THE GERMINATION AND SEEDLING DEVELOPMENT OF COTTON AS INFLUENCED BY SELECTED INERT SEED COATING MATERIALS APPLIED SINGLY AND IN COMBINATION WITH CERTAIN FUNGICIDES, FERTILIZERS, AND HORMONES

A THESIS

IN AGRONOMY

by

Coleman Y. Ward

Approved

Texas Technological College

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Submitted to the Graduate Faculty of Texas
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by

Coleman Y. Ward, B. S.

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CHAPTER I

INTRODUCTION AND OBJECTIVES

In the production of cotton, adequate stands of healthy seedlings are necessary if the full possibilities for yield are to be realized. A vast amount of improvement is yet needed to assure even, well spaced, optimal stands, when unfavorable planting conditions prevail. There is abundant evidence that the treatment of cottonseed with certain chemicals reduces seed decay, pre-emergence damping-off, and to some extent, post-emergence damping-off. Losses from damping-off and soreshin continue to occur , particularly in early-planted cotton in cool, moist soil even when the seed have been treated with approved fungicides (25). It is also known that the linters, remaining on the cottonseed after ginning, often prevent proper penetration of fungicides to the surface of the seed coat.

Although the lint serves as a wick to attract and hold moisture, it also inhibits close contact between the seed and the soil, which is necessary for the former to absorb sufficient moisture for germination. The entwining of linters between seeds caused the latter to cluster, resulting in irregular dispensing of cottonseed from the planter box. This causes erratic stands and the planting of many times the number of seed usually needed for an adequate stand if the seed were dispensed evenly.

These problems with fuzzy seed led to the process of delinting cottonseed by the use of a sulfuric acid bath or gaseous hydrochloric

acid and in other cases by reginning. The resulting seed have a smooth coat and will flow more uniformily through the planter. No distinct advantage other than more uniform dispensing has been shown for acid delinted or reginned seed when an effective fungicide is used for treatment. There is some evidence that heavy reginning and acid delinting may injure the seed coat, thus reducing germination (4).

During the past decade several manufacturing concerns have developed processes for coating seeds. These involve the covering of seeds with inert, pulverized mineral materials, which are built up in layers until the resulting seed reaches the desired size and shape. In coating cottonseed a thin layer of this inert material ties down the linters and results in remarkable improvement in precision planting. During the coating process, which is similar to that used by candy makers in coating nuts with chocolate, any one or a combination of substances such as fungicides, fertilizers and plant growth stimulants may be incorporated in the layers.

Interest in seed coating has been fostered by popular articles speculating on the potentialities of the process, rather than by spectacular field results. Many claims have been advanced regarding the effects of coating on seed germination, seedling vigor, root development, top growth and ultimate yield. These claims are quite impressive and it has been necessary for certain State Experiment Stations to release critical evaluations of these alleged advantages (18).

The possibilities of replacing the delinting of cottonseeds with the coating process led to the selection of this problem, in which coatings of cottonseed were made with two of the more widely used inert

materials. To further evaluate these supposed advantages, certain growth regulators and fertilizers were incorporated in the coatings of some treatments.

Results of coating the cottonseed were measured by germination and seedling growth. Since seed should be treated with a fungicide, all coatings contained Ceresan, a commonly used seed disinfectant (58).

The purpose of this work was to determine the effects of two inert coatings, singly, and in combination with certain plant growth regulators and fertilizers, upon germination and seedling growth of cotton.

CHAPTER II

REVIEW OF LITERATURE

I. Treatment of Cottonseed with Chemicals. -- Disinfectants applied to seed prior to planting act in two ways: first they destroy disease producing organisms on the surface of the seed, and second, they erect a protective chemical barrier between the seed and the soil. This barrier assists in preventing soil-borne disease microbes, of which there are several, from attacking young seedlings before they become self supporting (55).

One of the earliest treatments that was widely used in this country in an effort to increase the emergence and survival of cotton-seed was that of mixing the seed with moistened wood ashes (4). This treatment removed much of the lint and must have destroyed many of the fungus mycelia and spores on the seed coat. Although this method is today obsolete it was rather effective because of the high degree of alkali in the ashes. The delinting of seed with sulfuric acid, a process developed by Brown (15), is similar in action to this older method.

Barre (8) and Duggar and Cauthen (20) were among the first to attempt to disinfect fuzzy cottonseed with such chemicals as copper sulfate, mercuric chloride, and formaldehyde. Although these fungicides were only partially effective they were used as standard treatment for a number of years. Thus, effective treatment with a fungicide became possible only when the organic mercurials became available in the early thirties (41).

Smith, et al. (67), working at six locations in Texas, treated cottonseed for planting purposes with Ceresan, Bayer dust, and copper sulfate. Their results show that treating fuzzy cottonseed with Ceresan increased the number of emerging seedlings from eleven to sixty-five percent, and the yields from four to twenty-five percent when the seed were planted to optinum rates and dates. At Lubbock, Texas, in a three-year test, seed treated with Ceresan gave a smaller number of emerged seedlings than untreated seed, and there was no significant difference in the yield of cotton. Treating fuzzy seed with Bayer dust and copper carbonate did not give a significant increase in germination or yield. In an identical test at Temple, Texas, an increase of 65 percent in seedling emergence was obtained when fuzzy seed were treated with Ceresan.

Hawkins, (30) working in Georgia, found that damping-off diseases were most common when the moisture content of the soil was high and temperatures were low. Experiments with normal brand fungicides showed that best results were obtained for cottonseed protection by using two percent or five percent Ceresan M, according to the manufacturer's directions. Lehman (42) used Ceresan, Dow 9-B, and other fungicides in testing treated and untreated fuzzy, reginned and acid delinted cotton-seed. Results, based on emergence of seedlings, showed no significance in favor of any specific fungicide treatment. Results were similar in all trials. Fuzzy seed treated with a suitable fungicide, gave much better emergence than did reginned or acid delinted seed. Cottonseed treated with Ceresan and Dow 9-B germinated so dependably that farmers can eliminate thinning by using the correct seeding rate. Fuzzy seed in hills 11.5 inches apart at rates of four, six, and eight seed per hill

gave five, two, and two percent missing hills respectively. Further thinning did not significantly affect the yield of seed cotton (44).

In a series of experiments in which cottonseed were treated with a large number of fungicides, Pinckard (58) obtained best results with Two Percent Ceresan and New Improved Ceresan in the control of seedling diseases and increasing total yields of cotton. In routine tests from 1929 through 1940, Two Percent Ceresan gave an average annual increase of 238 pounds of seed cotton, while New Improved Ceresan gave a 240 pound yearly increase over non-treated seed. The rates of application were three ounces and one and one-half ounces per bushel, respectively, for Two Percent Ceresan and New Improved Ceresan.

Cotton seed naturally infested with Collectotrichum gossypii were treated by Arndt (3) with various substituted phenyl esters to measure their effectiveness in increasing the percentage of germination of fuzzy cottonseed. Results in sand cultures and field plantings were compared and indicated that 2, 4, 5-trichlorophenyl acetate at a dosage of one gram per kilogram of seed may be a satisfactory treatment for fuzzy cottonseed. The substitution of bromine for chlorine caused little change in effectiveness.

Based on final seedling stands, Winfield (80) found no significant difference between Du Bay 1452-F (7.7 percent ethyl mercury P-toluene sulfonanilide) and Dow 9-B (50 percent zinc. 2,4,5, trichlorophenyl) when these two chemicals were applied to fuzzy-matted, reginned, reginned-matted, and acid-delinted cottonseed. All treated seed were significantly superior to the non-treated, fuzzy seed lot. The stands of seedlings from the greatest to the least were: acid-delinted, lightly

reginned, heavily reginned, reginned matted, fuzzy matted, and fuzzy (non-treated).

Rogers (60), in studying the influence of fungicides on the germination of cotton, used 24 different treatments. Emergence counts varied from a low of fifty-two percent for non-treated fuzzy seed to a maximum of ninety-one percent for acid-delinted seed, or acid-delinted seed plus fungicidal dust treatment. No benefits were obtained from matting seed regardless of further treatment. Seed that were reginned once were somewhat superior in performance to seed that were reginned four times. No significant differences were obtained in yields of seed cotton.

Smith (66), working in Georgia in a three-year trial with new dust disinfectants, found that Du Bay 1452-F and Dow 9-B were satisfactory in treating fuzzy cottonseed. Du Bay was equally as effective as New Improved Ceresan, now most commonly used, and was less vesicant and disagreeable to workers. Dow 9-B, while slightly less effective than New Improved Ceresan, is much less toxic to animals, less vesicant and less disagreeable to workers. Fewer shank lesions occurred on seedlings treated with Dow 9-B than with any other material. It was also found that reginned seed produced three to five percent fewer seedlings than fuzzy seed; however, ease of planting, more rapid emergence, and better emergence on low moisture soils offset this value.

Gore (26) conducted tests with Ceresan treated and untreated, anthracnose infested cottonseed. Excellent stands were obtained, and an average increase of 159 pounds of seed cotton per acre resulted from the Ceresan treatment.

II. Plant Growth Regulators and Their Use For Seed Treatment. -- According to Skoog (62), the concept of hormonal regulation of growth dates back nearly a century to Sachs, who deduced from his experiments on plants that special substances were responsible for the formation and growth of different organs.

According to Went (77), the first major observation of the existence of plant growth substances came a few years from Sach's study, when Hans Fitting worked in Java on the flowering of orchids. He found that the swelling of the ovary and fading of the flowers after pollination were due to a water-soluble, heat stable substance which occurred in the pollen and which he compared with a hormone.

Fitting, also made a study of the Avena coleoptile (27) in an effort to determine the cause of its peculiar curved growth toward light. He refused to believe however, that the changes in growth might be accomplished by chemical or even physical means.

This work, however, was not in vain for it prompted Boysen-Jensen (13) to duplicate the study and expand it as much as possible. In a few experiments he completely severed the tip of an Avena coleoptile and then replaced it. This drastic treatment did not prevent the transmission of the growth stimulus from the severed tip to the growing shoot.

Boysen-Jensen (13) published his findings in which he stated that chemical reactions and physical conditions that are responsible for growth of plants are governed by certain substances. These were designated into two groups: nutritional substances and regulating substances. In the first group, he considers that from the broadest sense, belong the following: water, minerals, air, and the organic foodstuffs (i.e. sugars

or starch) which supply energy for building the plant's structure. He subdivides the second group as follows: (a) Localized chemical activators whose range of influence may be limited strictly to intra-cellular activities (i.e. those concerned with various genic effects) or to a comparitively small sphere. (b) Hormones which exercise specific effects upon cells or tissues other than those by which they are produced. The growth materials used in certain of the coatings of this experiment belong to the latter group.

Although Boysen-Jensen thought in terms of diffusible materials, either substances or ions, he failed to definitely connect the growth of the plant with a specific growth promoting substance (13). Paal, in 1914 was the first worker to definitely correlate growth of a plant stem with a substance produced in the tip of the coleoptile. He established this fact while investigating the transmission of a phototropic stimulus across a discontinuity. After excising the tip of the coleoptiles of Coix lacryma, he replaced them eccentrically on the stump and found that the coleoptile curved strongly from the side covered by the tip. He assumed this indicated that the tip produced a "growth accelerating" substance which passed across the moist discontinuity and down that side of the coleoptile. The result was that the treated side grew faster and caused the coleoptile to curve (64) (77) (52).

Many investigators such as Stark, Soding, and Nielsen (27) started to work on growth regulating substances in stems and coleoptiles all within a few years from the publishing of Paal's paper. However, definite proof of hormonal action in plants was not obtained until 1928 when Went (78) isolated the growth promoting substance from the tip of the Avena

coleoptile. This substance was later named "auxin" by Kogl and Haagen-Smit in 1931 (27).

Today this substance isolated by Went, as well as others isolated since that date, are variously termed auxin, plant regulator, growth substance, growth hormone, phytohormone, formative substance, and others (60). An attempt is being made to standardize such terminology after that suggested by Thimann (1) who suggests the use of two terms as follows:

> An auxin is an organic substance which promotes growth (i.e. irreversible increase in volume) along the longitudinal axis, when applied in low concentrations to shoots of plants freed as far as practical from their own inherent growth promoting substances. Auxins may, and generally do have other properties, this one, is critical.

A phytohormone has been defined as:

> Any organic substance produced naturally in higher plants controlling growth or other physiological functions at a site remote from its place of production and active in minute amounts.

Since the isolation of "auxin" by Went, in 1928 (78), and the discovery of the activity of indolacetic acid and many related auxins by Kogl and Haagen-Smit (27), and its extension into this country by Hitchcock and Zimmerman (33), it has been possible to apply growth-promoting substances and later, related growth-inhibiting and herbicidals substances, in concentrations far beyond what the plant tissues are normally subjected to (77).

The knowledge that plant growth regulators are readily absorbed by plants has led to the practical application of plant extracts and

synthetic, hormone substances to plants (53).

The chemicals best known as growth regulators are as follows: Indole compounds involving Beta-indoleacetic and Beta-indolebutyric acids; Naphthalene compounds involving alpha-naphthalene acetic acid and its derivatives; substituted phenoxalphatic acids, expecially 2,4-dichlorophenoxy acetic acid(2,4-D), and higher homologs; and unsaturated hydrocarbons, especially ethylene and acetylene (83).

According to Zimmerman (83), no chemicals or hormone-like chemicals have been found to stimulate growth of the entire plant in the same sense as is recognized for complete fertilizers. Rather these growth hormones are found to bring about specific functions such as inducement of root on stems; roots on roots; cell division, both in cambium and other stem tissue; growth of ovary in fruit and the streaming of protoplasm.

In seed, free and bound auxins have been shown to occur (27) (53). This auxin initiates growth of the young plant. The amount of auxin in seed varies between genera and within species (79). This fact has led to the treatment of seed with various growth substances in an attempt to initiate more rapid germination and seedling growth (77) (54).

A large number of papers have appeared describing the effects of auxin applied to seed. Many of the authors claim that such treatments cause favorable results; while others have found no visible results (52). In order to show more clearly the findings that have been made it is necessary to submit the results of a number of these authorities.

Bartholomew (9) received no significant increase in yields from cotton, corn, soybeans, rice, or grain sorghums when he soaked or dusted

the seed of these crops with Rootone, Staymone, and Naphthalene acetic acid. In five of fourteen experiments, untreated seed yielded more per acre than any of the treated seed; all variations in the remaining tests were very small.

Arnon (5) conducted a series of experiments using vitamin B_1 as a possible stimulator when placed in the nutrient solution given to a number of different plants growing in a water culture. As a check against possible error and contamination, equal amounts of deactivated vitamin B_1 were added to the check solutions. The results indicated that plants grown from seed under favorable conditions are not benefited by additions of vitamin B_1, nor is their growth affected by the amount they can assimulate.

Wedgeworth (76) soaked corn seed twelve hours in Stimulene, a synthetic growth hormone, which had been acclaimed a miraculous stimulator of plant growth. After drying, the seed were planted in 150 ft. rows with alternate rows planted with untreated seed. Six to ten replications of each test failed to show any apparent effects of this treatment on germination or final yield of the corn.

Ireland (36) (37) treated cottonseed with five growth substances and received yields of 680, 637, 625, 612, 525, and 514 pounds of seed cotton from naphthylacetic acid, Levalinic acid, Hormodin A_1, Graino, vitamin B_1, and untreated seed respectively.

Kisselbach (38) tested corn, soybeans, oats, and barley with water solutions of levulinic acid, indoleacetic acid, indolebutyric acid, and naphthylacetic acid, and dust treatments with Staleymone and Graino. He concluded that : (a) No significant benefits as to germ-

ination, seedling development, maturity, or yield were derived from any hormone seed treatment applied to corn, soybeans, oats, and barley; (b) One hundred and fifty parts per million solutions of naphthylacetic acid treatments were distinctly toxic to germination, growth, and yield.

Bonner and Green (12) found that Vitamin B_1 slightly increased the shoot growth of some slow growing perennial plants but found no response whatever when vitamin B_1 was added to the nutrient solutions for fast growing annuals.

Ayers and Young (6) tested cotton and Plainsman grain sorghum with solutions of indole propionic acid, phenylacetic acid and indole butyric acid and dust treatments of Rootone, Staleymone, and Graino. The results of this study showed no significant differences in the germination of cotton when treated with the above materials. The percentage range in germination was only four percent, which is only about one-third of that required for significance. The only significant difference in germination was obtained by seed treated with Ceresan, a fungicide used in combination with some of the tests. Germination of Plainsman sorghum was not significantly affected by treatment with the growth regulating substances. Yields of the two crops showed no significant increases due to the seed treatments. However, the use of Staleymone at the rate of four ounces per bushed tended to depress the yield of Plainsman sorghum.

III. The Use of Fertilizers in Seed Treatments. -- Experimental evidence in regard to the use of fertilizer materials for treatment of seed prior to planting is very limited. There are very definite reasons for the lack of research on the use of nutrient coatings on seed, some

of which are: (a) A seed per se represents natures most perfect food storehouse (50); (b) the normal germinating seedling uses only that food stored in the endosperm or cotylendons, until it is above ground and able to begin manufacture of its own through photosynthesis. It does not absorb nutrients from the soil until it is above ground (80); (c) the temporary root, which is the only absorbing organ until the plant is well above ground, has as its main function the absorption of water. This water serves to dilute and carry the soluble foods stored in the seed to various parts of the young growing seedling. It is generally accepted that this temporary root absorbs only water, and very little if any mineral nutrients from the soil (50); (d) the amount of fertilizer which can be placed on the seed and yet avoid burning of the germinating plant is neglible (55) (73).

In the light of these statements, the use of fertilizers in seed coatings does not appear to be as favorable as advocated by many; however, it seems probable that any increase in growth, no matter how small, at the time of germination would enhance the chances of seedling survival.

Lyman (48), in his book on Cotton Culture, published in 1868, mentions the desirability of rolling cottonseed in a fertilizer to hasten germination. He recommended a compound of two parts of ashes, to one of common salt. He also stated that some farmers practiced soaking cottonseed in a solution of salt dissolved in liquid manure and then rolling it in a plaster.

Watkins (75) of Australia, found that rolling cottonseed in superphosphate paste delayed maturity. Hall and Armstrong (29) of South Carolina showed that rolling cottonseed in nitrate of soda gave a sign-

ificant delay in germination.

