6-month period, but for the one month period six species germinated. In 1908, 21 different seeds of weeds and a few cultivated plants were left in the horse manure for five weeks. The highest percentage germination of any weed seed was one percent. Most of them failed to germinate.

METHODS AND MATERIAL

Manure Used

The material for this experiment consisted of chicken manure obtained from the poultry houses at the Utah State Agricultural College. With the cooperation of the poultry department arrangements were made to save the litter and droppings from poultry houses during the months of October and November. The manure was piled out side the coops in small piles until the experiment was started. Due to the long dry autumn, the manure was kept practically air dry during this period.

When the experiment was begun, the manure was gathered and placed in piles of desired size. Both large and small piles of manure were used. The large piles contained approximately 2 2/3 yards of the dry manure and the small piles contained approximately 1 1/3 yards. The manure was measured in a wagon box as it was hauled from the coops. The experimental piles were built as the seeds were placed in them. The approximate size of the piles was 32 inches in diameter at the base and 40 inches high for the large piles and 30 inches in diameter and 25 inches high for the small ones. Exceptions to this rule were the piles that were compacted, they being somewhat less in height and flattened on top.

Twelve piles, 6 large and 6 small, were alternately placed in two rows running east and west and were used over a period of four months. The four small piles that were used over a period of 30 days were located between the two rows so that each of these piles were surrounded by four other piles. (Figure 1.)

Figure 1, Showing manure piles at the end of the experiment. (1), large pile of litter alone; (2) small pile moistened and left loose; (3), small pile of litter and droppings mixed; (5), large pile of litter moistened and compacted; (6), small pile of litter moistened and compacted; others, duplication of above groups.

Seeds.

The weed seeds used for this experiment were Wild Morning-glory (Convolvulus arvensis), White-top (Lepidium draba) and Russian Knap weed (Centaurea picris).

The seeds were harvested in the fall of 1932. The Morning-glory seed was obtained at North Logan, about a mile north of the college. The White-top seed was gathered from about two miles west of Logan City and the Russian Knap weed seed was taken from the Bench farm, at Trenton, Utah.

Seeds of all three species were germinated before being placed in the manure in order to determine their viability. Some difficulty was encountered in getting the seeds of White-top and Morning-glory to give a high germination. The seed was treated in various ways, such as freezing for various periods of time, scarification and treating with sulphuric acid. None of these methods increased the germination of White-top. However, the germination did increase with the age of the seed so that after two months a reasonably high germination was obtained. The studies showed that a high percentage germination of Morning-glory could be obtained by treating with 25 Normal Sulphuric Acid for 15 minutes. This treatment for Morning-glory seed was necessary throughout the experiment. Even after the seed had remained in the center of a pile of manure that had been wet and packed for a period of four months. Only 1% germination was obtained with seed receiving no treatment compared to 80% germination with seed treated with sulphuric acid for 15 minutes. The hard seed coat of the Morning-glory is impermeable on many of the seeds and prevents the absorption of water.

Containers

In order to recover the seeds and at the same time bring them into direct contact with the manure, wire mesh containers were used. These containers were made of galvanized wire to prevent rapid oxidation and destruction. Although these containers served the purpose for this experiment, a more substantial container would be necessary if they were to be left in the manure for a longer period than four months, since the wire mesh of some of them was partly decayed at the end of the experiment. The containers were made by placing two square pieces of mesh wire together with seeds between and the edges sealed with a piece of galvanized tin, 5/8 inches wide, by being clamped over them as shown in Figure 2. Sixteen mesh, 5 X 5 inch containers were used for the Morning-glory seed and twenty-four mesh 3 X 3 inch containers were used for the White-top and Russian Thistle weed seed. Approximately six hundred seeds of each species were measured out and placed in separate containers. Sixteen containers of each of the three species were placed in each pile, making a total of 768 in all, with approximately 600 seeds in each container. This made approximately 460,800 seeds used for the experiment, or about 153,600 seeds of each specie.

As some of the baskets were taken out of the manure at four different periods, it was necessary to have a large number of manure piles or to perfect a method of removing certain containers from the pile without disturbing the others. As the former method was prohibitive and undesirable, a piece of light baling wire was fastened to the four sides of the container so that the seeds could be pulled out of the pile with little or no disturbance to the manure. The ends of the wires extended outside of the piles. They were bent and arranged so