Briggs (14) of Arizona, coated cottonseed with pastes containing sodium nitrate, lime, and flour. Results were similar to those obtained by Hall (28) in that a reduction and a delay in germination were the result of these paste coatings.

Murphy (55) and Vogelsang (73) state that, "Although it is not possible to add sufficient fertilizing material in seed coatings to carry a crop through to harvest, it is possible to add enough to produce a healthy and growing seedling, which is important when the problem is getting the seedling established." Vogelsang (73) has found from extensive tests with the use of fertilizers in coatings placed on sugar beet seed, that adequate amounts of phosphates and potassium can be added to give the seedlings increased vigor for a short time. In tests with nitrogen, he concluded that water soluble nitrogen has toxic effects upon the seed and seedling. To overcome this difficulty, tests were made with various organics, containing nitrogen. Results of these tests showed that soluble dried blood gave the most satisfactory results.

Ohlrogge and Warren (56) show that experimentation to date at several experiment stations, has demonstrated that no significant increases in seedling growth or yields can be ascertained from soaking seed in liquid mixed fertilizers when grown on soils of average fertility. They further state, however, that starter solutions (nutrient solutions) are valuable in transplanting of vegetables. Soils low in phosphorus responded quite well to this treatment.

IV. Coating of Seed With Inert Material and It's Use on Field Seed. --

A. Early History and Nomenclature. -- Any review of the litera-

ture of coated or pelleted seed should be prefaced by a paragraph on nomenclature. The term "pelleted seed" has been used rather indiscriminately as a synonym for "coated seed" (82). According to Burgesser (17), the term "coated seed" refers to a single seed coated with an inert material, primarily to increase its size to facilitate planting. Pelleted seed are a mixture of seed and an inert material formed into pellets, usually by molding through some mechanical means. The number of seed in a pellet is not controlled accurately and any average number can be included, depending upon the ratio of seed to pelleting material in the mixture from which the pellets are formed. Pelleted seed are generally used in airplane reseeding of range land; while coated seed are used in precision planted row crops, such as vegetables, flowers, and field crops (17).

The idea of coating seed to carry fertilizers, fungicides, or stimulants is fairly old. According to Work (82), a study of the United Patent Office files shows the first patent relating to seed coating was issued in 1868. Nearly all of these patents have as their subject matter the coating of seed with some growth-promoting substance. All used a binder of some sort to hold the coating material to the seed.

Coating of seed, according to Rudolf (62), has been tried intermittently on a small scale at least, since the time of the First World War. He further states, that large scale use of commercial coating of seed arose during the Second World War, when the sugar beet industry began developing drill seeders capable of very accurate sowing.

The above statement has been verified by Burgesser (17), Work (82), and Meulen (51). They maintained that the strong upsurge of the

idea of space planting or precision planting is primarily responsible for the large scale operations in the coating of seed.

According to Burgesser (17), the use of coatings on the seed before the recent developments were not of the same nature as those used today. Recent interest in coating is the outgrowth of the high cost expended for labor in thinning of sugar beets, lettuce, carrots, and even such field crops as cotton and corn (82). In the case of sugar beets, Meulen (51) quotes M. J. Buchlen, Agricultural Supervisor of the Farmers and Manufacturer's Beet Sugar Association of Saginaw, Michigan, as saying, "We plant two million seed germs to the acre and as soon as they germinate and start growing, we have to pay $15.00 or $20.00 per acre to have 95 percent of them pulled out." Many seed small in size, irregular in shape, or bearing a fuzz like cotton, give growers this same problem of irregular stands.

B. Development of Materials. -- The development of a suitable material to coat seed to the desired shape has required much research. The bulk of the materials tried have been inert substances, the most common being clays of various kinds. Aside from local clays, these include modeling clay, ball clay, kaolin, and montmorillonite (a soft clay-like mineral a hydrous-alumino silicate). In addition, the following materials have been used alone and in various combinations with or without clays: ground rattle bush bean, plaster of Paris, tung nut pomace, dextrine, powdered foam-glass, dithiobiuret, anthraquinone, feldspar, flyash, and diatomaceous earth. To these materials there has usually been added various rodent repellents and frequently fertilizers, fungicides, insecticides, and growth hormones (62) (51).

Vogelsang et al. (73) initiated a process for coating sugar beet seed with the objective of making a round smooth pellet of uniform weight from the irregular segmented seed for the purpose of facilitating precision planting. These pellets were to be made of materials which would not be injurious to the seed either before or after germination. They should be sufficiently firm to permit reasonable handling in the seeding apparatus, yet should disintegrate when placed in contact with moisture, and thus not interfering with normal germination.

In early work by Processed Seeds, Inc. (73), it was found that methyl cellulose, a water soluble plasticide was the most suitable binder. Burgesser (16) also found methyl cellulose to be a satisfactory binder in coatings of many vegetable and flower seed with montmorillonite clay.

The best inert material found by Vogelsang et al. (73) was a mixture of 65 percent ground feldspar (an aluminio-silicate) and 35 percent flyash (a product resulting from burning of powdered coal in large boiler installations).

Burgesser (16) (17), in extensive tests with different inert materials, concluded that a volcanic clay deposit found in California gives the most satisfactory coatings. This type clay knows as montmorillonite, is an ultra fine, hydrous-alumino silicate. Since montmorillonite has a great affinity for water, it would be of value to a germinating seed.

According to Perrins (57), Wagner (74), and Rudolf (62), a coating process developed by Adams utilizes adobe clay. This clay, the type used by Indians in the making of adobe bricks, is highly plastic

when wet. This property allows pellets to be easily shaped.

C. Methods of Coating and Pelleting Seed. -- Many pellets or coated seed for small scale tests have been made by hand (62). Such was the case in the early coatings of cotton with fertilizers as mentioned by Lyman (48) in 1868.

According to Rudolf (62), Meulen (51), and Murphy (55) present processes for commercial coatings and pelleting are of two general types: (a) accretion processes in which the coatings are built up by adding successive layers of material until the desired size and shape is obtained: (b) pressure processes in which a mixture of the seed and coating material are forced through openings. The latter process is used very little on field seed (74).

D. Trials With Pelleted and Coated Seed. -- Sugar beet seed are the most frequently coated. According to Carolus (19) 40,000 acres were planted with coated sugar beet seed in 1948. Vogelsang et al. (73) used feldspar and flyash to coat seed of sugar beets, various vegetables, flowers, trees, and certain field crops. Trials with these coated seed and an uncoated check were tested every three months for a period of two years after coating. Each lot of coated seed was tested: (a) in greenhouse flats, (b) in flats in cool rooms, (c) in a road cellar under damp, humid, cool, and poor light conditions, and (d) hand planted out doors. From these out door seeding tests with coated sugar beet seed as compared with uncoated seed in 100 ft. rows with four replications, the results gave 60.89 percent emergence for coated seed and 36.36 percent for the check. Vogelsang et al. (73) concluded: (a) most irregular seed can be coated to a uniform size and weight; coating does

not hinder germination under normal conditions; (b) net emergence and livability can be increased by the incorporation of proper amounts of fungicides, fertilizers, and starting agents; (c) the coated seed can be more accurately planted because of more uniform size and increased weight; and (d) under normal germinating conditions the rate of emergence of coated and uncoated seed are the same, while under cool conditions the emergence of coated seed may be delayed several days.

Carolus (19), reporting on the use of coated seed in Michigan, stated that during 1948 many detailed studies were made on the influence of the coating process upon germination of vegetable seed under various conditions of soil, moisture, and temperature. To find out the effect of the coating process, the seed were coated without the addition of fungicides, fertilizers, or growth stimulating chemicals. Fifteen kinds of vegetable seed were tested, involving 960 germination determinations. The results indicated that coatings delayed emergence of all seedlings an average of 34 hours. With turnip seed there was no delay in emergence; while with onions, coating delayed emergence by two days. With carrot, cauliflower, and turnip seed the percentage germination was not influenced by the coating treatment. With tomato seed, coating increased the percentage germination at 70 degrees Fahrenheit but reduced it 18 percent at 40 degrees Fahrenheit. The germination of cabbage, Chinese cabbage, kale, onion, radish, spinach, and parsnip was reduced more than 20 percent when seed were coated. Results from different plantings were quiet variable and significant differences were had for replications of the same treatment. His findings were in essential agreement with other workers.

In field trials conducted by Carolus various fertilizers, fungicides, and hormones were incorporated into the coatings and compared with unpelleted treated seed. Coating of the seed killed lima beans and reduced the germination of onions 46 percent. The germination of tomato seed was increased 160 percent; cucumber, 38 percent; and melon 47 percent under unfavorable growing conditions. Under favorable growing conditions, coating increased the germination of snap beans nine percent, and sweet corn from nine to 65 percent, depending on the variety.

Coatings containing superphosphate and growth hormones resulted in increases in germination, seedling growth, and earlier maturity for sweet corn, pepper, tomato, and cucumber. The resulting plants also appeared to be more drought resistant. He concluded that under certain conditions, coating of seed is invaluable but consistent results are not always obtained and he recommends use of coated seed only on an experimental basis.

Bishop (10) of California, coated lettuce, onion, and tomato seed with a finely divided Bentonite clay with a moisture equivalent of about 88.7 percent. No pressure was used in applying the coating on the seed. Both coated and uncoated seed of the same seed lot were tested for germination and rate of emergence under several conditions: (a) germination by seed laboratory, on moist filter paper, in petri fishes using Standard Laboratory Germination Test; (b) germination in field soil, Yolo fine sandy loam, in uncovered cold frames; (c) germination on raised beds, in the field, on Yolo fine sandy loam. At least four replications were made for each treatment in all tests. Upon

analysis of variance, it was found the coating significantly decreased the percentage germination of onion and lettuce seed in the standard laboratory test. The same tendency was evident for tomato seed but the decrease from coating was not significant. In both cold-frame and field tests, coated seed germinated as well, but at a slightly slower rate than uncoated seed.

Ferguson (22) of the Canadian Experiment Station at Ottawa, made tests with seed of carrot, beet, radish, cucumber, spinach, and lettuce coated with methyl cellulose and a diatomaceous earth. He compared coated seed with untreated seed for speed of germination and uniformity of stand. In 76 trials, eight were in favor of coated seed, 42 in favor of untreated seed, and 26 showed no difference. It was concluded that the chief point in favor of coating was the ease of sowing and spacing, while a marked disadvantage was noted in an increase in shipping and handling costs since the coated seed weighed 20 times more than the untreated.

Tests with coated Jack pine seed at four points in Minnesota and Michigan using two types of commercial coatings, designated A and B, were reported by Rudolf (61). In Type A the coating material was 65 percent feldspar and 35 percent flyash. In Type B the coating material was montmorillonite clay. Five treatments were applied to plots laid out in the form of a Latin square. In each plot, 100 seed were sown the first week in June. The plots were examined for germination at 10-day intervals for the first 40 days and at 30-day intervals thereafter until October. Results are given in Table I.

According to Smith (65), a number of tests with coated cottonseed

have been made by the Agronomy Staff at Alabama Polytechnic Institute. Results of these tests show no consistent emergence of seed coated with 65 percent feldspar and 35 percent flyash over fuzzy seed treated with a fungicide. Smith further states that their conclusions are that coating of cottonseed is of no special benefit in the Alabama area and that acid delinting and reginning are equally satisfactory when the seed are treated with a fungicide.

TABLE I (61)

PERCENTAGE OF LIVING SEEDLINGS AT THE END OF GROWING SEASON

	Percent of seed sown producing seedlings[1]			
	Hugo Sauer nursery	Eveleth nursery	Michigan State College nursery[2]	Seed laboratory[3]
	Percent			
Bare seed, sown ½-In. deep	32.4	34.2	21.2	41.0
Type A pellets, Surface sown	5.2/	8.4/	.4/	28.0*
Type A pellets, sown ½-in. deep	18.4/	17.8/	1.8/	48.0
Type B pellets, surface sown	2.0/	11.8/	.6/	6.0/
Type B pellets, sown ½-in. deep	39.2	28.4	13.2/	48.0

[1]Potential germination of laboratory sample was 51 percent.
[2]Results are from July 1 examination because of considerable mortality thereafter.
For the other two nurseries, results are from October examination.
[3]Germination at 40 days.
*Significant difference from bare seed at 5 percent point.
/Significant difference from bare seed at 1 percent point.

Arndt (2), states that results of tests with coated cottonseed in South Carolina will show very little promise until the development of a precision planter. He further states that possible benefits from the addition of adjunctives to the pelleting material have not been fully investigated.

Loden (47) made tests in 1953 at Plainview, Texas with coated cottonseed. The coatings used were: (a) a standard coating of 65 percent feldspar, 35 percent flyash, and the fungicide, Ceresan; (b) standard plus one percent Systox; (c) standard plus 40 P.P.M. Terramycin. Results were measured on the basis of seedling emergence and yield of seed cotton per acre. Four to eight replications were used for each treatment in the various tests.

Loden was unable to establish that increased yields in cotton could be obtained from planting coated seed. Likewise he found no increase in yield from the addition of 40 P.P.M. Terramycin or one percent Systox. Coated seed were found to be inferior to uncoated seed with regard to: (a) rate of germination, and (b) plants per linear foot of row following complete emergence. The decreases for emergence and total stand were significant for coated seed.

The Association of Official Seed Analysts (31) reports that new methods for testing coated seed will be necessary if accurate results are to be obtained. It has been found by the California Seed Testing Laboratory with all kinds of seed, except cotton, that preliminary counts for the coated seed are lower and sometimes delayed in comparison with the uncoated seed. Final germination counts for the coated cottonseed are as high by one or more of five new methods tested, as for the uncoated seed tested by the regular method. (The seed used in the above test were coated with a montmorillonite clay and no fungicide was added to the coating.)

Leach et al. (40) compared emergence rate of coated sugar beet seed with untreated seed of the same lot, in Yolo fine sandy loam, at

six moisture and two temperature levels. The results of this study showed that coated beet seed gave a significantly lower emergence, and required a longer period for emergence than did the uncoated seed. At the lower moisture levels the delay in emergence from coated seed was more pronounced.

A large amount of research has been carried out with pelleted range grass seed in the Western States (57). Pelleted seed are normally seeded by airplane due to the inaccessability of vast areas. No attempt has been made in this review to cover this method of treating seed since its use for row crops appears to have no real value.

CHAPTER III

MATERIALS

The experiments reported herein (with the exception of one field planting) were conducted on the Agronomy farm, in the Botany and Horticulture greenhouses, and in the State Seed Laboratory at Texas Technological College.

The certified seed used were from the 1952 crop of Stormmaster cotton grown on the Agronomy farm.

Material for Germination Studies. -- The soil type used in the field and greenhouse plantings was Amarillo fine sandy loam, the predominant soil type of the area.

Field plantings were made on Amarillo fine sandy loam. The soil heterogeneity was masked by randomized replications of each treatment. A standard two-row planter was used in making the field plantings. The fuzzy seed checks were planted with a regular cotton plate; while the coated seed were planted with an eight-hole corn plate in the planter box.

Laboratory germination tests were made in the Texas State Seed Laboratory on the campus. These tests were made in accordance with the Texas Seed Law and Regulations (70), in a germinator.

Eleven different materials, including a fungicide, fertilizers, hormones, and growth stimulators were used as additives to the basic seed coating, see Table II. These materials were tested for effects on germination and seedling development immediately after treatment and again after the treated seed had been in storage for one year.

The materials used were:

(1). Ceresan (5 percent ethyl mercuric phosphate) E. I. du Pont d Nemours and Company (Inc.) (21).

(2). Hyponex (a special plant food containing 7 percent water soluble nitrogen, 6 percent water soluble phosphorus, and 19 percent water soluble potassium). Hydroponic Chemical Company, Inc. (35).

(3). Soluble Dried Blood (82 percent protein, 6 percent ash, pH 7.0) Armour and Company (39).

(4). Grainc (a patented commercial dust type plant growth hormone) J an Maclean Company (49).

(5). Rootone (a patented, commercial dust type plant growth hormone) American Paint Chemical Company (1).

(6). Rootone No. 10 (a patented, commercial dust type plant growth hormone) American Paint Chemical Company (1).

(7). Actmus (a 100 percent organic, odorless, extract of bulk organic matter, patented) Foreign Products Corporation. (23).

(8). Superphosphate (from a phosphrous fertilizer, treblesuper-phosphate, 48 percent P_2O_5) Filtrol Corporation.

(9). Terramycin (one of the four most used anti-biotics in medicine) Pfizer Company by Processed Seeds Inc. (72).

(10). Systox (Ortho-ortho di-ethyl-ortho-2(ethyl-mercapto) ethyl thiophosphate) Processed Seeds Inc. (72).

(11). A special Catylitic Material (Composition unknown) Filtrol Corporation (17).

Materials for Study of Cotton Seedling Growth. -- Glazed, four gallon pots with drainage holes at the bottom were used. Well washed,

sharp, builders sand was used as the medium for growth.

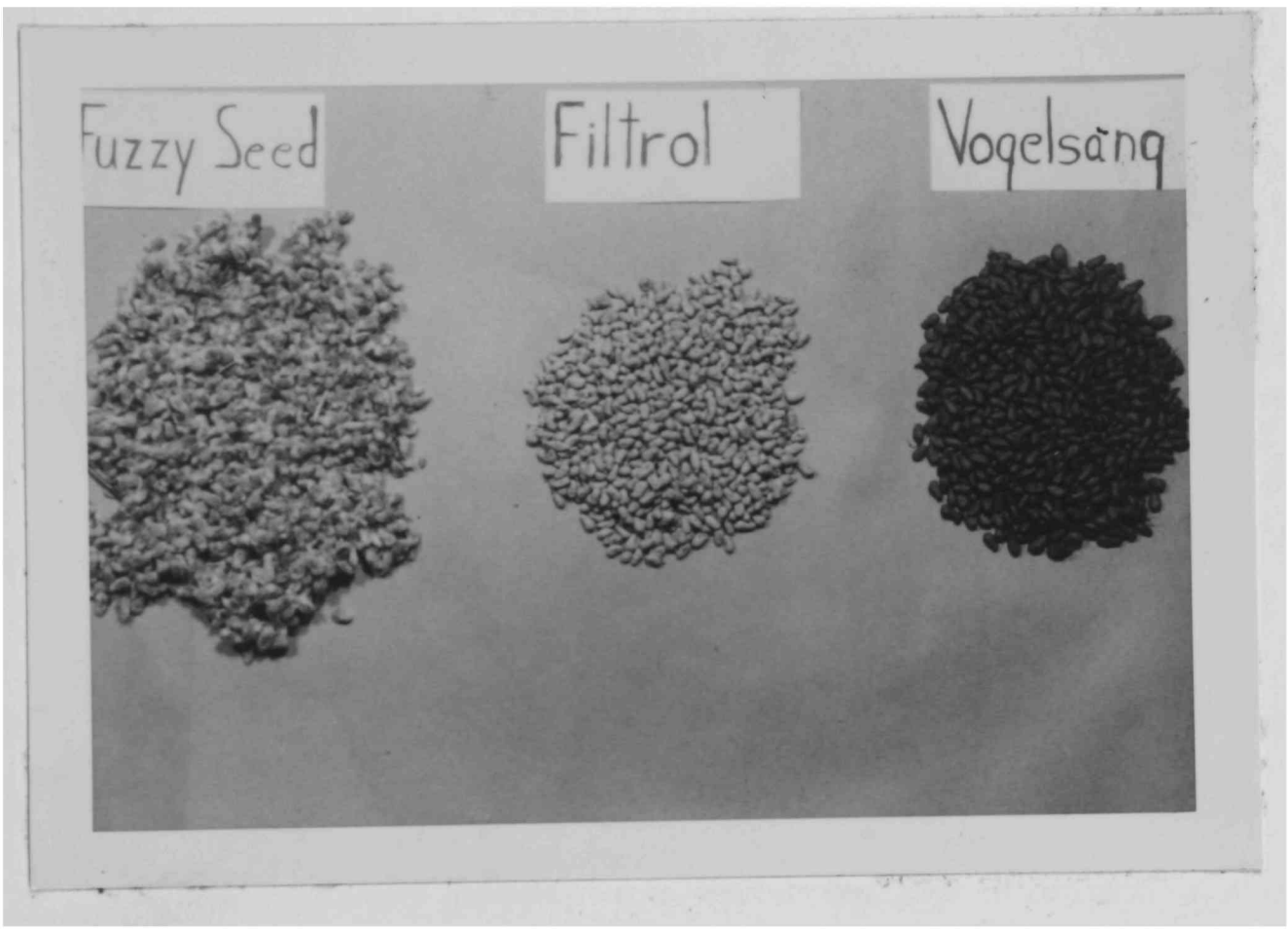

Figure 4. From Left to Right, Fuzzy Seed Check, Montmorillonite Coated Seed, and Feldspar-Flyash Coated Seed, the Three Basic Treatments Used in this Study.

CHAPTER IV

METHODS

Coating Procedure. -- After preliminary tests with various fungicides and stioker compounds, it was decided to have commercial concerns, with the necessary equipment, do the coating. Three lots of Stormmaster cottonseed were coated in thirty-three pound lots by Processed Seeds Inc., Midland, Michigan. These three lots were designated VR, VT, and VS in Table II. The Filtrol Corporation, Vernon, California, coated twenty lots of five pounds each and these are designated as 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6a, 6b, FR, FP, and FCT. The compositions of these coatings are given in Table II.

Although details of the exact procedure are trade secrets with the two companies, the general method described below is given for clarification.

The dry seed are placed in a revolving pan or sphere shaped recepticle, similar to pans used in putting chocolate coating on nuts or the sphere used by brick layers for mixing concrete. A small amount of water containing methyl cellulose (51), an adhesive, is added to the seed until each seed is moistened and separated from nearby seed. Then a portion of the dry coating material is added and the seed are turned in the pan until each seed has a smooth even coating. Additional water and methyl cellulose are added as before and the process is repeated until the coated seed reaches the desired size. In the case of cottonseed, a very thin coating is applied, usually 20 percent by weight of the

seed. (17).

Any special materials that are to be added to the coating may be mixed with the inert, basic coating material or may be added alone. This may be done at any stage in the coating process.

The coatings placed on the cottonseed by The Filtrol Corporation contain as a basic material the methyl cellulose binder and a finely ground, volcanic montmorillonite clay (a hydrous alumino-silicate) (16). The coatings made by Processed Seeds Inc. contained methyl cellulose, ground feldspar, (an alumino-silicate) flyash, and a thin outer covering of graphite designed to cut down friction in the planter box (72).

The one hundred pounds of seed were divided into equal lots for each coating treatment given in Table II. The materials were added to the coating of each seed as described above. The fungicide, Ceresan (21), was used in all the coatings along with other materials indicated. Dosages of the various compounds added were those recommended by the manufacturer. In some treatments, a larger dosage was chosen for additional treatments to note any changes that might occur from larger amounts. In each case, a lot of seed to be used as a standard was coated with only the basic material.

Planting Plans. -- Plantings were made using the randomized-block design (32). Two 100 ft. rows were used for each treatment. Each treatment was assigned a plot by drawing numbers from a hat, starting with block I and repeating the process for blocks II, III, and IV, since four replications were made. All treatments were planted to a depth of two inches with a two row cotton planter using planting plates as described in materials. The untreated fuzzy seed were planted at the

rate of 1195 seed per 100 ft. row and the coated seeds were planted at the rate of 443 seed p r 100 ft. row. The number of seed dropped per 100 ft. row was determined by calibrating the planter prior to making the plantings. The number of seed per pound was predetermined using the method employed by the Texas Agricultural Experiment Station (25).

The first planting made on May 28, 1953 was a failure due to unfavorable moisture conditions. A second planting was made July 4, 1953, with irrigation water available to "water the seed up". Approximately two-acre inches of water were applied immediately after planting. Counts for determining the percentage germination were made on a 50 ft. section of each row. This section was 25 ft. from each end of each row for all measurements. The number of germinating seedlings found was then multiplied by two and this sum divided by the total number of seeds planted in the 100 ft. row. This gave the percentage germination. Counts were made on the 9th and 18th days. A seed was considered to have germinated when it had developed into a normal seedling, which might be expected to continue its development in soil under favorable conditions.

A third planting was made on the Roy Rhode's farm, ten miles south of Texas Technological College, on Amarillo fine sandy loam that had been pre-irrigated and was wet to a depth of six feet. This planting was similar to those made on the college farm except a different make of planter was used, which changed the seeding rate. The seeding rate was 262 and 205 seed per 100 ft. row for untreated fuzzy seed and coated seed treatments respectively. Emergence counts were made in the same manner as for the other field plantings.

Greenhouse Plantings. -- The randomized-block design was used in greenhouse plantings, as in the field plantings; the treatments and replications were the same. Flats were filled within one inch of the top with field soil, each flat being divided by appropriate markers into four sections. This allowed four treatments within each flat. One hundred seed were planted one inch deep in each section of the flats. Each treatment was replicated four times. This number of seed and replications were used to comply with standards used by the Texas State Seed Laboratory (70). All flats received similar treatment with regard to water, light and temperature. The flats were watered very lightly each day. Emerging seedlings were counted each day beginning on the fifth and continuing through the fourteenth day.

Laboratory Plantings. -- Lots of the same treated seed were tested for germination in the State Seed Laboratory according to the requirements and specifications of the Texas State Seed Testing Law (70). In these tests four lots of one hundred seed for each treatment, were placed between rolled towels in the germinator and counts were made on the seventh and fourteenth days.

At the end of a one year storage period, the planting of the seed in the flats and germinator was repeated in the same way. In all trials uncoated fuzzy seed checks were used as in the field plantings.

Influence of Coatings on Seedling Growth. -- The treatments used in this study were like those used for the germination trials. The plants were grown in four gallon glazed clay pots with drainage openings at the base. Each pot was filled with well washed, sharp, builders sand and enough seed planted to insure ten plants per pot. One quart of

water was sprinkled on each pot daily. Four replications were used with each treatment. At the end of eighteen days the ten seedlings in each pot were very carefully washed free of the sand and placed between paper towels and allowed to soak for several hours. This was necessary to loosen the sand crystals on the roots. The seedling were then rinsed several times and the roots cut from the tops. After separation, these portions were placed in an oven at 100 degrees Centigrade and dried. Weights were then made in milligrams for the roots and tops.

TABLE II

RATES OF VARIOUS MATERIALS ADDED TO THE INERT FELDSPAR-FLYASH[a] AND MONTMORILLONITE[b] COATINGS

Symbol for Treatment[c]	Type and Amount of Coating[d] and Material Added
Fuzzy	Normal seed used as check dusted with Ceresan
	Montmorillonite Coatings
FR	Regular coating-used at a rate of 20 percent of seed weight
1a	Regular coating + 0.5 percent Hyponex
1b	Regular coating + 1.0 percent Hyponex
2a	Regular coating + .05 percent Dried Blood
2b	Regular coating + 0.5 percent Dried Blood
3a	Regular coating + 1.0 ounce Graino per bushel
3b	Regular coating + 3.0 ounces Graino per bushel
4a	Regular coating + 1/3 ounch Rootone per bushel
4b	Regular coating + 1.0 ounce Rootone per bushel
5a	Regular coating + 1/3 ounce Rootone 10 per bushel
5b	Regular coating + 1.0 ounce Rootone 10 per bushel
6a	Regular coating + 3.0 ounces Actmus per bushel
6b	Regular coating + 16.0 ounces Actmus per bushel
FC	Regular coating + 1.0 percent Catylitic material
FP	Regular coating + 4.0 percent P_2O_5
	Feldspar-flyash Coatings
VR	Regular coating-used at rate of 20 percent of seed weight
VT	Regular coating + 30. P.P.M. Terramycin
VS	Regular coating + 1 percent Systox

[a]An inert, powdered, rock used as a basic coating for all seeds by Processed Seeds, Midland, Michigan.

[b]A finely ground clay, (Hydrous alumino-silicate) used as a basic coating for all seeds by Filtrol Corporation, Los Angeles, California.

[c]These symbols may be used in all future tables.

[d]In each case the recommendations of the manufacturer were followed in the first dosage, then this amount was increased by varying amounts in additional trials.

CHAPTER V

RESULTS AND DISCUSSION

Emergence Data and Statistical Analysis of Field Planting Trials of Coated and Fuzzy Cottonseed

The term, "emergence", in this paper refers to seed planted in the greenhouse and field; while the term, "germination", refers to seed placed in the germinator.

"Rate of emergence" (73), as used in this discussion was obtained for each treatment by dividing the percentage emergence of the fuzzy seed or coated seed (as the case may be) on the seventh day by the percentage emergence on the 14th day.

A. Emergence trials on the college farm. -- The percentage emergence of the coated seed and fuzzy seed check treatments are given in Table III.

An analysis of variance was calculated on the percentage emergence data according to the method of Hays and Immer (32). (See Table IV.) It was found that the calculated F values for differences in the treatments were greater than the theoretical F value at the one percent point. Therefore the differences between treatments were highly significant[a]. To test further the importance of the differences found in Table IV, a test for the least or minimum difference was made according to Hayes and Immer (32). A difference in emergence percentage of

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[a]In the discussion of the results in this paper the term "highly significant" refers to variations in treatments that exceed the requirement for significance at the one percent point.

TABLE III

PERCENTAGE EMERGENCE OF FUZZY AND COATED COTTONSEED WHEN PLANTED IN THE FIELD IN AMARILLO FINE SANDY LOAM

Treatment Used	Percent Emergence	% Deviation of % Emergence of coated Seed from Check
Montmorillonite coating		
Standard	45.6	-8.8
Plus .5% Hyponex	28.7	-31.5
Plus 1.0% Hyponex	36.7	-12.4
Plus .05% Dried Blood	29.6	-29.4
Plus .5% Dried Blood	35.4	-15.5
Plus 4% P_2O_5	21.9**a	-47.8
Plus 1 oz. Graino per bu.	27.5*b	-34.4
Plus 3 oz. Graino per bu.	32.9	-21.5
Plus 1/3 oz. Rootone per bu.	18.3**	-56.3
Plus 1 oz. Rootone per bu.	19.0**	-54.7
Plus 1/3 oz. Rootone 10 per bu.	21.0**	-49.9
Plus 1 oz. Rootone 10 per bu.	31.4	-25.1
Plus 3 oz. Actmus per bu.	35.0	-16.5
Plus 16 oz. Actmus per bu.	29.8	-28.9
Plus 1% special Catylitic material	29.4	-29.9
Feldspar-flyash coating		
Standard	36.1	-13.9
Plus 30 P.P.M. Terramycin	64.1**	52.9
Plus 1% Systox	49.9	17.0
Fuzzy Seed Check	41.9	- - -

a Exceeds the one percent point, therefore, the difference is highly significant.

b Exceeds the five percent point, therefore, the difference is significant.

Note: In future tables one asterisk(*) denotes significance at the five percent level and two asterisks (**) at the one percent level.

13.3 was required for significance while a difference of 17.7 percent was required for high significance.

TABLE IV

ANALYSIS OF VARIANCE OF THE EFFECT OF COATING TREATMENTS ON PERCENTAGE EMERGENCE OF COTTON IN FIELD PLANTING

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	681.82	227.27	2.578	
Treatments	18	9018.35	501.01	5.68**	
Error	54	4760.38	88.15		
Total	75	14460.55			

The results show that no significant[a] increase or decrease in emergence from that of the fuzzy seed check, resulted from the standard montmorillonite clay or the standard feldspar-flyash coatings. There was, however, a significant decrease in emergence when one-ounce of Graino per bushel was added to the standard montmorillonite coating. Highly significant decreases in emergence resulted from the treatments of four percent P_2O_5, one-third ounce Rootone, one ounce Rootone, and one-third ounce Rootone No. 10 added to the standard montmorillonite coating.

When comparing the percentage emergence of the standard montmorillonite coating with treatments containing montmorillonite plus certain fertilizers and growth regulators, it was found that significant decreases resulted from adding: .05 percent Hyponex, .05 percent dried blood, one ounce Rootone and 16 ounces Actmus. Highly significant de-

[a] In the discussion of the results of this paper the term "significant" refers to variations in treatments that exceed the requirement for significance at the five percent point.

creases resulted from the additions of one ounce Graino, one-third ounce Rootone, one ounce Rootone, one-third ounce Rootone No. 10, one percent special Catylitic material, and four percent P_2O_5. Although the percentage emergence from the remaining treatments combined with the montmorillonite were not significantly changed, the trend of percentages obtained was lower than the emergence of the standard montmorillonite, the standard feldspar-flyash, and the fuzzy seed check.

Though the results showed no significant differences in the percentage emergence due to the standard feldspar-flyash coating, highly significant increases of 22.2 percent and 28.1 percent over the fuzzy seed and the standard coating respectively, were obtained from the addition of 30 P.P.M. of Terramycin to the standard coating. A significant increase was obtained from the addition of one percent Systox to the feldspar-flyash coating.

B. Rate of emergence of cottonseed in field planting. -- The rate of emergence of the various treatments when planted in the field are given in Table V.

An analysis of variance test was made on the rate of emergence data, and is given in Table VI. The results show that there was a highly significant difference in rate of emergence of cottonseed due to seed treatments.

The standard error of the difference between two means was 10.497. This gives a minimum difference of 21.1 percent and 28.03 percent for significance and high significance, respectively, between treatments.

The data in Table VI show that the standard montmorillonite

TABLE V

RATE OF EMERGENCE OF COATED AND FUZZY COTTONSEED WHEN PLANTED IN THE FIELD

Treatment Used	Percent Emergence	% Deviation of % Emergence of Coated Seed from Check
Montmorillonite coating		
Standard	45.1**	-42.4
Plus .5% Hyponex	40.3**	-48.5
Plus 1.0% Hyponex	50.8*	-35.9
Plus .05% Dried Blood	46.2**	-41.0
Plus .5% Dried Blood	38.3**	-51.1
Plus 4% P_2O_5	19.2**	-75.5
Plus 1 oz. Graino per bu.	30.9**	-60.5
Plus 3 oz. Graino per bu.	61.1	-21.9
Plus 1 1/3 oz. Rootone per bu.	40.4**	-48.5
Plus 1 oz. Rootone per bu.	37.2**	-52.5
Plus 1 1/3 oz. Rootone 10 per bu.	47.9**	-38.8
Plus 1 oz. Rootone 10 per bu.	56.1*	-28.3
Plus 3 oz. Actmus per bu.	57.6	-26.3
Plus 16 oz. Actmus per by.	63.1	-19.4
Plus 1% special Catylitic material	40.2**	-48.6
Feldspar-flyash coating		
Standard	80.3	-12.7
Plus 30 P.P.M. Terramycin	68.5	-12.4
Plus 1% Systox	67.7	-13.5
Fuzzy seed check	78.2	- - -