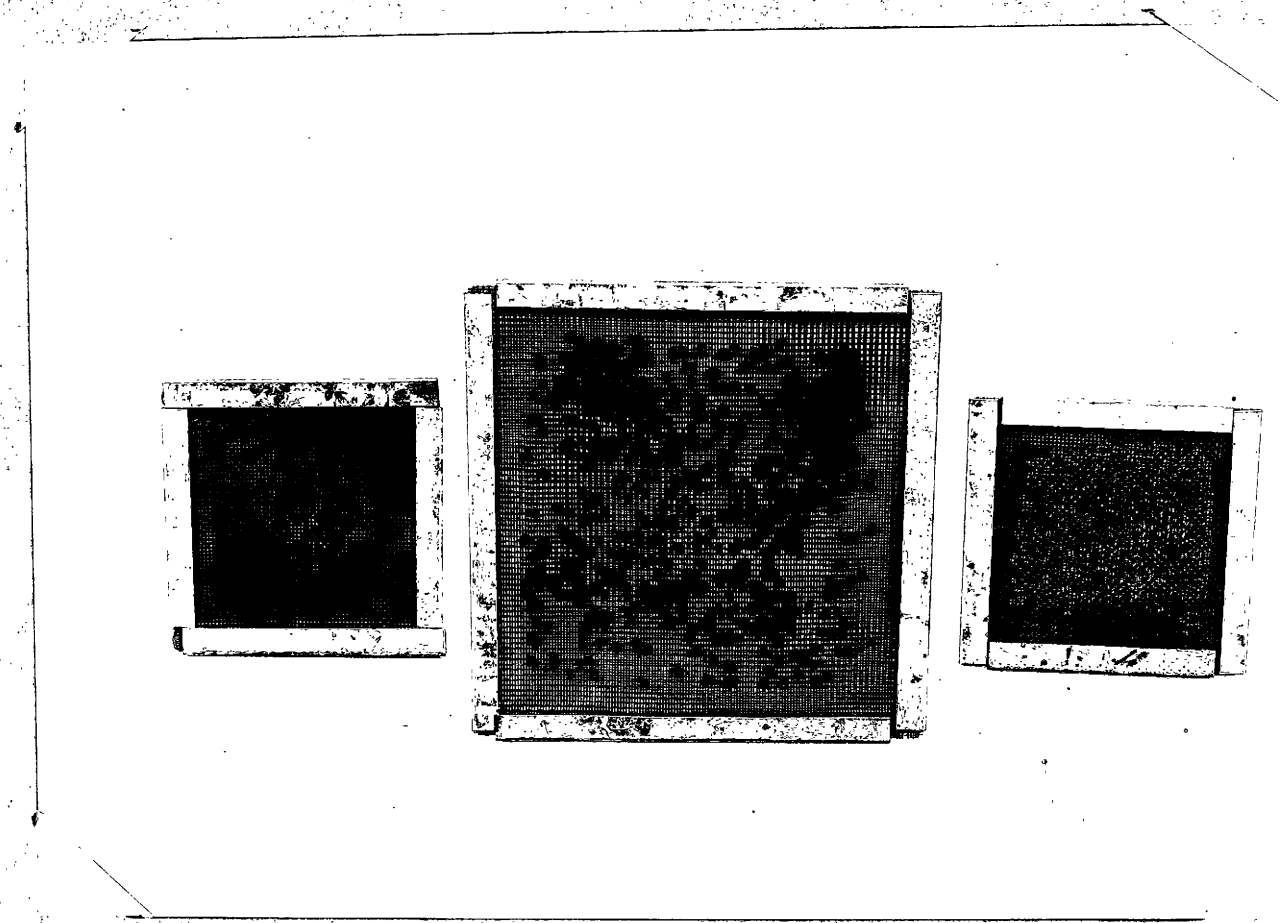

Figure 2, Showing wire mesh containers with seeds. Left, White-top (Lepidium drabe) seed; center, Morning-glory seed, (Convolvulus arvensis) and right, Russian Knap Weed (Centaurea piaris) seed.

as to indicate the kind of seed and the location of each container in the pile.

The containers were placed at two horizontal depths. The height of the pile was divided as near as possible into thirds. The top and bottom layer being at 1/3 and 2/3 the distance, respectively. Each of these layers were divided vertically into fourths, by laying two, one-inch strips of wood perpendicular to each other on the pile so that the ends coincided with the four pegs that were driven in the ground on the South, North, East and West sides of the pile. The strips of wood were removed, however, after the containers were set in place. The bottom third of the pile was built, and the wire mesh containers with the seeds were set in place, then about one-third of the remaining manure was placed on top of the containers and the next layer of containers were laid in position and the remaining manure added to complete the pile. The top and bottom horizontal layers each consisted of 24 containers, 8 containers of seeds for each of the three species. The two layers were identical except that the top layer was taken out just opposite the bottom layer. The following description of the bottom arrangement will apply to the top. Half of the baskets formed a small circle in the center of the pile and the other half formed a larger circle near the outer edge of the pile as shown in Figure 3. Each quarter section of the layer contained 6 containers--3 in the center of the pile and 3 near the edge. The three center containers were the same as the three outer ones, but to be removed after different periods of time. From between two stakes going from left to right the species were arranged in a systematic order as follows: Russian Knap Weed, Whitetop and Morning-glory. The containers that were to be taken out last from each section were set in and covered with about two inches of manure

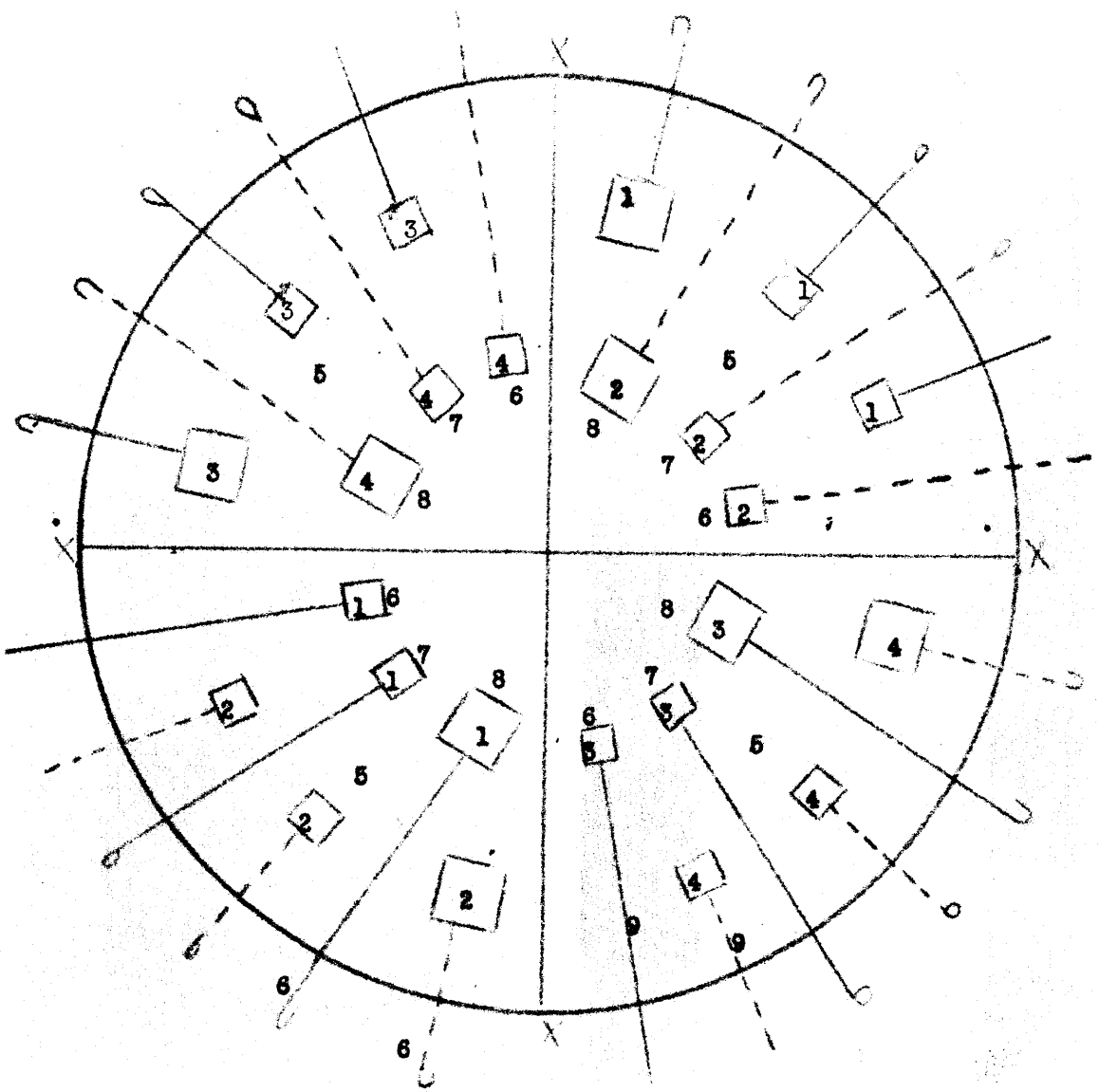

Figure 3. - Showing the location of the containers at one horisontal layer or depth in the pile. (1) Containers removed first period, (2) containers removed second period, (3) Containers removed third period, (4) containers removed fourth period, (5) quarter or section, (6) Russian Knap Weed seed, (7) White-top seed, (8) Morning-glory seed, (9) wire fastened to baskets, (X) stake.

and the others were then set in place. This was done to prevent any disturbance when the first set was pulled out.

The center containers of the bottom layer averaged about 20 inches from the edge, while those of the top layer were slightly less, averaging about 17 inches. The outer containers were about 9 inches from the edge on the bottom and about 8 inches from the edge on the top layer. Twelve containers were taken from each pile at four different periods, 3 from the bottom center, 3 from the bottom edge, 3 from the top center and 3 from the top edge of the pile. The three containers represented the three species of seeds, thus making four lots of each species from each pile each time they were removed.

The order in which they were removed is as follows:

First period.

South-west section of pile.
Bottom - center
top - edge

North-east section.
bottom - edge
top - center

Second period.

South-west section of pile.
bottom - edge
top - center

North-east section.
bottom - center
top - edge.

Third period.

South-west section of pile.
bottom - center
top - edge

North-west section.
bottom - edge
top - center

Fourth period.

South-east section of pile.
bottom - edge
top - center

North-west section
bottom - center
top - edge.

The bottom and top refers to the horizontal layers or depths in the pile and the center or edge indicates the position vertically or the distance from the outer surface of the pile.

As the baskets were removed from the manure, they were tagged and brought to the laboratory for germination tests.

Germination of Seed in Lab.

The germination tests were made in the seed laboratory. The seeds were germinated on blotter paper and also in soil. A sample of one hundred seeds taken from each basket was germinated on the surface of blotter paper in tin plates 6 inches in diameter for a period of 30 days. A similar number were germinated in the soil for a period of two months. Where the viability of the seeds was destroyed, all the remaining seeds from those lots were placed in the soil to determine if any were viable. Similar seed kept under reasonably good storage conditions were used as checks. These seeds planted in the soil were seeded in duplicate rows, containing 50 seeds to the row. They were seeded in boxes 17 1/2 inches wide, 22 1/2 inches long and 5 1/2 inches deep. soil
The seeds were placed in moist and lightly covered. A fine sand soil was used except for the first two sets taken from the loose, moistened piles, which heated and for these a loam soil was used. The germination in the soil was continued for a period of 60 days.

TREATMENT AND RESULTS

Twelve piles were used over a period of four months; four piles, over a period of 30 days. The twelve consisted of three duplicate treatments containing a large and a small pile. The first treatment was litter and droppings mixed in the same proportion as was obtained on cleaning the poultry house. The second was litter alone. (As the coops were cleaned, the litter was kept separate from the droppings.) The third was litter alone with water added and the pile compacted. The water was added and the manure compacted by trampling as the pile was being built. One hundred gallons of water were used on the large piles and seventy gallons, on the small piles.

The remaining four piles consisted of two duplicate treatments. They were small piles (387 pounds) composed of litter. Two piles were nearly saturated (17) by adding 100 gallons of water and to the other two, 50 gallons were added. In the case of these four piles, the manure was mixed as the water was added. The manure was left loose to make the conditions favorable for rapid heating.

The seeds were taken from these four piles at intervals of 10, 20, 30 and 50 days. At the end of the first 10 days, the percentage germination of the White-top and Russian Knap Weed seeds was very low. (Table 1.) White-top germinated only 0.5 per cent in the soil with the treatment where the 50 gallons of water were added. Russian Knap showed a similar percentage germination of 0.5 in the soil and 0.1 on blotter paper when a hundred gallons of water were added to the manure. In the case of the Russian Knap Weed the seed that germinated

Table 1 - The Effect of Different Treatments of Chicken Manure and the Duration of Time on the Viability of Morning-glory (Convolvus arvensis), White Top (Lepidium draba), and Russian Knap Weed (Centaurea picris).

Treatments	Size of Pile	Percentage Germination: Check (1) Dec. 20 Soil	Check (1) Dec. 20 B.P.(2)	Period of Time Seed Remained in the Manure: Dec. 5 to Dec. 20 Soil	Dec. 5 to Dec. 20 B.P.	Dec. 5 to Jan. 5 Soil	Dec. 5 to Jan. 5 B.P.	Dec. 5 to Jan. 8 Soil	Dec. 5 to Jan. 8 B.P.	Dec. 5 to Jan. 29 Soil	Dec. 5 to Jan. 29 B.P.	Check (2) Jan. 30 Soil	Check (2) Jan. 30 B.P.
Morning-glory													
Litter Loose With 100 gal. water Added	Small	94.0	88.0	70.0	46.6	82.0	87.0	85.0	87.0	85.0	85.1	81.0	72.0
Litter Loose With 50 gal. water Added	Small	84.0	88.0	80.0	38.0	73.0	78.0	72.0	82.0	77.0	80.1	81.0	72.0
White-top													
Litter Loose With 100 Gal. Water Added	Small	80.0	85.0	0	0	0	0	0	0	0	0	87.0	82.0
Litter Loose With 50 Gal. Water Added	Small	80.0	85.0	0.2	0	0	0	0	0	0	0	87.0	82.0
Russian Knap Weed													
Litter Loose With 100 Gal. Water Added	Small	88.5	86.0	0.5	0.1	0	0	0	0	0	0	86.0	84.0
Litter Loose With 50 Gal. Water Added	Small	88.5	86.0	0	0	0	0	0	0	0	0	86.0	84.0

(1) Germination of seed before placing in manure.