TABLE VI

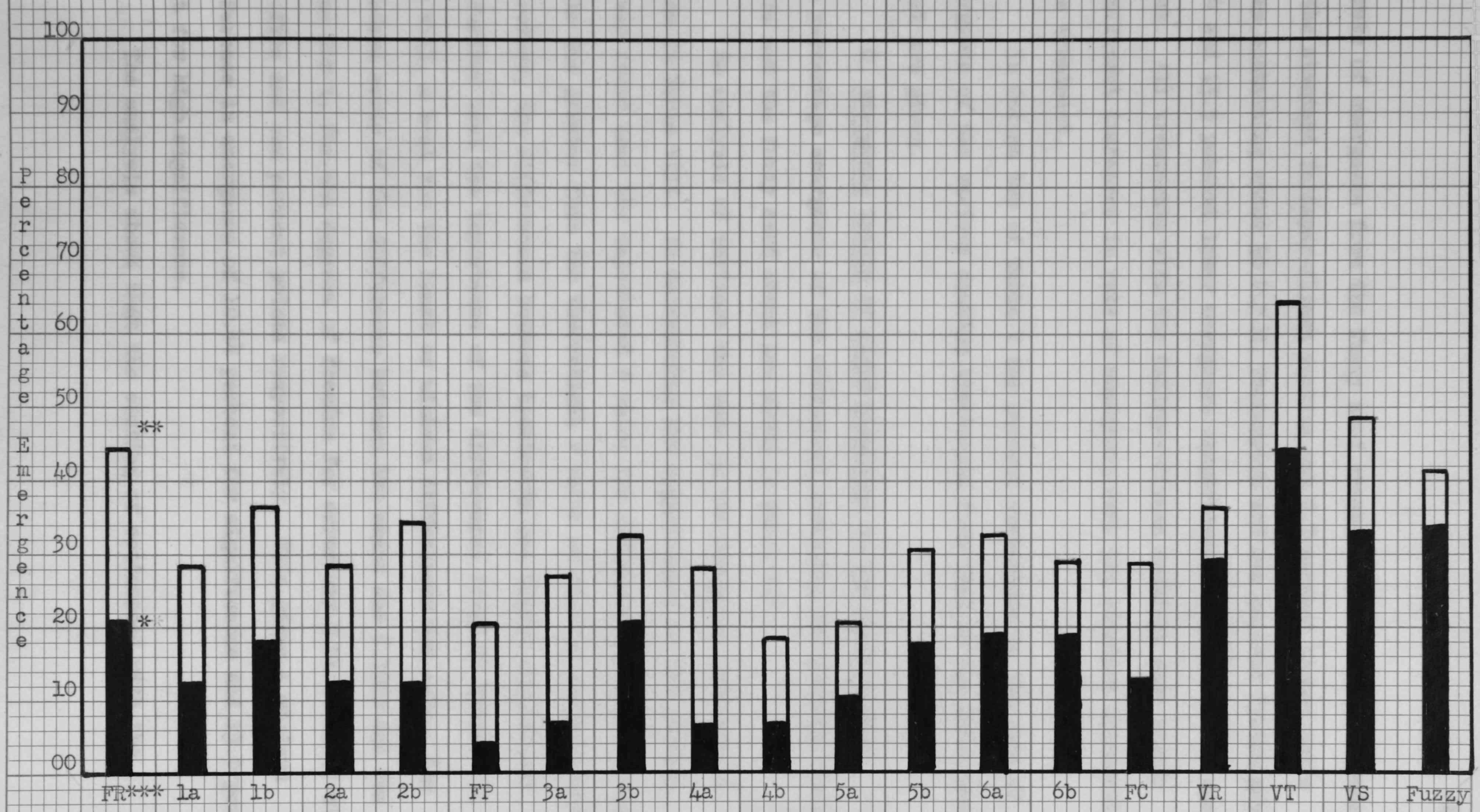
ANALYSIS OF VARIANCE OF THE EFFECTS OF COATING TREATMENTS ON THE RATE OF EMERGENCE OF COTTON PLANTED IN FIELD

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	131.88	43.96		
Treatments	18	18,727.22	1.040.40	4.76**	
Error	54	11,900.58	220.38		
Total	75	30,759.69	410.12		

coating decreased the rate of emergence of cottonseed 42.4 percent below the fuzzy seed check and 45.1 percent below the standard feldspar-flyash coating. Highly significant reductions in rate of emergence were shown for the same coating with the addition of the following treatments: .05 percent Hyponex, .05 percent dried blood, .5 percent dried blood, four percent P_2O_5, one ounce Graino, one-third ounce Rootone, one ounce Rootone, one-third ounce Rootone No. 10, and one percent special Catylitic material. Significant, though markedly lesser decreases, are shown for one percent Hyponex and one ounce of Rootone No. 10 when added to the montmorillonite coating. The data show that the addition of four percent P_2O_5 to the montmorillonite coating gave significant reduction in the rate of emergence. Rates of emergence were not significantly higher from the addition of one percent Hyponex, .05 percent dried blood, three ounces of Graino, one-third and one ounce dosages of Rootone 10, and the two dosages of Actmus, although the trend of percentages obtained was higher.

The feldspar-flyash treatments were not significantly different

Figure 2. A Comparison of the Percentage Emergence from Fuzzy and Coated Cottonseed when Planted in the Field.



* Percentage emergence at 7th day indicated by solid bar.

** Percentage emergence at 14th day indicated by clear bar.

*** Indicates treatments used (See Table II for Meaning of Symbols).

in rate of emergence from the fuzzy seed check. The rate of emergence of the standard feldspar-flyash coating was 2.7 percent higher while those containing added 30 P.P.M. Terramycin and one percent Systox gave 12.4 and 13.5 percent lower emergence respectively, than the fuzzy seed check. All treatments with the feldspar-flyash coatings gave highly significant increases in rate of emergence over the standard montmorillonite treatment.

In Column two of Table V the percent deviations in the rate of emergence of the various coating treatments from that of the fuzzy seed check are given.

C. Emergence trials of field plantings on the Rhode's farm. -- The percentage emergence of the cottonseed receiving the coating treatments and the fuzzy seed check are shown in Table VII.

An analysis of variance was made on the emergence data and is given in Table VIII. In determining the significance of the results, it was found that the calculated F value for differences between treatments was greater than the theoretical F value at the one percent point. Therefore, the differences between treatments was highly significant. To further test the importance of the differences found in Tables VII and VIII, a test for the least or minimum differences was made. The standard error of the difference between two means was 5.1925 and the value for t, for the degrees of freedom for error was 2.01 and 2.67 at the five and one percent points respectively. This gives a minimum difference in emergence of 10.44 percent for significance and 13.9 percent for high significance.

The analysis shows that the coating of cottonseed with the

TABLE VII

PERCENTAGE EMERGENCE OF FUZZY AND COATED COTTONSEED WHEN PLANTED IN THE FIELD ON PRE-IRRIGATED AMARILLO FINE SANDY LOAM

Treatment Used	Percent Emergence	% Deviation of % Emergence of Coated Seed from Check
Montmorillonite coating		
Standard	23.9*	-36.0
Plus .5% Hyponex	21.7**	-41.9
Plus 1% Hyponex	13.4**	-64.1
Plus .05% Dried Blood	13.6**	-63.6
Plus .5% Dried Blood	11.7**	-68.7
Plus 4% P_2O_5	8.5**	-77.3
Plus 1 oz. Graino per bu.	18.3**	-50.9
Plus 3 oz. Graino per bu.	18.5**	-50.5
Plus 1/3 oz. Rootone per bu.	11.9**	-68.1
Plus 1 oz. Rootone per bu.	11.4**	-69.5
Plus 1/3 oz. Rootone 10 per bu.	5.1**	-86.4
Plus 1 oz. Rootone 10 per bu.	8.3**	-77.8
Plus 3 oz. Actmus per bu.	8.8**	-76.5
Plus 16 oz. Actmus per bu.	13.2**	-64.7
Plus 1% special Catylitic material	12.0**	-68.1
Feldspar-flyash coating		
Standard	26.4*	-29.3
Plus 30 P.P.M. Terramycin	33.9	- 9.2
Plus 1% Systox	18.7**	49.9
Fuzzy seed check	37.3	- - -

standard montmorillonite resulted in a significant decrease in emergence when compared to that of the fuzzy seed check. In all coating treatments with fertilizers and growth regulators in the montmorillonite base, highly significant decreases in the emergence below that of the fuzzy cottonseed resulted. The results in Table VIII also show that significant decreases in emergence below that of the standard montmorillonite treatment were obtained from the treatments of one percent Hyponex, .05 percent dried blood, and one-third ounce Rootone, one ounce Rootone, 16 ounces of Actmus, and one percent special Catylitic material. Highly significant decreases in emergence under that of the standard montmorillonite coating were obtained from treatments with three ounces of Actmus, four percent P_2O_5, one ounce Rootone 10, and one-third ounce Rootone 10, with the latter showing the greater decrease.

TABLE VIII

ANALYSIS OF VARIANCE OF THE EFFECTS OF SEED TREATMENTS ON THE PERCENTAGE EMERGENCE OF COTTON PLANTED IN THE FIELD ON PRE-IRRIGATED AMARILLO FINE SANDY LOAM

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	309.52	103.18	1.912	
Treatments	18	5476.60	304.25	5.638**	
Error	54	2913.62	53.96		
Total	75	8699.74			

The results in Tables VII and VIII show that coating of cottonseed with the standard feldspar-flyash treatment and the feldspar-flyash plus one percent Systox gave a significant decrease in emergence from the fuzzy seed check. The feldspar-flyash coating plus 30 P.P.M.

Terramycin treatment was not significantly different from the fuzzy seed check.

It will be noted that emergence percentages in this field test are much lower than those obtained from the planting made on the college farm. This can possibly be explained by the extremely high temperatures and dry winds which prevailed for several days following planting. Maximum daily temperatures during the week following planting exceeded 100 degrees Fahrenheit. According to Simpson (63), temperatures in excess of 90 to 95 degrees Fahrenheit increases the respiration rate of young cotton seedlings to the extent that many are killed.

No data was obtained on rate of emergence for this planting because no seedlings emerged after the eighth day and a second count was not taken on the fourteenth day.

D. General conclusion regarding the emergence results of field plantings. -- The results of both plantings were somewhat similar. On the Rhode's farm, all coating treatments (except feldspar-flyash plus 30 P.P.M. Terramycin) resulted in significant decreases in the percentage germination. The mean for percentage emergence on the Rhode's farm for all montmorillonite coatings was 13.35, all feldspar-flyash coatings 26.33, while the mean for the fuzzy seed check was 37.3. This indicates that the mean of the feldspar-flyash coatings was significantly lower than the fuzzy seed; while the montmorillonite coatings mean percentage emergence was significantly lower than the feldspar-flyash and highly significantly lower than the fuzzy seed check.

In the field trial on the Agronomy Farm, none of the seed lots coated with montmorillonite clay exceeded the emergence of the fuzzy seed

check. The seed lots coated with feldspar-flyash showed significantly higher emergence percentages than the montmorillonite coatings and the coating containing .30 P.P.M. Terramycin showed a highly significant increase over the fuzzy seed check. This same treatment gave the highest emergence of all coated seed in both field tests, indicating that beneficial results may result from the use of this antibiotic as a seed treatment.

The averages for the percentage emergence on the college farm were: All montmorillonite coatings, 29.5; all feldspar-flyash coatings, 49.7; and the fuzzy seed check, 41.9. Although a trend toward increased emergence resulted from the feldspar-flyash coatings over the montmorillonite and fuzzy seed check, it was not a significant increase over the fuzzy seed check.

In most instances, the addition of fertilizers and hormones resulted in further decreases in percentage emergence. This was especially true of the four percent P_2O_5 fertilizer and the Rootone hormone treatments. On the basis of this trial, no consistent definite benefit can be shown for any coating treatment. Results of percentage emergence were variable between plantings indicating further study is needed.

The results show that the rate of emergence of all treatments involving the montmorillonite coatings were lower than either the fuzzy seed check or the feldspar-flyash coatings. The decreases were highly significant in 10 of the 15 treatments involving the montmorillonite coating and two of the remaining five were significantly decreased.

The rate of emergence of the seed having feldspar-flyash coat-

ings were not significantly different from that of the fuzzy uncoated seed.

The mean rate of emergence for the treatments involving the montmorillonite coatings was 43.6 percent; feldspar-flyash, 72.1 percent; and the fuzzy seed check 78.10 percent.

These results indicate that generally the rate of emergence is highly significantly decreased when cottonseed are coated with the materials tested.

Emergence Data and Statistical Analysis of Greenhouse Plantings

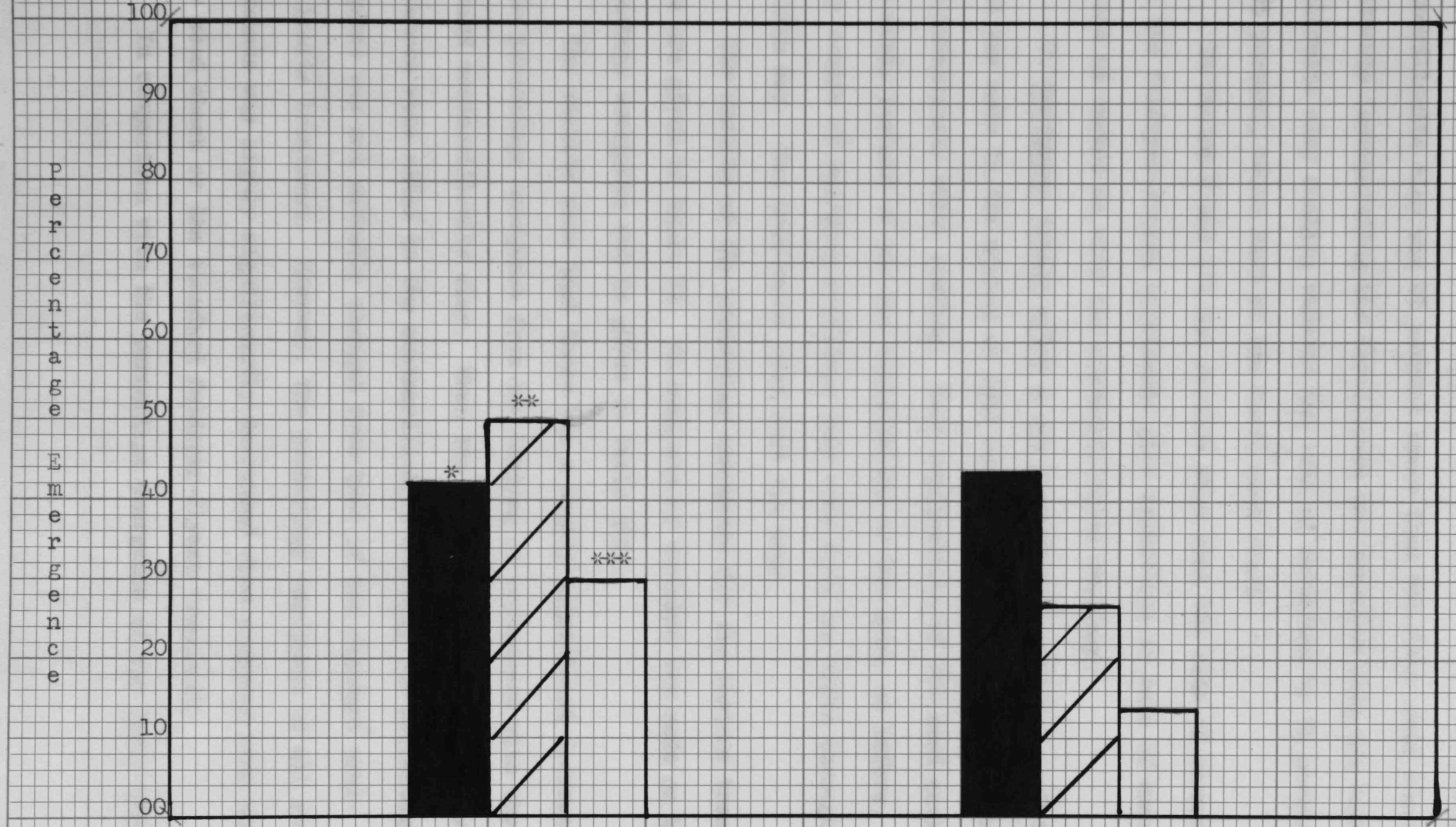
A. Emergence trials immediately after the coatings were applied.

Two hundred seed of each treatment were planted at a uniform depth of one inch in flats of Amarillo fine sandy loam and replicated twice. The percentage emergence was determined by daily counts from the fifth through the 14th day. The plants emerging each day were removed to facilitate more accurate counts.

The mean percentage emergence of the various treatments is given in Table IX. The treatments were not properly replicated nor randomized for statistical analysis. The results of this trial show that the trend was for marked reductions in the percentage emergence for all treatments involving the montmorillonite coatings; while those treatments using feldspar-flyash coatings gave an increase in percentage emergence over the fuzzy seed check. (See Table XI.)

B. Rate of emergence of cottonseed planted in the greenhouse immediately following coating. -- The results of this trial are given in Tables X and XII. Since only two replications were used, the significance of the results was not established but apparent trends

Figure 3. A Comparison of Mean Percentage Emergence of Cotton from Fuzzy Uncoated, Feldspar-Flyash Coated, and Montmorillonite Coated Seed when Planted in the Field.



* Fuzzy seed treatment indicated by solid bar.

** Feldspar-Flyash treatments indicated by shaded bar.

*** Montmorillonite treatments indicated by clear bar.

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can be noted. The rate of emergence of seed coated with the standard montmorillonite clay was 45 percent lower than the fuzzy seed check. Treatments incorporating the fertilizers and hormones with the montmorillonite clay coating reduced the rate of emergence by 52 percent to 85 percent, below that of the fuzzy seed check.

In Tables X and XII the results show that the rate of emergence with the feldspar-flyash treatments gave reductions in rate of emergence but not as marked as with the montmorillonite coatings.

C. Emergence trials after a one year storage period. -- This trial was made in the spring of 1954 under similar conditions as those made immediately after coating. Four replications of 100 seed each were used, instead of the two replications of 200 seed, as before. Daily counts of emerging seedlings were made from the fifth through the 14th day. The treatments used were the same.

The results of the percentage emergence for the various treatments are given in Table IX. An analysis of variance was made on the percentage emergence and is given in Table XIII.

The results show that there was a highly significant decrease in the percentage emergence from the coating of cottonseed with the standard montmorillonite clay. When the fertilizers and plant growth regulators were added to the montmorillonite coating, the percentage emergence was not markedly changed from that of the standard montmorillonite treatment. However, the percentage emergence of all such treatments was highly significantly decreased when compared with the fuzzy seed check or the standard feldspar-flyash treatment.

In comparison with the percentage emergence of the fuzzy seed

TABLE IX

PERCENTAGE EMERGENCE OF COTTON FROM COATED AND FUZZY SEED PLANTED IN FLATS OF FIELD SOIL IN THE GREENHOUSE

Treatment Used	Emergence in Percent		% Deviation Due to Storage
	Immediate Planting	After One Year Storage	
Montmorillonite coating			
Standard	43	52**	+20
Plus 0.5% Hyponex	60	37**	-38
Plus 1.0% Hyponex	45	41**	- 9
Plus .05% Dried Blood	45	58**	+29
Plus 5% Dried Blood	43	54**	+26
Plus 4% P_2O_5	25	42**	+68
Plus 1 oz. Graino per bu.	33	48**	+45
Plus 3 oz. Graino per bu.	48	51**	+ 6
Plus 1/3 oz. Rootone per bu.	42	56**	+33
Plus 1 oz. Rootone per bu.	39	55**	+41
Plus 1/3 oz. Rootone 10 per bu.	42	58**	+38
Plus 1 oz. Rootone 10 per bu.	39	48**	+23
Plus 3 oz. Actmus per bu.	38	52**	+37
Plus 16 oz. Actmus per bu.	30	36**	+20
Plus 1% Catylitic material	30	41**	+37
Feldspar-flyash coating			
Standard	76	77	+ 1
Plus 30 P. P. M. Terramycin	77	73	- 5
Plus 1% Systox	65	62*	- 5
Fuzzy seed check	60	76	+27

TABLE X

RATE OF EMERGENCE OF COTTON FROM COATED AND FUZZY SEED PLANTED IN FLATS OF FIELD SOIL IN THE GREENHOUSE

Treatment Used	Emergence in Percent		% Deviation Due to Storage
	Immediate Planting	After One Year Storage	
Montmorillonite coating			
Standard	49	57**	+16
Plus 0.5% Hyponex	18	26**	+44
Plus 1.0% Hyponex	13	29**	+123
Plus .05% Dried Blood	27	34**	+26
Plus .5% Dried Blood	33	40**	21
Plus 4% P_2O_5	32	26**	-19
Plus 1 oz. Graino per bu.	42	31**	-26
Plus 3 oz. Graino per bu.	31	28**	-10
Plus 1 1/3 oz. Rootone per bu.	24	22**	- 8
Plus 1 oz. Rootone per bu.	33	38**	+15
Plus 1 1/3 oz. Rootone 10 per bu.	26	36**	+38
Plus 1 oz. Rootone 10 per bu.	26	25**	- 4
Plus 3 oz. Actmus per bu.	39	23**	-41
Plus 16 oz. Actmus per bu.	33	29**	-12
Plus 1% Catylitic material	33	29**	-12
Feldspar-flyash coating			
Standard	68	80	+18
Plus 30 P.P.M. Terramycin	69	76*	+10
Plus 1% Systox	78	71**	- 9
Fuzzy seed check	88	88	0

TABLE XI

PERCENTAGE INCREASE OR DECREASE IN EMERGENCE AT FOURTEENTH DAY COUNT OF COATED OVER FUZZY COTTONSEED WHEN PLANTED IN AMARILLO FINE SANDY LOAM IN THE GREENHOUSE

Coating Material Used	Immediate Planting	After Stored One Year
Montmorillonite coating		
Standard	-28.4	31.6
Plus 0.5% Hyponex	0.0	-51.0
Plus 1.0% Hyponex	-25.0	-46.3
Plus .05% Dried Blood	-25.0	-22.8
Plus .5% Dried Blood	-28.4	-28.1
Plus 4% P_2O_5	-58.4	-45.1
Plus 1 oz. Graino per bu.	-45.0	-36.1
Plus 3 oz. Graino per bu.	-20.0	-33.2
Plus 1 1/3 oz. Rootone per bu.	-30.0	-25.5
Plus 1 oz. Rootone per bu.	-35.0	-26.8
Plus 1 1/3 oz. Rootone 10 per bu.	-30.0	-32.9
Plus 1 oz. Rootone 10 per bu.	-35.0	-37.1
Plus 3 oz. Actmus per bu.	-36.7	-31.4
Plus 16 oz. Actmus per bu.	-50.0	-52.4
Plus 1% Catylitic material	-50.0	-46.0
Feldspar-Flyash coating		
Standard	426.6	4 1.7
Plus 30 P.P.M. Terramycin	428.3	- 4.0
Plus 1% Systox	4 8.3	-18.2

TABLE XII

PERCENTAGE DECREASE IN RATE OF EMERGENCE AT FOURTEENTH DAY COUNT OF COATED FROM FUZZY COTTONSEED WHEN PLANTED IN AMARILLO FINE SANDY LOAM IN THE GREENHOUSE

Coating Material Used	Immediate Planting	Stored One Year
Montmorillonite		
Standard	45	57
Plus .5% Hyponex	79	71
Plus 1.0% Hyponex	85	68
Plus .05% Dried Blood	70	62
Plus 5% Dried Blood	63	55
Plus 4% P_2O_5	64	71
Plus 1 oz. Graino per bu.	52	65
Plus 3 oz. Graino per bu.	64	69
Plus 1/3 oz. Rootone per bu.	73	76
Plus 1 oz. Rootone per bu.	62	58
Plus 1/3 oz. Rootone 10 per bu.	70	60
Plus 1 oz. Rootone 10 per bu.	71	72
Plus 3 oz. Actmus per bu.	55	74
Plus 16 oz. Actmus per bu.	62	67
Plus 1% special Catylitic coating	62	68
Feldspar-flyash		
Standard	22	10
Plus 30 P.P.M. Terramycin	22	14
Plus 1% Systox	11	20

check, the results in Table XI show no significant difference due to coating cottonseed with the standard feldspar-flyash material.

The addition of the one percent Systox gave an emergence of 62 percent as compared to an emergence of 76 percent for the fuzzy seed check. A minimum deviation of 11.4 percent is required for significance at the five percent point; thus the one percent Systox treatment gave a significant decrease in emergence. The feldspar-flyash coating plus 30 P.P.M. Terramycin did not show a significant change in percentage emergence from the fuzzy seed check.

TABLE XIII

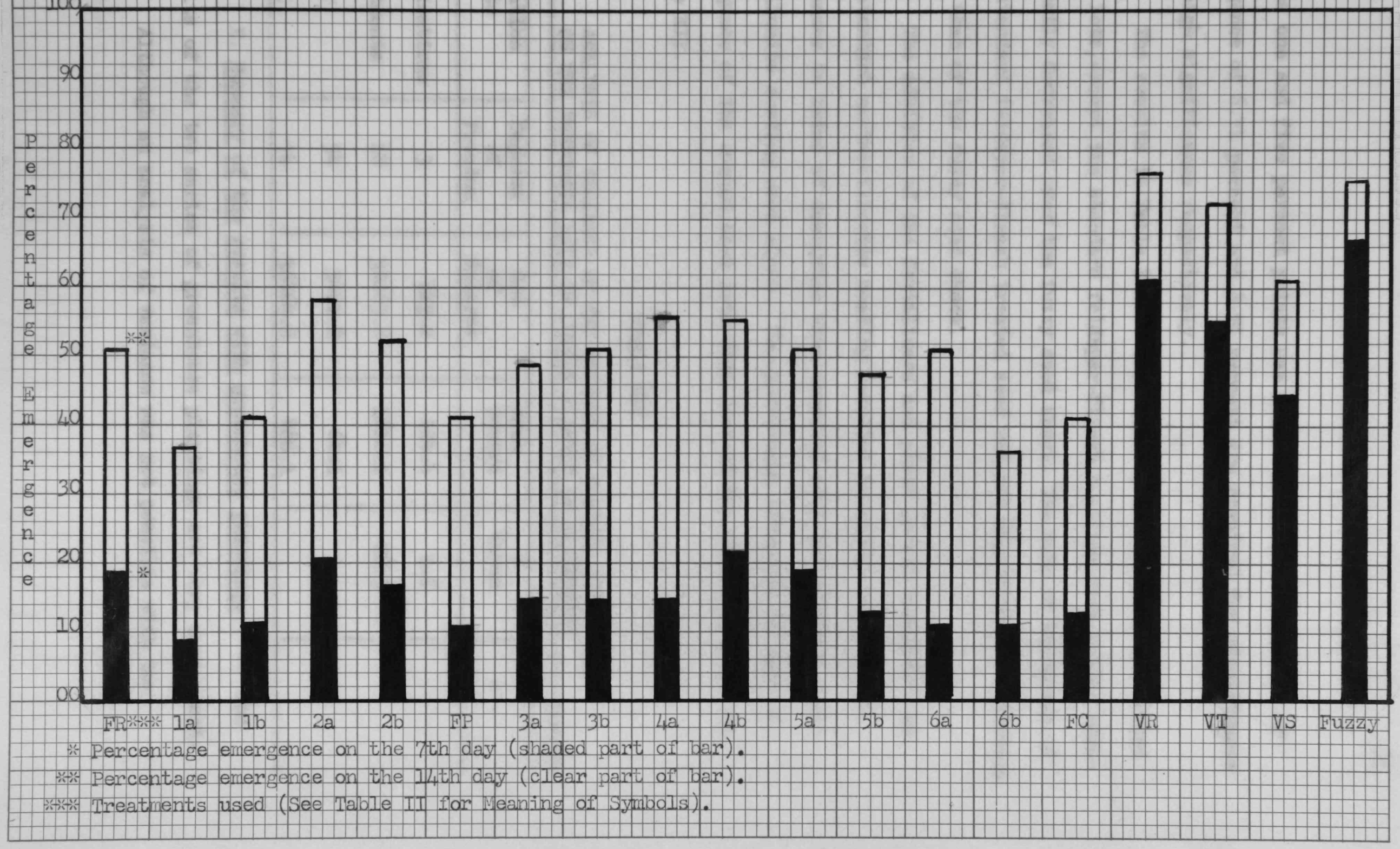
ANALYSIS OF VARIANCE OF THE EFFECT OF SEED TREATMENTS ON THE PERCENTAGE EMERGENCE OF COTTON PLANTED IN THE GREENHOUSE

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	158.6	52.86		
Treatments	18	10466.0	581.4	9.02**	
Error	54	3745.4	64.4		
Total	75	14370.0			

D. Rate of emergence in the greenhouse treatments after a one-year storage period. -- The rate of emergence for the coated cottonseed treatments and the fuzzy seed check are given in Table X and Figure 4. An analysis of variance test was made on the rate of emergence of the various treatments and is given in Table XIII.

The results in Table XIII show that there was a highly significant difference in rate of emergence between treatments. To test further, a test for the minimum difference required for significance

Figure 4. A Comparison of the Percentage Emergence from Fuzzy and Coated Cottonseed Planted in Field Soil in the Greenhouse.



* Percentage emergence on the 7th day (shaded part of bar).

** Percentage emergence on the 14th day (clear part of bar).

*** Treatments used (See Table II for Meaning of Symbols).

at the one and five percent points was made. A difference in rate of emergence of 6.71 percent and 8.91 percent are required for significance and high significance respectively.

The results in Table X show the rates of emergence of all coated seed lots, except the standard feldspar-flyash coatings, were highly significantly decreased over the fuzzy seed check. The rate of emergence of the standard feldspar-flyash treated seed was not significantly different from that of the fuzzy seed check.

The addition of the fertilizers and plant growth regulators to the standard montmorillonite coating resulted in highly significant decreases in rates of emergence when compared with the standard montmorillonite coating used alone. The percentage deviation in rate of emergence of the coated seed lots from that of the check are shown in Table XII.

TABLE XIV

ANALYSIS OF VARIANCE OF THE EFFECTS OF COATING TREATMENTS ON THE EMERGENCE RATE OF COTTON PLANTED IN GREENHOUSE

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	313.2	104.4	1.6	
Treatments	18	32689.8	1816.1	28.3**	
Error	54	3461.8	64.1		
Total	74	36464.8	486.1		

E. Summary of the results with greenhouse plantings. -- The results of the two series of greenhouse plantings are very consistent. Although an analysis of variance was not possible with the

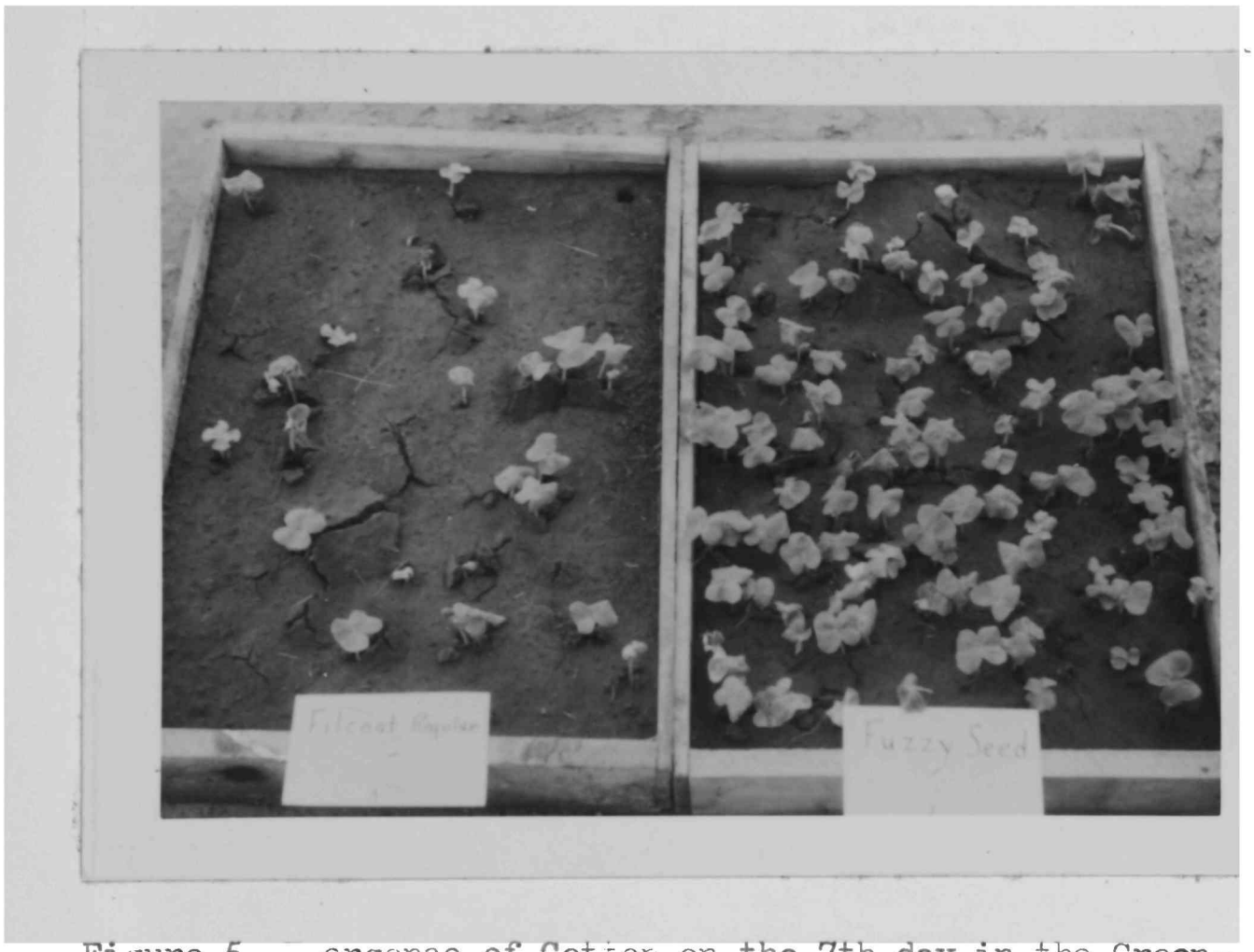


Figure 5. Emergence of Cotton on the 7th day in the Greenhouse, Montmorillonite Coated Seed are shown on the Left and Fuzzy Seed Check on the Right.

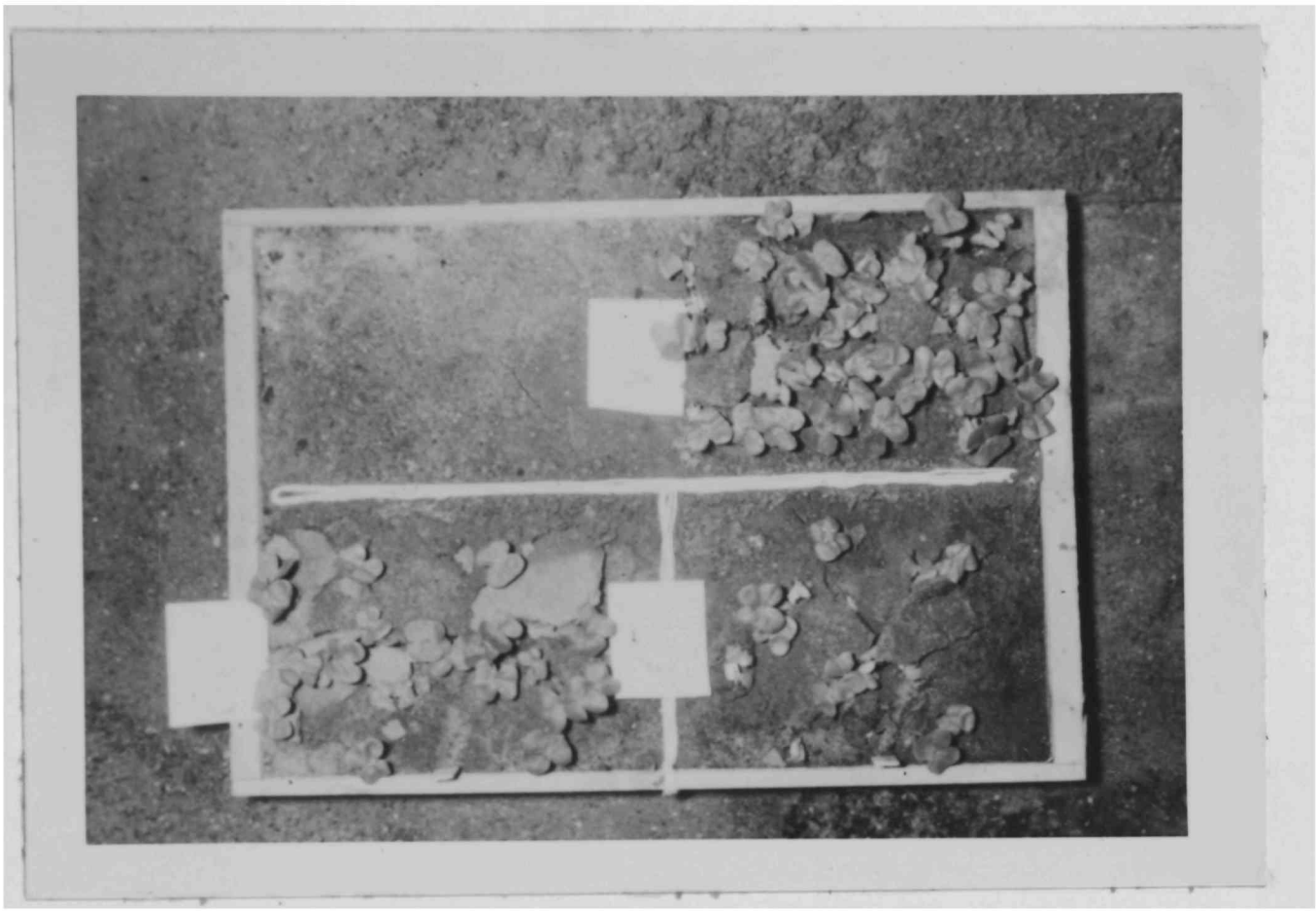


Figure 6. Emergence of Cotton on the 6th day: Lower Left Fuzzy Seed Check, Lower Right Montmorillonite Coated Seed, Upper Right Feldspar-Flyash Coated Seed.