(2) Similar seed kept under reasonably good storage conditions.

(3) Blotter paper.

was taken from the bottom edge of a pile that was slower to start heating than the others. This was probably due to the fact that when the seed was placed in the pile, the water that had been added to the manure was frozen. It was the last pile completed and the temperature of the atmosphere at the time was falling rapidly. At the end of the 20-day period and there after, the White-top and Russian Knap Head seeds failed to germinate. This was not true, however, with Morning-glory, Figure 4. The Morning-glory germinated even better at the end of 30 days than it did at the end of 10 days. The lower percentage germination the first 10 days may be partially due to the heat being turned off from the laboratory for a few days after the seeds were planted, although a high percentage was obtained with the checks that were planted at the same time. It was evident, while taking data, that Morning-glory seed taken from the moistened piles germinated sooner than seed taken from dry piles. This may help to explain the lower percentage germination, at the end of the first ten day period. The seeds from the manure piles germinating sooner than the checks would likely be injured more from lowering the room temperature. The seeds from the top center of the pile where the temperature was highest showed a lower percentage germinated, which helps to substantiate the previous explanation. The Morning-glory in every case showed a lower percentage germination where the 50 gallons of water were added to the manure than where 100 gallons were added. The difference is small and one is not especially concerned so much with the amount of germination as with the viability being or not being destroyed.

The temperature of these piles was taken at irregular intervals by placing the thermometer in the pile and reading the temperature as soon as possible on removing it from the pile. The experiment began

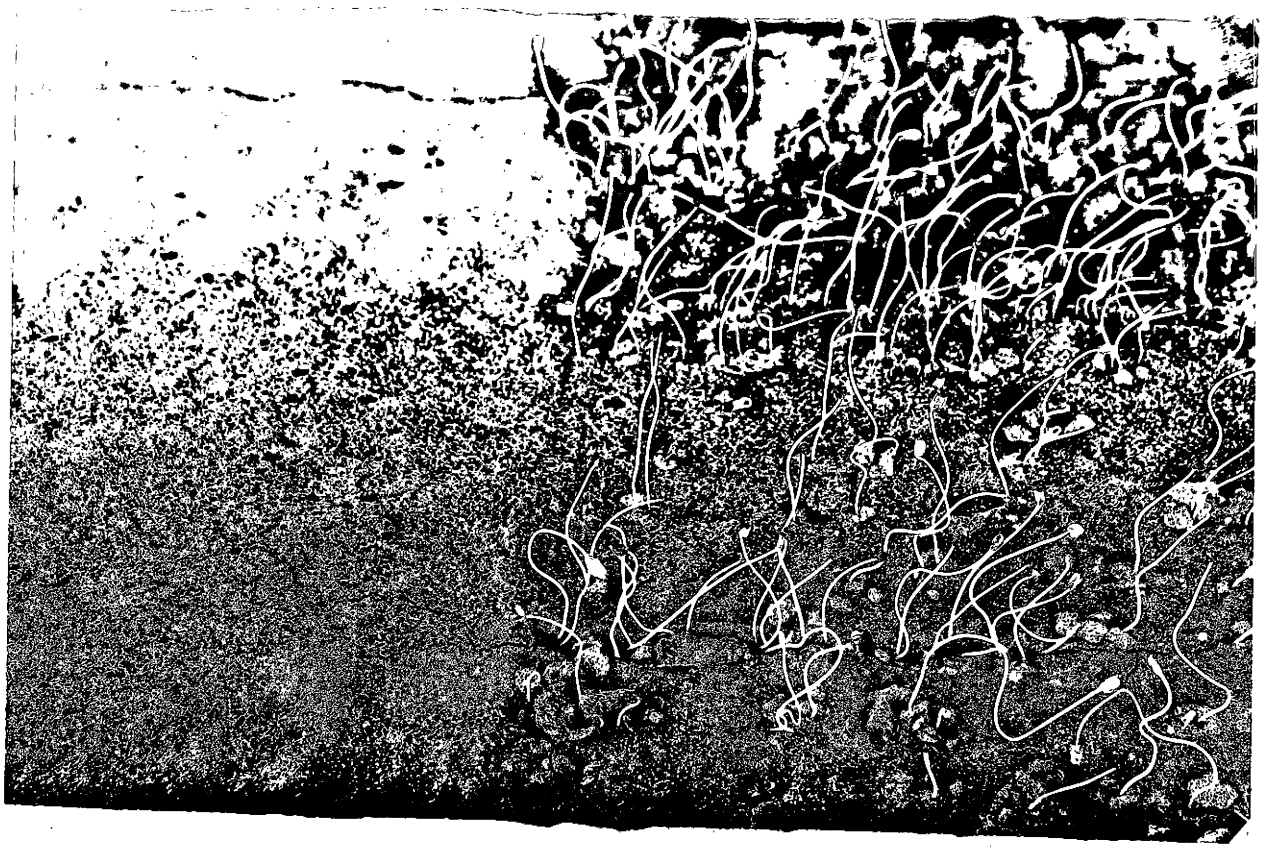

Figure 4. Showing that White-top (Lepidium draba) (left) failed to germinate at the end of the 30-day period after being in loose, moistened manure, while the Morning-glory (Convolvulus arvensis) (right) continued to germinate.

December 13, 1922 and December 15, three of the piles were heating to a temperature of 65° to 70° C. at the top center of the pile. The other pile had started to heat a little on the south side. The following day it was heating to a temperature of between 65° to 70° C. The sides of the pile 9 inches from the edge was about 50° C. These temperatures were taken during sub-zero weather. When the seeds were taken out the first time, December 20, all of the piles were heating to a temperature of between 65° to 70° C. December 30, the end of 20 days, one pile of each treatment was about the same temperature as the atmosphere, the other two were about 15° and 25° above the atmospheric temperature, the one slow in starting to heat having the higher temperature. The maximum temperature of the piles that were moistened and compacted was about 20° C. lower than the maximum temperature of the four piles mentioned above.

Seed was taken from the other twelve piles at monthly intervals and the results were similar to those obtained on the four piles. The results for the three species of seed will be discussed seperately.

Morning-glory

As shown in Table 2, the viability of the Morning-glory seed was not destroyed nor reduced after being in the manure for a period of four months even in manure that was moistened and compacted. (Figure 6) The check at the end of the experiment is lower than any of the other percentages but the checks aren't so reliable for they were based only on 200 seeds (100 in soil and 100 on blotter paper) while the other per cents were obtained from 1600 seeds. There doesn't seem to be any appreciable difference between the percentage germination of soil and blotter paper. Likewise, there doesn't seem to be any appreciable dif-

Table 5. The Effect of Different Treatments of Chicken Manure and the Duration of Time on the Viability of Bermudagrass (Cynodon dactylon) Seed

Treatment	Size of Pile	Percentage Germination: (Check (1)) Soil	(2) Blot.	Period of Time Seeds Remained in the Manure: Dec. 2 to Jan 2 Soil	Blot.	Dec. 2 to Feb. 2 Soil	Blot.	Dec. 2 to March 2 Soil	Blot.	Dec. 2 to April 2 Soil	Blot.	Check (2) April 2 Soil	Blot.
Litter and Droppings Mixed	Large	94.0	98.0	95.4	94.0	93.4	86.6	93.0	92.0	84.0	88.0	87.0	89.0
	Small	94.0	88.0	79.0	92.0	82.0	88.0	88.6	85.1	87.4	80.0	87.0	88.0
Average		94.0	93.0	92.7	93.4	93.8	87.3	87.3	21.1	93.2	88.6	87.0	89.0
Litter Alone	Large	94.0	88.0	89.0	90.4	92.0	86.3	88.5	90.6	89.0	81.1	87.0	89.0
	Small	94.0	88.0	89.0	90.6	92.3	87.6	89.2	88.0	82.0	81.0	87.0	89.0
Average		94.0	88.0	89.4	90.5	89.5	90.0	87.0	89.3	86.1	81.1	87.0	89.0
Litter Alone Moistened and Covered	Large	94.0	96.0	94.4	97.0	85.1	94.0	94.6	90.5	96.2	87.0	87.0	89.0
	Small	94.0	88.0	91.6	86.6	83.0	88.0	88.6	89.6	87.0	90.0	87.0	89.0
Average		94.0	92.0	93.6	91.6	87.0	91.0	90.6	87.7	91.6	88.0	87.0	89.0

(1) Germination of seed before placing in manure.

(2) Similar seed kept under reasonably good storage conditions.

(3) Blotter paper.