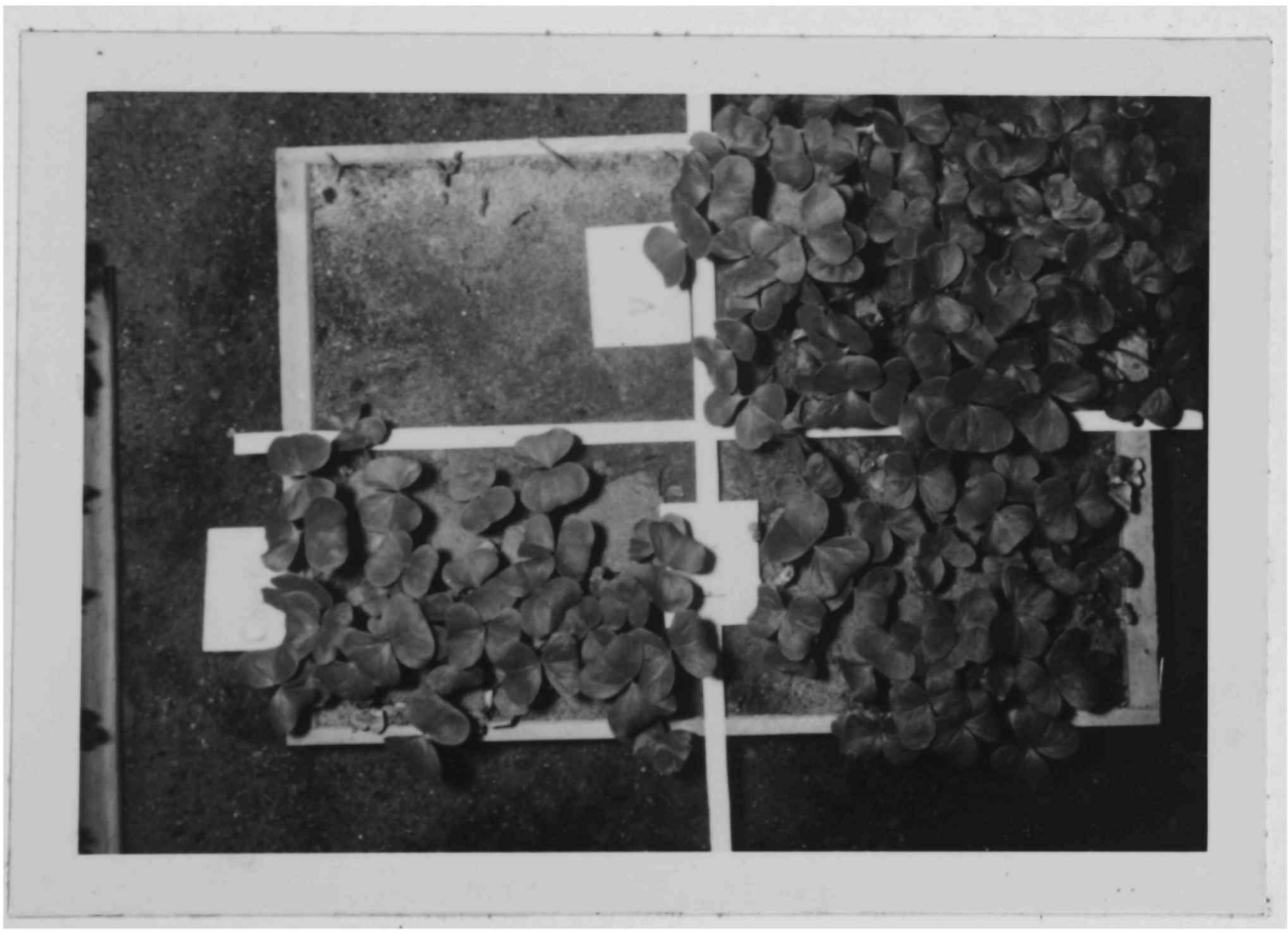
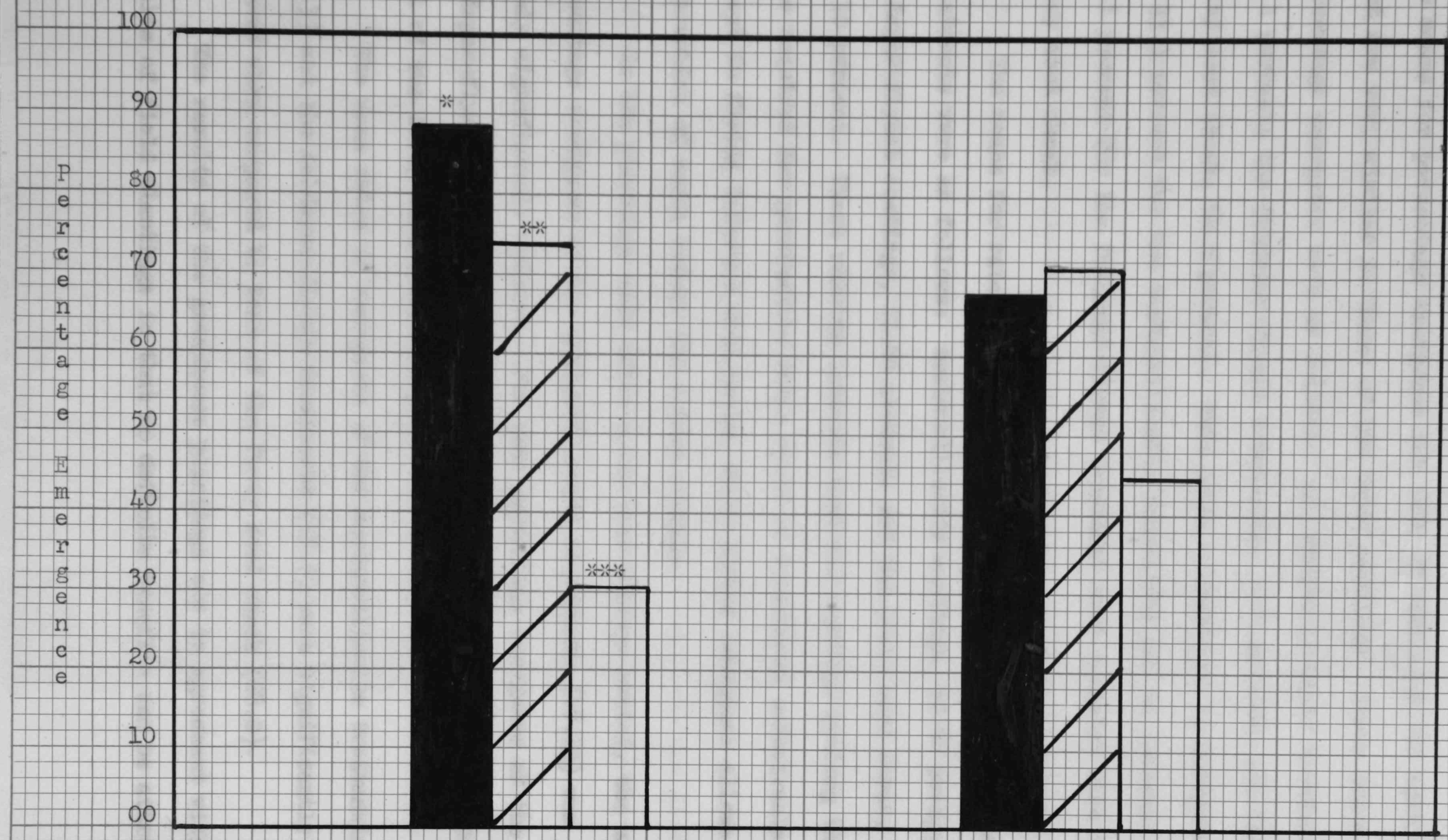


Figure 7. Emergence of Cotton on the 10th day: Lower Left Fuzzy Seed Check, Lower Right Montmorillonite Coated Seed, Upper Right Feldspar-Flyash Coated Seed.

Figure 8. A Comparison of the Mean Percentage Emergence of Cotton from Fuzzy Uncoated and Coated Cottonseed in the Greenhouse.



* Fuzzy seed treatment indicated by solid bar.
** Feldspar-Flyash treatments indicated by shaded bar.
*** Montmorillonite treatments indicated by clear bar.

results of the planting made immediately following the coating process, the means for percentage emergence and rate of emergence for each treatment are very similar to those of the later planting. These means for percentage emergence were as follows: all montmorillonite treatments, 40.1 percent; the feldspar-flyash treatments, 72.7 percent; and the fuzzy seed check, 60.0 percent. This gives a reduction in emergence of 33.3 percent for the montmorillonite treatments and an increase of 12.1 percent for the feldspar-flyash treatment when compared with the fuzzy seed check.

The means for rate of emergence resulting from the three basic treatments were as follows: montmorillonite coatings, 30.66 percent; feldspar-flyash coatings, 71.86 percent; and the fuzzy seed check, 88.30 percent. These results indicate that all coatings prolong the time required for germination which would be considered undesirable, except in fields infested with weeds, where slower emergence allows destruction of weeds before the cotton emerges.

In the plantings made after a one year storage period, the mean percentage emergence of the montmorillonite treatments (48.10) was highly significantly reduced. The mean percentage emergence of the feldspar-flyash treatments (70.4) was not significantly different from that of the fuzzy seed check (75.5).

The mean rates of emergence of the montmorillonite treatments (30.3) and the feldspar-flyash treatments (75.7) were significantly reduced when compared to that of the fuzzy seed check (88.0).

The results of the greenhouse plantings are in agreement with the results of field plantings in that no definite benefits can be attributed

to coating treatments on cottonseed; although the trend was for higher percentage germination from two of the three feldspar-flyash treatments.

Percentage Germination and Rate of Germination Data with Statistical Analysis of Trials Made in the Germinator

The following results were obtained from germination studies using a germinator in the Texas State Seed Laboratory. Tests were made according to State regulations governing the procedure for germination of cotton (70).

Four replications of 100 seed each were germinated between rolled towels and counts for germinating seedlings were made on the seventh and 14th days. The "rate of germination", was determined by dividing the number of the seed germinated on the seventh day by the number of seed germinated on the 14th day. Treatments used were identical with the greenhouse and field trials.

A. Germination trials immediately following coating. -- The data on percentage germination with the various treatments are given in Table XV. An analysis of variance test was made on the percentage germination and is given in Table XVI.

In analyzing the results it was found that variations due to treatments were highly significant. To test further the importance of the differences in Table XV, a test for the least or minimum difference was made. A minimum difference in percentage germination of 5.697 percent was required for significance and a difference of 7.568 percent for high significance.

The results show that highly significant increases in percentage germination over the fuzzy seed check were obtained when cottonseed were

TABLE XV

PERCENTAGE GERMINATION OF COTTON FROM COATED AND FUZZY SEED SPROUTED BETWEEN PAPER TOWELS IN A GERMINATOR

Treatment Used	Percentage Emergence		% Deviation Due to Storage
	Immediate Planting	Stored one Year	
Montmorillonite coating			
Standard	80**	74	- 7.7
Plus .5% Hyponex	66	71	+ 7.6
Plus 1.0% Hyponex	81**	74	- 9.5
Plus .05% Dried Blood	78*	73	- 9.4
Plus .5% Dried Blood	78*	72	- 7.7
Plus 4% P_2O_5	67	60**	-10.5
Plus 1 oz. Graino per bu.	73	74	+ 1.4
Plus 3 oz. Graino per bu.	73	69*	- 5.5
Plus 1 1/3 oz. Rootone per bu.	80**	64**	-25.0
Plus 1 oz. Rootone per bu.	74	69*	- 7.2
Plus 1 1/3 oz. Rootone 10 per bu.	78**	68*	-14.6
Plus 1 oz. Rootone 10 per bu.	77**	65**	-19.1
Plus 3 oz. Actmus per bu.	75	68*	-10.0
Plus 16 oz. Actmus per bu.	70	73	+ 5.0
Plus 1% special Catylitic material	78*	56**	-39.2
Feldspar-flyash coating			
Standard	85**	87**	+ 3.0
Plus 30 P.P.M. Terramycin	78**	88**	+12.0
Plus 1% Systox	79**	86**	+10.0
Fuzzy seed check	71	76	+ 6.6

coated with the standard montmorillonite coating or the standard feldspar-flyash coating. As given in Table XVII, the standard feldspar treated seed germinated 20 percent higher than the fuzzy seed check and seven percent higher than the standard montmorillonite treated seed. Highly significant increases in germination were also evidenced by treatments of one percent Hyponex, one-third ounce Rootone, combined with the montmorillonite clay, and the treatment incorporating one percent Systox with the feldspar-flyash coating. Significant increases were obtained from .05 percent dried blood, 0.5 percent dried blood, one-third ounce Rootone 10, one ounce Rootone 10, and one percent Catylitic material incorporated with the montmorillonite clay, and from 30 P.P.M. Terramycin incorporated with the feldspar-flyash.

This shows that all treatments involving the feldspar-flyash coatings gave increased germination over the fuzzy seed check; with the standard coating and the standard coating plus one percent Systox, increases were highly significant. The increase due to the 30 P.P.M. Terramycin treatment was significant. The percent deviations of germination of coated seed lots from that of the fuzzy seed check are given in Table XVIII.

Further analysis of Table XV shows that the addition of four percent P_2O_5, 0.5 percent Hyponex and 16 ounces of Actmus to the montmorillonite clay resulted in highly significant decreases in percentage germination over the standard montmorillonite treatment. Further, that significant decreases were obtained from the treatments of one ounce of Graino, three ounces of Graino, and three ounces of Rootone. The percentage germination from treatments of .05 percent dried blood, .5 per-

cent dried blood, one-third and one ounce Rootone 10, three ounces of Actmus, one percent Catylitic material, and one percent Hypone$_X$ was not significantly different from the standard montmorillonite treatment.

TABLE XVI

ANALYSIS OF VARIANCE OF THE PERCENTAGE GERMINATION OF COATED AND FUZZY COTTONSEED IN THE GERMINATOR IMMEDIATELY AFTER TREATMENT

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	12.32	4.11		
Treatments	18	1710.95	95.05	5.914**	
Error	54	867.68	16.07		
Total	75	2590.95			

B. Rate of germination trials immediately following coating. -- The rates of germination for the different seed treatments are given in Table XIX.

An analysis of variance test was made on the rate of emergence and is given in Table XX.

In determining the significance of the results, it was found that the calculated F value for differences in the treatments were greater than the theoretical F value at the one percent point. Therefore, the differences between treatments are highly significant. To further test the importance of the differences between treatments found in Table XIX, the least minimum difference was found. A difference in rate of emergence of 6.71 percent was required for significance and a difference of 8.91 percent was required for high significance.

The results in Table XIX and XX show that under the conditions

TABLE XVII

PERCENTAGE INCREASE OR DECREASE IN GERMINATION AT THE 14th DAY COUNT OF COATED SEED OVER FUZZY COTTONSEED WHEN SPROUTED BETWEEN PAPER TOWELS IN THE GERMINATOR

Coating Material Used	Immediate Planting	Stored One Year
Montmorillonite coating		
Standard	- 3	⁄13
Plus 0.5% Hyponex	- 8	- 7
Plus 1.0% Hyponex	- 3	⁄14
Plus .05% Dried Blood	- 4	⁄10
Plus .5% Dried Blood	- 5	⁄10
Plus 4% P_2O_5	-21	- 6
Plus 1 oz. Graino per bu.	- 3	⁄ 3
Plus 3 oz. Graino per bu.	- 9	⁄ 3
Plus 1⅓ oz. Rootone per bu.	-16	⁄13
Plus 1 oz. Rootone per bu.	- 9	⁄ 4
Plus 1⅓ oz. Rootone 10 per bu.	-11	⁄10
Plus 1 oz. Rootone 10 per bu.	-15	⁄ 9
Plus 3 oz. Actmus per bu.	-11	⁄ 6
Plus 16 oz. Actmus per bu.	- 4	⁄ 2
Plus 1% special Catylitic material	-26	⁄10
Feldspar-flyash coating		
Standard	⁄14	⁄20
Plus 30 P. P. M. Terramycin	⁄16	⁄10
Plus 1% Systox	⁄15	⁄11

TABLE XVIII

PERCENTAGE DECREASE IN THE RATE OF GERMINATION OF COATED OVER FUZZY COTTONSEED WHEN SPROUTED BETWEEN PAPER TOWELS IN THE GERMINATOR

Coating Material Used	Immediate Planting	Stored One Year
Montmorillonite coating		
Standard	16.3	27.1
Plus 0.5% Hyponex	12.8	30.8
Plus 1.0% Hyponex	09.6	30.2
Plus .05% Dried Blood	13.8	17.5
Plus .5% Dried Blood	10.6	31.2
Plus 4% P_2O_5	29.9	50.1
Plus 1 oz. Graino per bu.	36.4	47.4
Plus 3 oz. Graino per bu.	25.5	70.5
Plus 1⅓ oz. Rootone per bu.	18.1	81.8
Plus 1 oz. Rootone per bu.	25.2	30.4
Plus 1⅓ oz. Rootone 10 per bu.	21.0	37.5
Plus 1 oz. Rootone 10 per bu.	61.4	33.1
Plus 3 oz. Actmus per bu.	38.3	31.7
Plus 16 oz. Actmus per bu.	17.8	83.8
Plus 1% special Catylitic material	22.6	36.6
Feldspar-flyash coating		
Standard	5.5	1.2
Plus 30 P.P.M. Terramycin	4.5	57.9
Plus 1% Systox	7.6	69.9

TABLE XIX

RATE OF EMERGENCE OF COTTON FROM COATED AND FUZZY SEED SPROUTED BETWEEN PAPER TOWELS IN A GERMINATOR

Treatment Used	Rate of Emergence		Deviation Due to Storage
	Immediate Planting	Stored 1-Year	
Montmorillonite coating			
Standard	82.1**	65.9**	-20
Plus 5% Hyponex	85.5**	62.5**	-27
Plus 1% Hyponex	88.6**	63.1**	-29
Plus .05% Dried Blood	84.5**	74.5**	-12
Plus .5% Dried Blood	87.7**	62.2**	-29
Plus 4% P_2O_5	68.8**	45.1**	-35
Plus 1 oz. Graino per bu.	62.4**	47.5**	-24
Plus 3 oz. Graino per bu.	73.1**	26.7**	-64
Plus 1/3 oz. Rootone per bu.	80.3**	16.5**	-79
Plus 1 oz. Rootone per bu.	73.4**	62.9**	-14
Plus 1/3 oz. Rootone 10 per bu.	77.5**	56.5**	-27
Plus 1 oz. Rootone 10 per bu.	37.9**	60.5**	+60
Plus 3 oz. Actmus per bu.	60.5**	61.7**	+ 2
Plus 16 oz. Actmus per bu.	80.6**	14.7**	-82
Plus 1% special Catylitic material	75.9**	57.3**	-25
Feldspar-flyash coating			
Standard	92.7	89.3	- 4
Plus 30 P.P.M. Terramycin	93.6	38.1**	-59
Plus 1% Systox	90.6*	27.2**	-70
Fuzzy seed check	98.0	90.3	- 8

of this experiment, all montmorillonite treatments decreased the rate of germination of cotton by slightly more than 23 percent. A significant decrease was shown for the feldspar-flyash coating containing one percent Systox. Rate of germination was not significantly decreased by the standard feldspar-flyash coating or the feldspar-flyash plus 30 P.P.M. Terramycin.