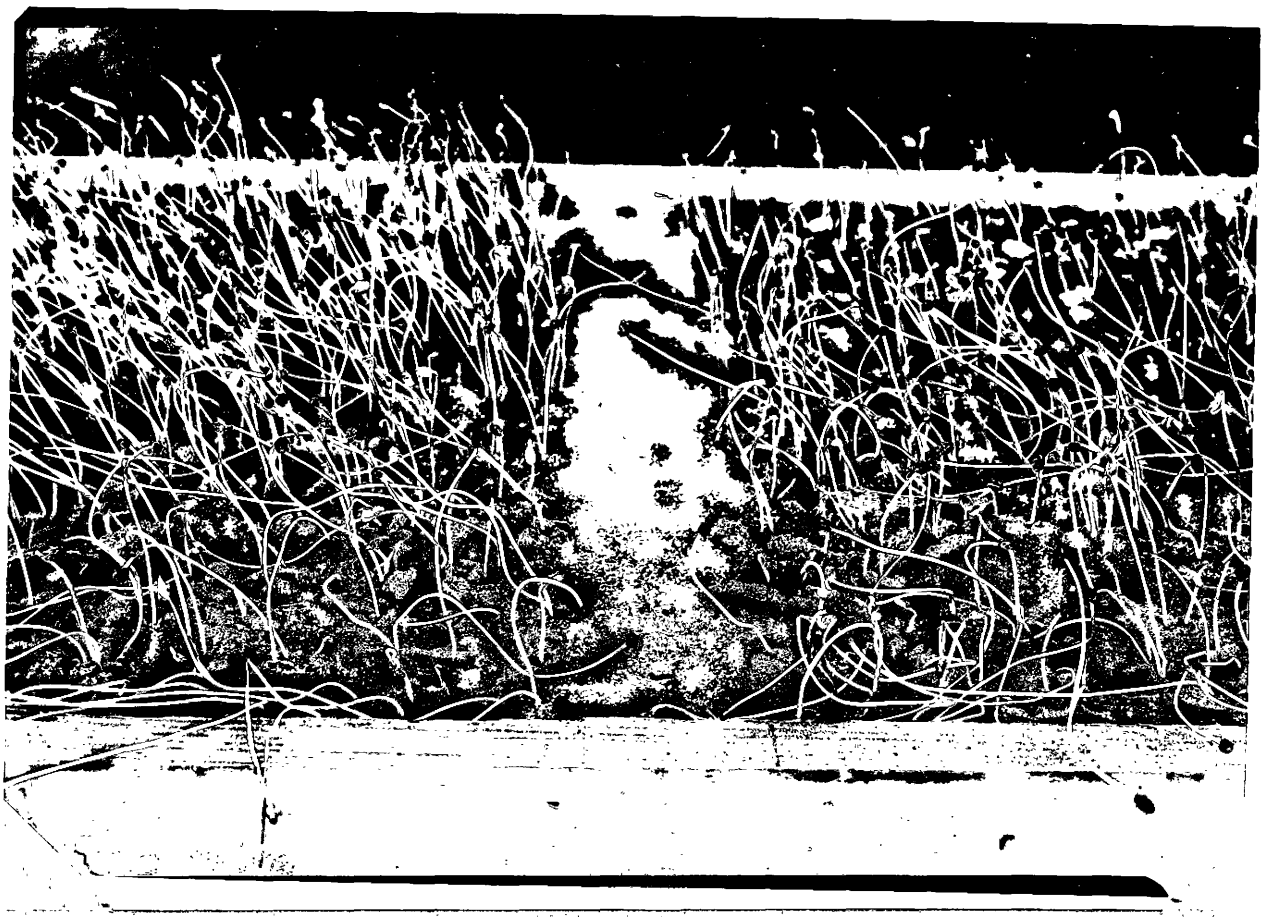

Figure 5, Showing the germination of Morning-glory (Convolvulus arvensis) seed after being in moistened, compacted manure for a period of four months.

ference between the large and small piles. For a period of four months, the viability is not affected whether the seeds are in litter and droppings mixed, litter alone, or litter alone moistened and compacted. Nor does the position in pile effect the percentage germination as shown in Table 3. The only difference that could be observed was that the seeds that had been in moistened manure germinated a little sooner and more evenly than those that had been in the dry piles.

White-Top

The percentage germination of White-top seed was lower and more variable than the percentage obtained for Morning-glory. (Table 4). A greater variation would be expected because the viability of White-top seed is markedly effected when the manure is moistened. The piles consisting of litter and droppings mixed and litter alone were dry at the beginning and as the snow melted in the spring, they became moistened and started to heat. In some cases only parts of the top of the pile heated, in others, the entire upper part of the pile heated, which would effect the seeds according to their location in the pile. A very good example of this was observed when the seeds were removed from the pile on February 3. The White-top seed taken from the top edge of one small pile containing litter alone was in manure that had become moistened and was heating, while the Russian Knap Weed seed taken from the same location was just at the edge of the heating manure. The White-top seed showed no germination, while the Russian Knap weed seed showed a germination of 10 per cent in the soil and 24 per cent on blotter paper. The percentage germination for the preceding month in the corresponding location in this pile was: White-top, 11 per cent in soil, 79 per cent

Table 5. - Showing the Percentage Germination of Morning-glory (Convolvulus arvensis) Obtained in Four Different Locations in the Various Piles of Manure for Different Periods of Time.

Treatment - Litter and Dressings Mixed

Location in Pile		Period of Time Seeds Remained in the Manure															
		Dec. 5 to Jan. 5				Jan. 5 to Feb. 5				Feb. 5 to Mar. 5				Dec. 5 to Apr. 5			
		Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile	
		Soil	B.P.[1]	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.
Bottom	Center	87.5	92.5	79.0	93.0	92.5	96.5	87.0	88.5	88.5	91.0	87.0	83.0	85.5	87.0	85.0	87.5	
"	Edge	91.5	97.0	89.0	92.5	94.5	77.5	90.0	87.0	87.5	91.5	85.5	89.0	85.0	87.5	87.5	91.0	
Top	Center	83.0	93.5	75.0	92.5	87.5	91.5	82.5	93.5	92.0	90.5	85.0	96.5	85.5	89.5	85.5	93.5	
"	Edge	75.5	93.0	77.5	85.0	88.0	89.5	86.5	89.0	89.0	85.0	90.5	89.0	85.5	83.0	85.5	87.5	
Average		86.4	94.0	73.9	92.3	88.4	88.5	86.3	89.0	89.0	89.0	86.5	89.1	84.9	86.9	87.4	88.9	

Treatment - Litter Alone

Bottom	Center	91.5	89.0	85.5	91.0	91.5	92.5	86.5	86.5	86.0	91.5	87.5	92.0	92.5	91.0	83.5	92.5	
"	Edge	90.5	93.5	92.5	92.0	89.5	91.5	88.0	92.5	92.5	93.5	89.0	89.0	85.0	95.0	92.5	91.0	
Top	Center	89.5	92.5	83.5	90.5	90.0	92.5	90.0	84.0	97.0	91.0	85.5	90.0	87.5	89.5	85.0	90.5	
"	Edge	87.5	87.5	90.0	89.5	89.5	90.5	92.5	87.5	93.5	86.5	87.0	87.5	89.5	91.0	85.5	93.0	
Average		89.3	90.4	88.0	90.5	90.6	92.5	89.5	87.6	92.5	90.6	89.3	89.6	89.6	91.1	86.6	91.9	

Treatment - Litter Alone Moistened and Covered

Bottom	Center	82.0	75.5	86.0	83.0	89.0	89.0	87.0	88.0	84.5	81.0	87.5	87.5	87.0	85.5	85.0	91.0	
"	Edge	89.5	87.5	89.0	87.0	91.5	92.0	92.5	91.5	85.0	91.0	89.5	89.0	87.0	90.5	90.5	89.0	
Top	Center	84.0	87.0	83.0	83.0	76.5	75.5	82.0	88.5	80.5	79.5	92.5	90.5	71.5	81.5	88.0	92.5	
"	Edge	87.0	87.5	89.0	76.0	84.5	85.5	85.0	87.0	88.0	89.5	92.5	89.0	87.5	90.5	88.0	87.0	
Average		84.4	87.9	86.5	85.3	85.1	86.8	89.9	89.0	84.5	88.5	88.5	89.3	85.5	87.0	87.9	89.9	

(1) Blotter paper.

Table 4. - The Effect of Different Treatments of Chicken Manure and the Duration of Time on the Viability of White-top (Lepidium drabe) Seed.

Treatment	Size of Pile	PERCENTAGE GERMINATION											
		Check (1)		Period of Time Seeds Remained in Manure								Check (2)	
				Dec. 2 to Jan 2		Dec. 2 to Feb. 2		Dec. 2 to March 2		Dec. 2 to April 2		April 2	
		Soil	B.P.(3)	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.
Litter and Droppings Mixed	Large	80.0	85.0	0.4	5.6	0.5	5.0	0.3	1.5	7.1	4.4	16.0	10.0
	Small	80.0	85.0	5.4	72.5	10.0	67.1	17.4	46.1	17.5	10.1	16.0	10.0
Average		80.0	85.0	2.9	39.5	5.1	33.1	8.1	23.7	12.3	7.3	16.0	10.0
Litter Alone	Large	80.0	85.0	4.4	75.0	13.4	75.0	5.4	58.8	42.4	15.6	16.0	10.0
	Small	80.0	85.0	6.3	60.0	6.1	55.6	6.5	57.1	52.9	3.0	16.0	10.0
Average		80.0	85.0	5.4	67.5	9.8	65.5	4.0	41.0	47.8	10.3	16.0	10.0
Litter Alone Moistened and Compacted	Large	80.0	85.0	0	0	0	0	0	0	0 (4)	—	16.0	10.0
	Small	80.0	85.0	0	0	0	0	0	0	0	—	16.0	10.0
Average		80.0	85.0	0	0	0	0	0	0	0	—	16.0	10.0

(1) The germination of seed before placing in manure.

(2) Similar seed kept under reasonably good storage conditions.

(3) Blotter paper.

(4) All of seed was germinated in the soil.

on blotter paper; Russian Knap weed, 80 per cent in soil and 78 per cent on blotter paper. It is possible that this is due to a difference in species but further evidence does not indicate any such difference.

The viability of the seeds in the manure consisting of litter and droppings mixed, and litter alone, was not destroyed in the four months. While the viability of the seeds in the litter alone moistened and compacted, was destroyed at the end of a month. The large pile of litter and droppings mixed reduced somewhat the percentage germination of the seeds. The viability of the seeds located at the bottom center and top edge were destroyed within a month and the top center, by the end of two months. (Table 5.) The small pile of litter and droppings mixed gave similar results to the piles of litter alone.

Russian Knap Weed

The effect of the manure on the viability of Russian Knap Weed seed was practically the same as that on White-top. (Table 6.) The litter and droppings and the litter alone did not destory the viability during the four-month period, although the large pile of litter and droppings mixed reduced the percentage germination and destroyed the viability of seeds located in certain sections of the pile. (Table 7.) The viability of the seeds in the litter alone moistened and compacted, was destroyed with the exception of the one taken out February 3 from the bottom edge of one pile. This is possibly due to the fact that the container was so near the edge of the pile that a few seeds were allowed to escape the effects of the manure. Only four seeds germinated out of approximately 4,800.

Table 5. - Showing the Percentage Germination of White-top (Lepidium drabe) Obtained in Four Different Locations in the Various Piles of Manure for Different Periods of Time.

Treatment - Litter and Steaming Used

Location in Pile	Period of Time Manure Remained in the Pile: Dec. 5 to Jan. 5				Dec. 5 to Feb. 5				Dec. 5 to Mar. 5				Dec. 5 to Apr. 5			
	Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile	
	Soil	B.P.(1)	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.
Bottom Center	0	0	10.5	61.5	0	0	11.0	64.5	0	0	30.5	59.0	0	0	13.0	10.5
" Edge	1.0	22.5	4.0	72.5	1.0	12.0	10.5	20.0	5.0	5.0	16.5	47.5	28.5	17.5	47.5	24.5
Top Center	0.5	0	5.0	80.5	0	0	15.0	51.5	0	0	10.5	35.5	0	0	8.5	1.5
" Edge	0	0	4.0	71.5	0	0	1.5	75.5	0	0	55.0	32.5	0	0	1.0	2.0
Average	0.4	5.6	5.4	72.5	0.3	3.0	10.0	53.1	0.3	1.3	17.4	46.1	7.1	4.4	17.5	10.1

Treatment - Litter Alone

Bottom Center	6.5	84.5	6.0	84.0	6.5	79.0	11.5	43.5	1.0	74.0	5.0	55.5	40.0	16.5	13.5	5.5
" Edge	3.5	75.5	5.0	72.0	17.0	60.5	3.0	31.5	4.5	61.0	2.5	11.5	20.0	7.0	48.5	24.0
Top Center	5.0	73.5	8.5	53.0	21.0	61.5	5.5	28.0	2.0	40.0	6.0	28.0	44.5	17.0	21.0	5.0
" Edge	3.5	80.5	6.5	74.0	2.0	79.0	1.5	35.5	4.0	31.5	3.5	36.5	50.0	28.0	0.5	1.5
Average	4.6	78.0	6.5	60.0	15.4	76.0	6.1	35.9	3.4	58.6	6.3	37.1	48.4	15.6	22.9	9.0

Treatment - Litter Alone Notched and Covered

Bottom Center	0	0	0	0	0	0	0	0	0	0	0	0	0(2)	—	0	—
" Edge	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
Top Center	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
" Edge	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
Average	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—

(1) Blotter paper.

(2) All of seed was germinated in the soil

Table 6. - The Effect of Different Treatments of Chicken Manure and the Duration of Time on the Viability of Russian Knot Weed (Centaurea picris) Seed.

Treatment	Size of Pile	Percentage Germination: Check (1)		Period of Time seeds Remained in the Manure: Dec. 5 to Jan. 5		Dec. 5 to Feb. 5		Dec. 5 to March 5		Dec. 7 to April 7		Check (2) April 7	
		Soil	B.P.(3)	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.
Litter and Droppings Mixed	: Large	58.5	86.0	8.5	10.5	5.4	7.6	5.4	7.0	0.4	1.5	46.0	62.0
	: Small	58.5	86.0	20.1	51.0	38.4	74.8	22.8	45.6	5.8	8.8	46.0	62.0
Average		58.5	86.0	11.7	47.0	20.9	41.6	15.6	26.8	5.2	5.2	46.0	62.0
Litter Alone	: Large	58.5	86.0	18.9	81.1	25.4	59.9	14.8	65.1	28.9	38.1	46.0	62.0
	: Small	58.5	86.0	20.4	82.5	27.9	62.0	24.8	41.9	4.8	8.4	46.0	62.0
Average		58.5	86.0	19.5	82.2	26.6	60.0	24.8	53.5	16.8	23.8	46.0	62.0
Litter Alone Point-ed and Compacted	: Large	58.5	86.0	0	0	0.05(4)	0.8(4)	0	0	0(5)	—	46.0	62.0
	: Small	58.5	86.0	0	0	0	0	0	0	0	—	46.0	62.0
Average		58.5	86.0	0	0	0.02	0.8	0	0	0	—	46.0	62.0

(1) The germination of seed before placing in manure.
(2) Similar seed kept under reasonably good storage conditions.
(3) Blotter paper.
(4) This lot of seed was taken from the outer edge of one of the piles and it is highly possible that this accounts for the remaining viability of these few seeds.
(5) All of seed was germinated in the soil.