TABLE XX

ANALYSIS OF VARIANCE OF THE RATE OF EMERGENCE OF COATED COTTONSEED IN THE GERMINATOR IMMEDIATELY AFTER TREATMENT

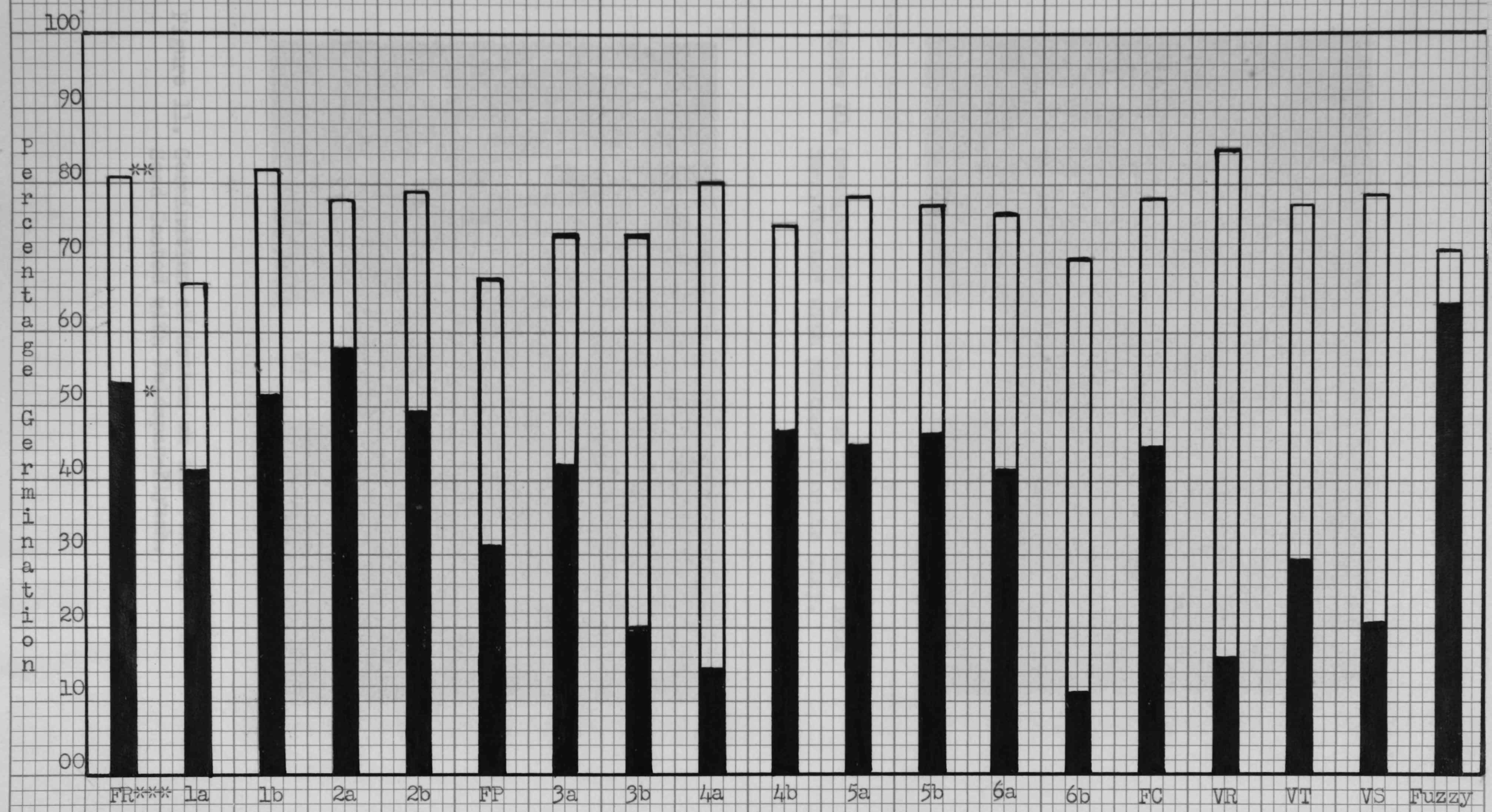
Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	88.22	29.41	1.32	
Treatments	18	14,555.76	808.65	36.31**	
Error	54	1648.25	22.27		
Total	74	16,292.23			

The rate of emergence of the treatments bearing the montmorillonite coatings were significantly lower than the standard feldspar-flyash treatment, except the treatments of one percent Hyponex and 0.5 percent dried blood.

In analyzing the results of the rate of germination of the fourteen treatments involving fertilizers and growth regulators combined with montmorillonite clay, it was found that six of the treatments caused significant reductions. The eight remaining treatments were neither increased or decreased significantly over the standard montmorillonite coating.

C. Germination trials after a one-year storage period. -- The

Figure 9. A Comparison of the Percentage Germination from Fuzzy Uncoated and Coated Cottonseed in the Germinator Immediately after Coating.



* Percentage emergence at 7th day indicated by solid bar.

** Percentage emergence at 14th day indicated by clear bar.

*** Indicates treatments used (See Table II for Meaning of Symbols).

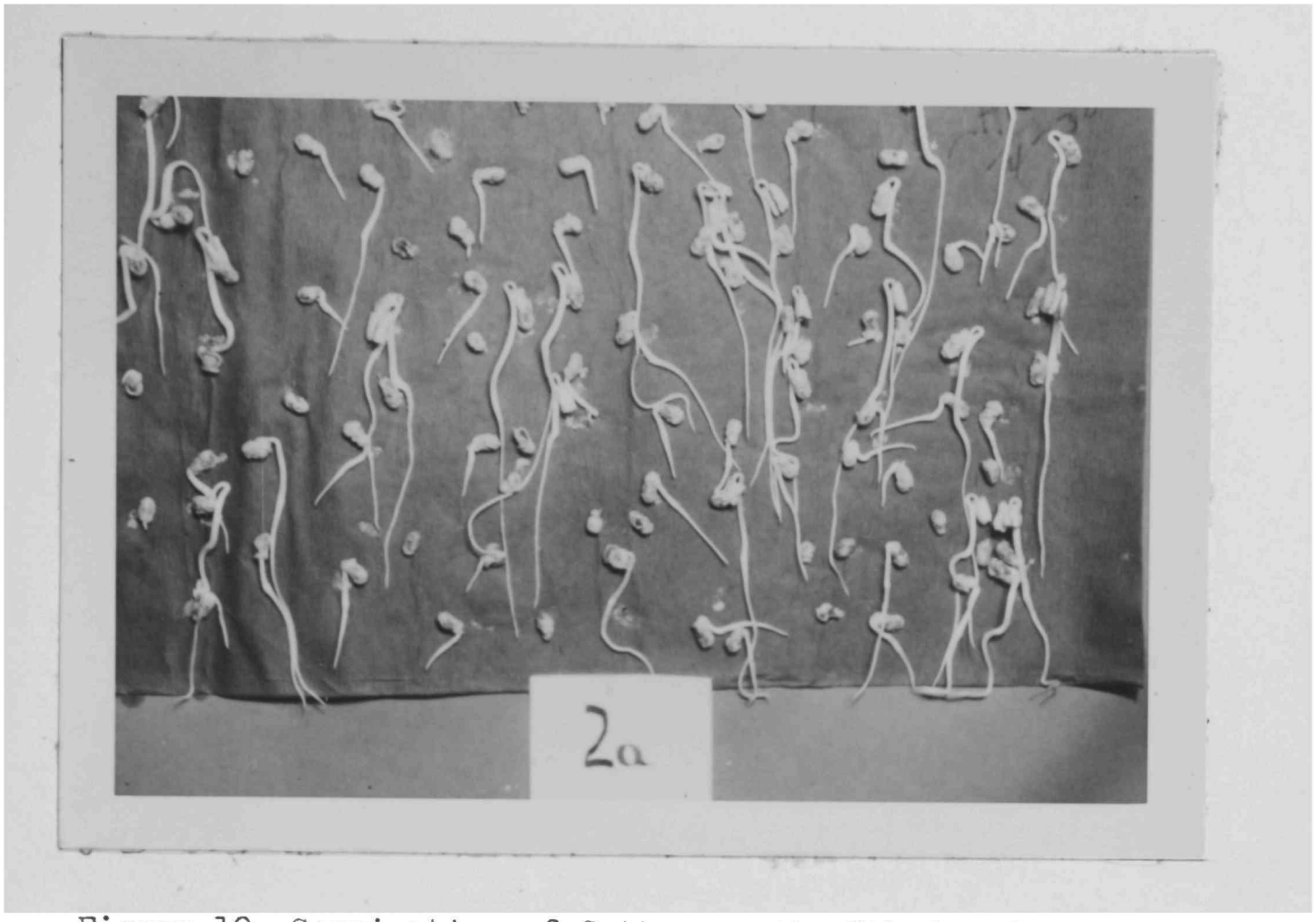


Figure 10. Germination of Cotton on the 7th day from Seed Coated with Montmorillonite Clay.

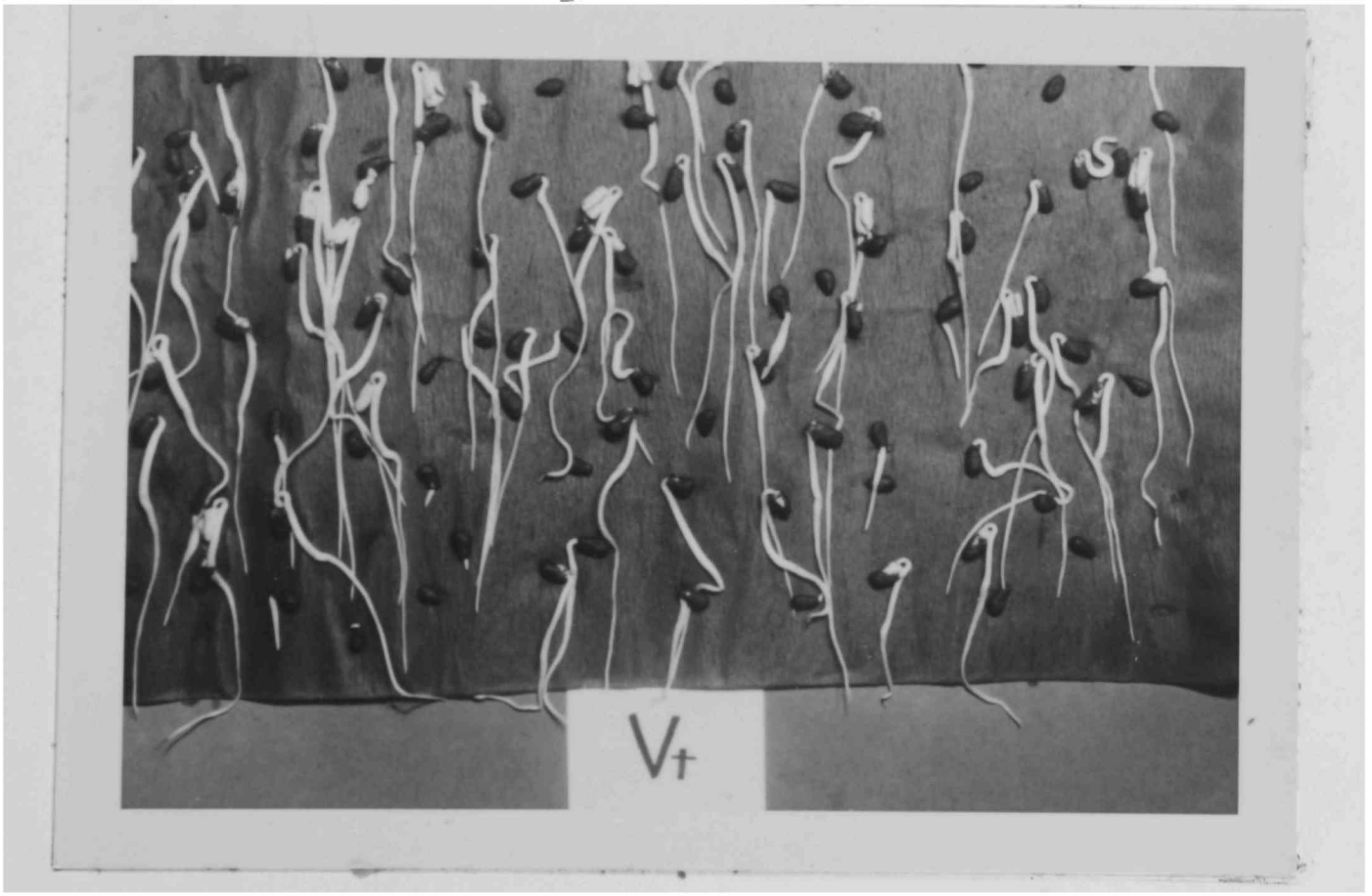


Figure 11. Germination of Cotton on the 7th day from Seed Coated with Feldspar-Flyash.

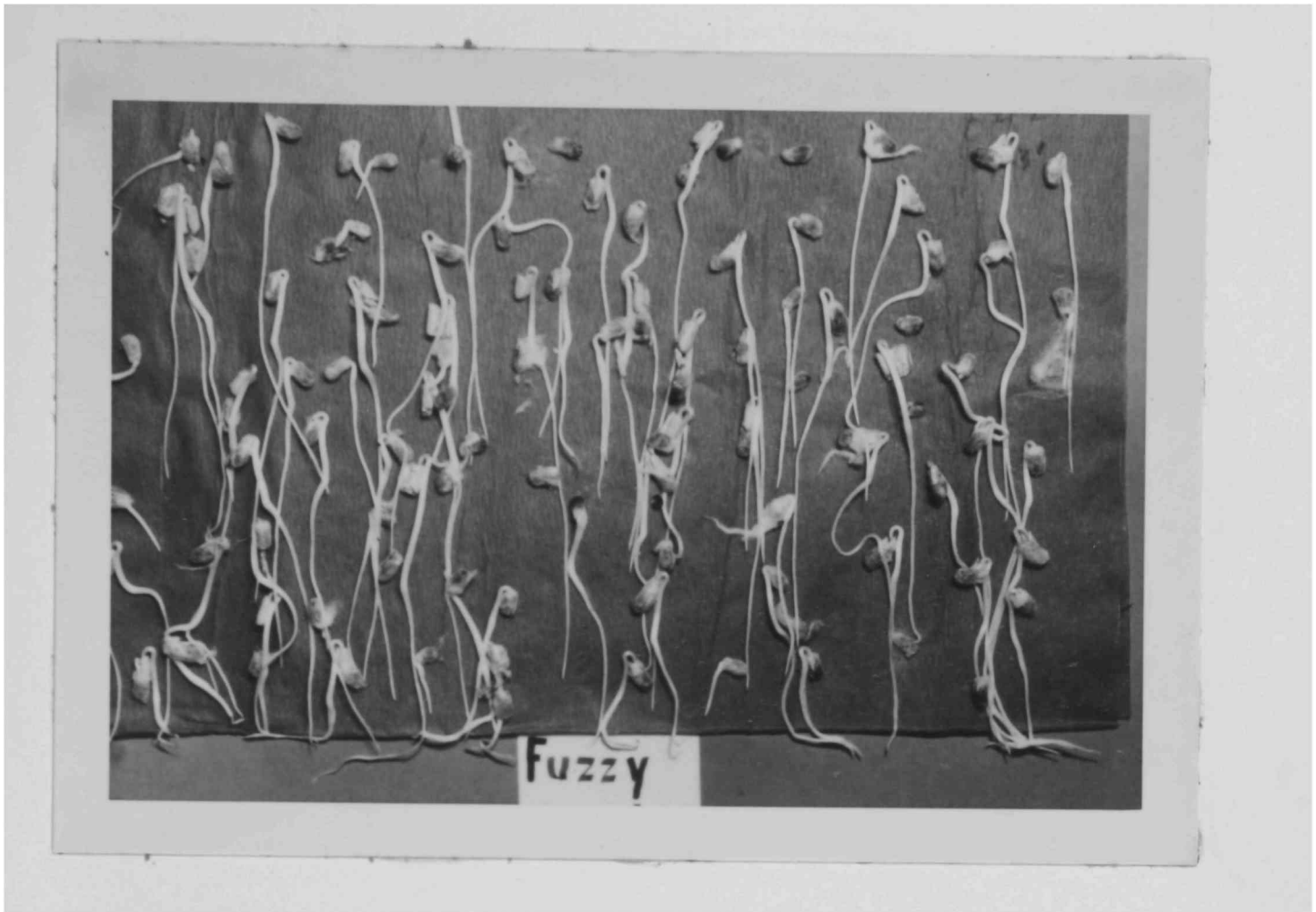


Figure 12. Germination of Cotton on the 7th day from Untreated Fuzzy Seed.