Table 7. - Showing the Percentage Germination of Burning Bamp Weed (Centaurea picris) Obtained in Four Different Locations in the Various Piles of Manure for Different Periods of Time

Treatment - Litter and Broadcast Weed

Location in Pile	Percentage of germination obtained in the manure															
	Dec. 3 to Jan. 3				Dec. 3 to Feb. 3				Dec. 3 to Mar. 3				Dec. 3 to Apr. 3			
	Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile		Large Pile		Small Pile	
	Soil	B.P.s.(1)	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.	Soil	B.P.
Bottom Center	0	0.5	10.0	87.0	0	7.5	52.0	70.5	0	0	34.5	70.5	0	0	2.0	4.0
" Edge	13.0	42.5	80.0	88.5	18.5	37.0	84.0	75.5	18.5	27.5	42.5	68.5	1.5	6.0	18.0	65.5
Top Center	0	0	25.0	82.0	0	0	48.0	78.0	0	0	15.5	23.5	0	0	1.0	0.5
" Edge	0	0.5	16.5	80.5	0	0	12.5	78.0	0	0.5	2.5	7.0	0	0	2.5	5.0
Average	3.3	10.9	32.1	82.0	5.4	7.8	39.4	76.5	5.4	7.0	23.8	42.5	0.4	1.5	5.9	8.3

Treatment - Litter Alone

Bottom Center	25.0	87.0	21.0	73.5	38.5	75.0	58.0	77.0	54.5	65.0	27.5	52.0	48.5	77.5	1.5	11.5
" Edge	23.5	75.0	27.5	53.5	58.5	46.5	84.0	66.5	32.5	74.5	29.5	48.5	17.5	57.5	9.5	19.0
Top Center	14.5	83.5	18.0	81.0	10.5	40.0	28.0	57.0	13.0	52.5	21.5	51.5	23.5	65.0	2.5	3.5
" Edge	13.5	85.0	21.0	50.0	17.0	70.0	52.0	47.5	15.0	45.5	20.5	31.5	10.5	38.5	4.5	2.5
Average	19.0	34.1	20.4	82.3	25.6	58.9	37.5	62.0	24.5	65.1	24.9	41.9	28.8	62.1	4.8	8.4

Treatment - Litter Alone Moistened and Covered

Bottom Center	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
" Edge	0	0	0	0	.2(2)	1.0(2)	0	0	0	0	0	0	0	—	0	—
Top Center	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
" Edge	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—
Average	0	0	0	0	.05(2)	0.2(2)	0	0	0	0	0	0	0	—	0	—

(1) Blotter paper.

(2) See foot note Table 6.

DISCUSSION

Unless one stops to analyze this experiment, he may conclude that the germination percentages were calculated from a few seeds. It is true only representative samples from each container were germinated in the case of Morning-glory, and with White-top and Russian Knap where the viability was not destroyed. But these samples were representatives of many replications. In the first place four baskets or four replicates of about 600 seeds each were taken from each pile each time and the piles were duplicated for each treatment, thus making 8 containers or about 4,800 seeds of each of the three species. Then there is a small pile for every large one which would increase the number to 9,600 seeds for each specie taken out each time from each of the following: litter and droppings mixed, litter alone, and litter alone moistened and compacted. Only small piles duplicated were used for the two treatments moistened and left loose.

Further analysis will show that some of the manure was left dry in the piles, some was moistened and compacted, and some was moistened and left loose. The viability of the Morning-glory seed shows no indication of being destroyed by the fermenting manure. It is very doubtful whether the viability would be destroyed if the seeds were left in the manure a few months longer. Such a practice would be unsanitary and prohibitive in many sections. The farmer must take special precaution to avoid using hay, straw and grain feed containing Morning-glory seed.

If the manure is moistened, piled properly and allowed to ferment for a period of a month, the farmer can be reasonably sure that the viability of the White-top and Russian Knap weed seed will be destroyed and possibly this would apply to other seeds not possessing hard seed

coats. As the viability is destroyed in both the manure that was moistened and compacted and the manure that was moistened and left loose, the better method of storing the manure should be used. Experiments have proven that the moistening and compacting of the manure is the most desirable method of keeping the manure in storage.

SUMMARY

Seeds of Morning-glory (Convolvulus arvensis), White-top (Lepidium draba) and Russian Knap Weed (Centaurea picris) were put in wire containers and placed in chicken manure for various periods of time and then germinated in the laboratory (in soil and on blotter paper) to test the viability of the seeds.

Eight duplicated treatments of manure were used as follows:

1-Large pile of litter and droppings mixed.

2-Small " " " " " "

3-Large pile of litter alone.

4-Small " " " "

5-Large pile of litter alone, but moistened and compacted.

6-Small " " " " " " " "

7-Small pile of litter moistened to nearly saturation and left loose.

8-Small pile of litter about half saturated with water and left loose.

In no case was the viability of the Morning-glory seed destroyed. A high percentage germination was obtained even after the seed had been in the moist, loose manure 50 days and in moist, compact manure four months.

The viability of the White-top and Russian Knap Weed seed was destroyed after being in the moist, loose manure for 20 days or after being in the moist compacted manure for one month. There was one exception in which four Russian Knap Weed seeds germinated out of approximately 4,900 in the test. These seeds were removed the second month from the large piles of litter alone; moistened and compacted. This was thought to be due to the fact that the container was taken from the bottom edge of one pile and may have been so near the edge that a few seeds were not affected by the manure.

The viability of the White-top and Russian Knap weed seeds was not completely destroyed at the end of four months in any of the piles that were not moistened.

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