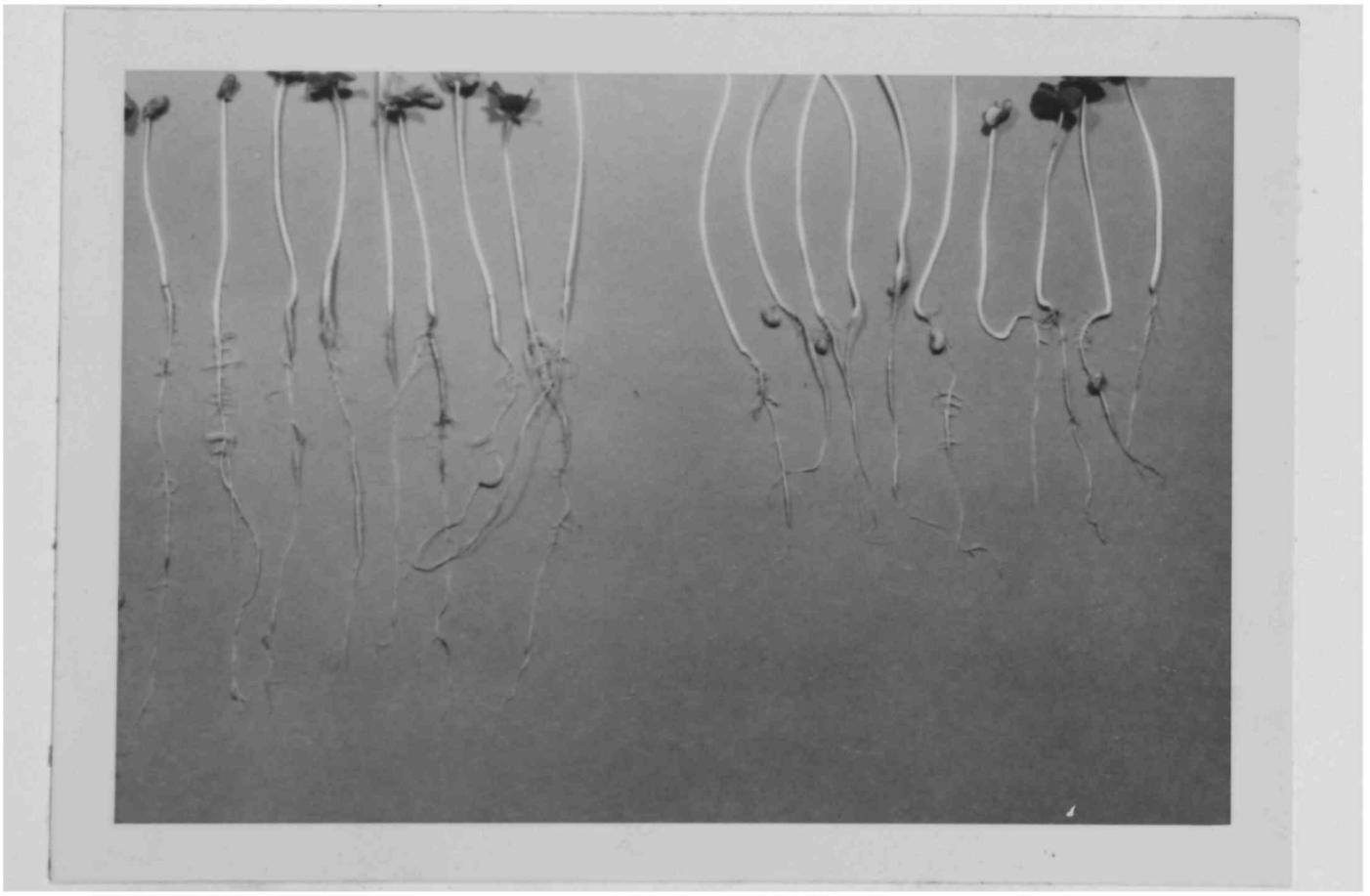


Figure 13. Root Growth of Cotton in the Germinator, Feldspar-Flyash Treatment on Left and Montmorillonite on Right.

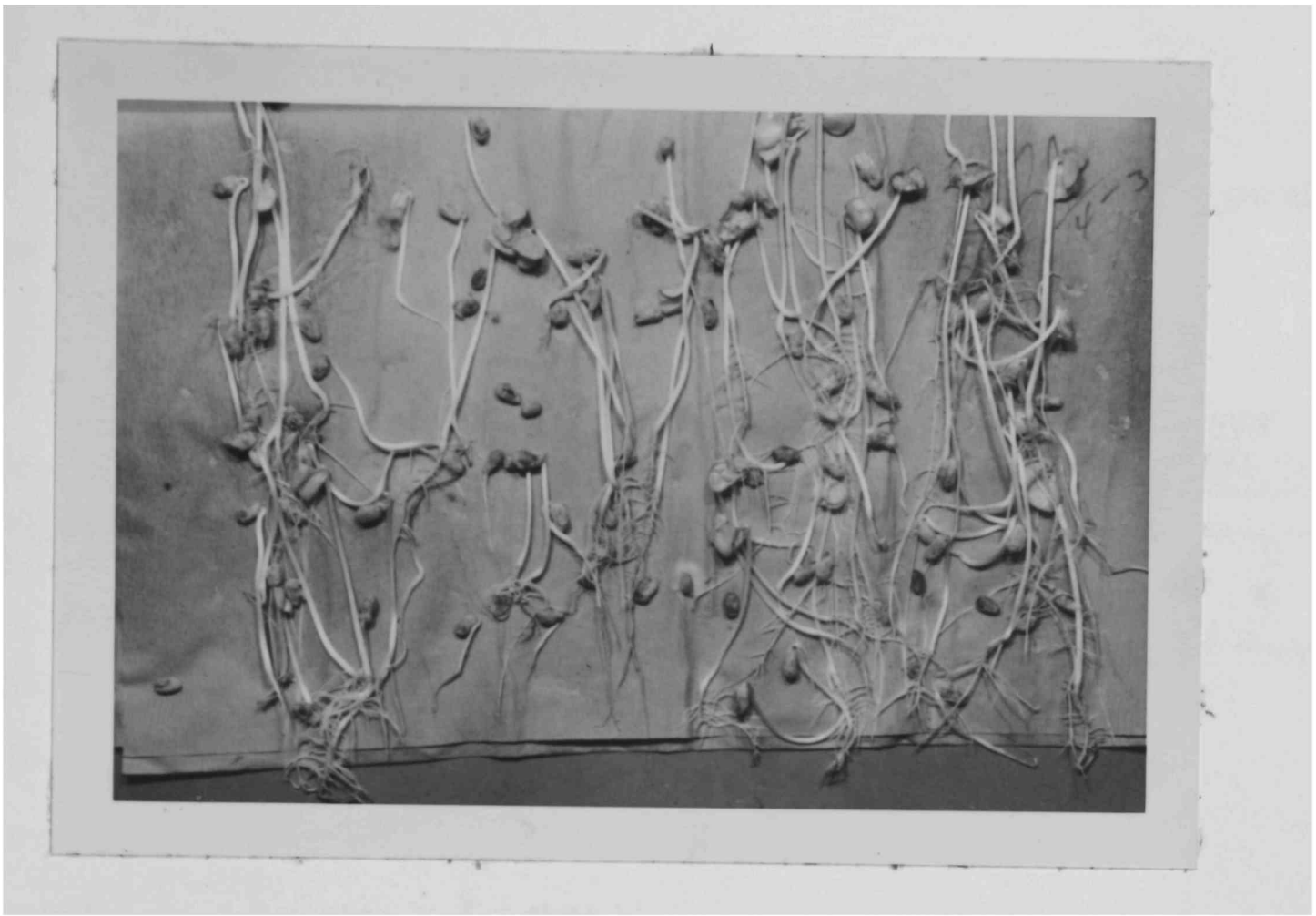


Figure 14. Germination of Cotton on the 14th day from Seed Coated with Montmorillonite Clay.

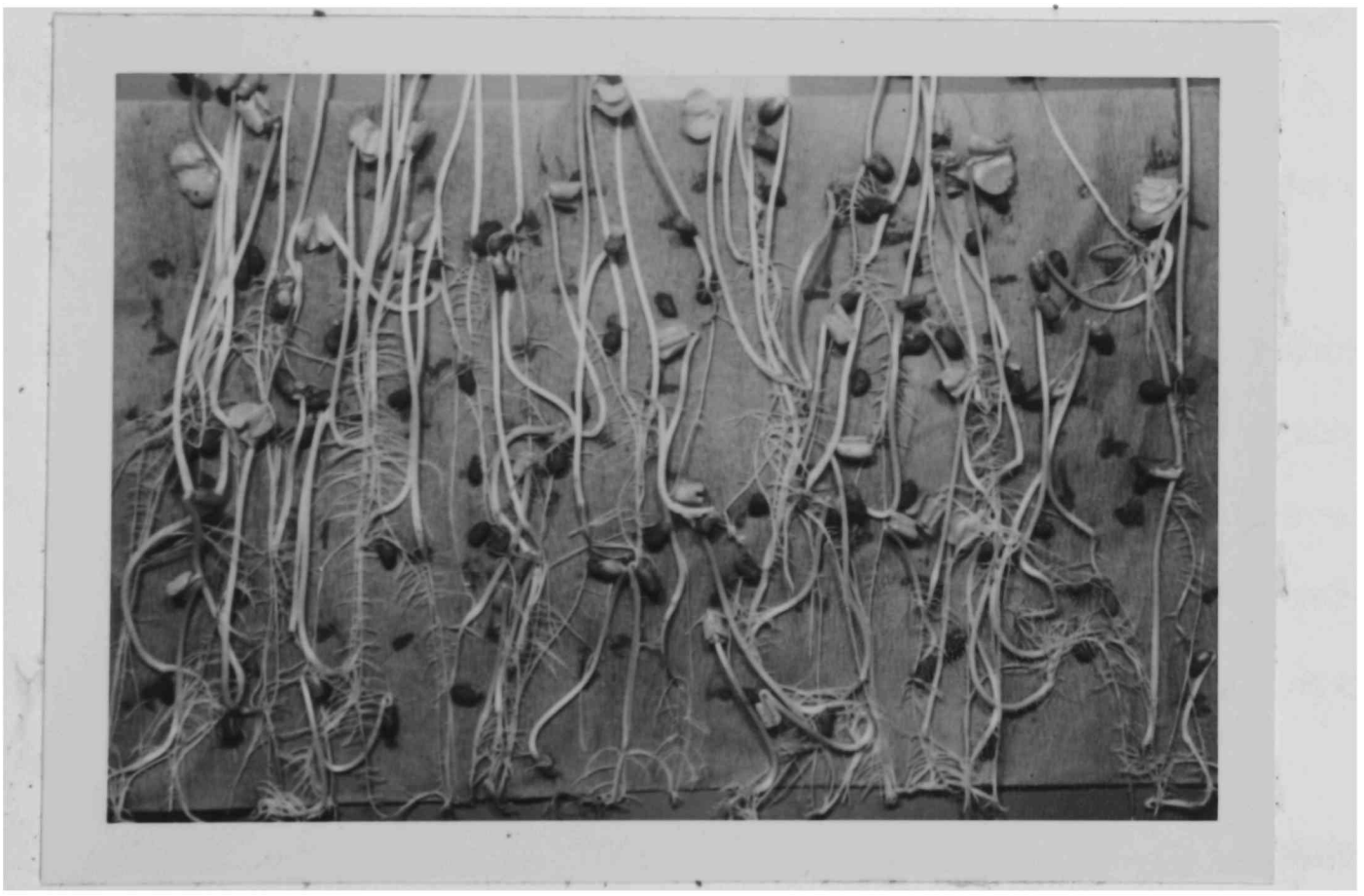


Figure 15. Germination of Cotton on the 14th day from Seed Coated with Feldspar-Flyash.

percentage germination of each treatment is given in Table XV.

An analysis of variance test was made on the percentage germination of the various treatments and is given in Table XXI.

TABLE XXI

ANALYSIS OF VARIANCE OF THE GERMINATION OF COATED AND FUZZY COTTONSEED IN THE GERMINATOR AFTER A STORAGE PERIOD OF ONE YEAR

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	55.94	18.65		
Treatments	18	5265.66	292.54	14.34**	
Error	54	1101. 8	20.40		
Total	75	6423.41			

The results show that the differences between treatments were highly significant. To test further the difference between treatments, the least or minimum difference was obtained. A difference of 64.2 percent was required for significance and a difference of 8.53 percent for high significance.

It was found that the percentage germination of the standard montmorillonite treatment was not significantly different from the fuzzy seed check. Highly significant decreases resulted from treatments with one-third ounce Rootone, one ounce Rootone 10, four percent P_2O_5, and one percent special Catylitic material when compared with the fuzzy seed check.

Significant decreases in percentage germination were obtained from treatments of three ounces of Graino, one ounce Rootone, one-third ounce Rootone 10, and three ounces of Actmus.

Highly significant increases in the percentage germination of 14 percent, 16 percent, and 15 percent respectively were obtained from the standard feldspar-flyash, standard plus 30 P.P.M. Terramycin, and standard plus one percent Systox treatments.

D. Rate of germination of treatments after a one-year storage period. -- The rate of germination for each treatment is given in Table XIX.

An analysis of variance test was made on the rate of germination data and is given in Table XXII.

The results show that after being in storage for one-year the rate of germination of all coated seed lots except the standard feldspar-flyash treatment, was highly significantly reduced over the fuzzy seed check. The standard feldspar-flyash treatment was not significantly reduced.

Table XIII shows the percentage deviation in rate of germination of the coated treatments from the fuzzy seed check.

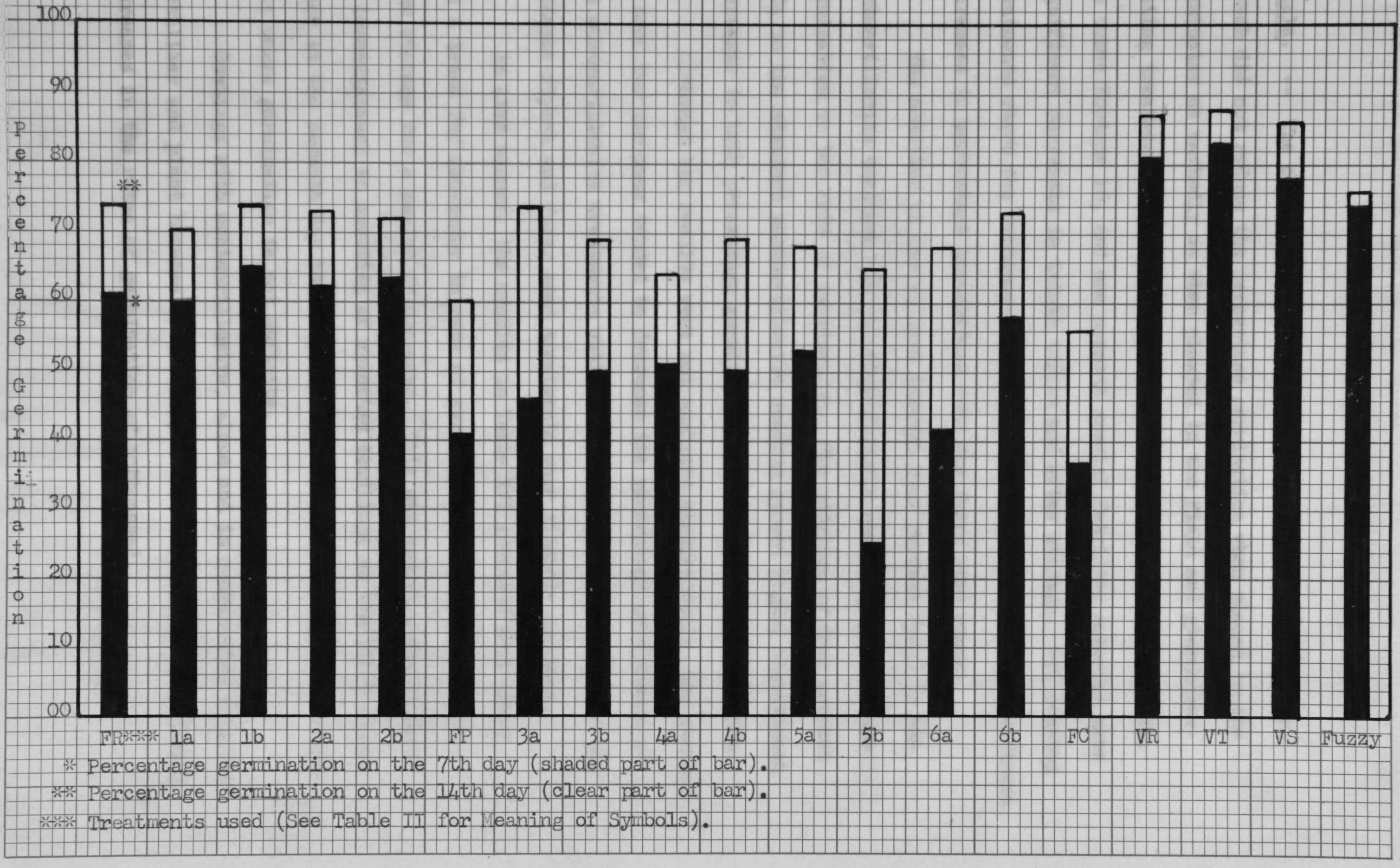
TABLE XXII

ANALYSIS OF VARIANCE FOR RATE OF EMERGENCE OF COTTONSEED IN GERMINATOR AFTER STORAGE FOR ONE YEAR

Variation Due to	Degrees of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	59.05	19.68	.67	
Treatment	18	33,316.03	1850.89	62.86**	
Error	54	1589.91	29.44		
Total	75	34,964.99			

E. General conclusions regarding the laboratory germination

Figure 16. A Comparison of the Percentage Germination from Fuzzy and Coated Cottonseed in a Germinator after a One-Year Storage Period.



* Percentage germination on the 7th day (shaded part of bar).

** Percentage germination on the 14th day (clear part of bar).

*** Treatments used (See Table II for Meaning of Symbols).

trials. -- The coating of seed with montmorillonite and feldspar-flyash did not reduce the percentage germination when placed in the germinator as markedly as when planted in the field and greenhouse. Coating treatments of one ounce Rootone, one-third ounce Rootone 10, one ounce Rootone 10, and one percent special Catylitic material gave significant decreases in trials before and after storage. All coating treatments where the feldspar-flyash material was used showed significant increases in percentage germination over the fuzzy seed check.

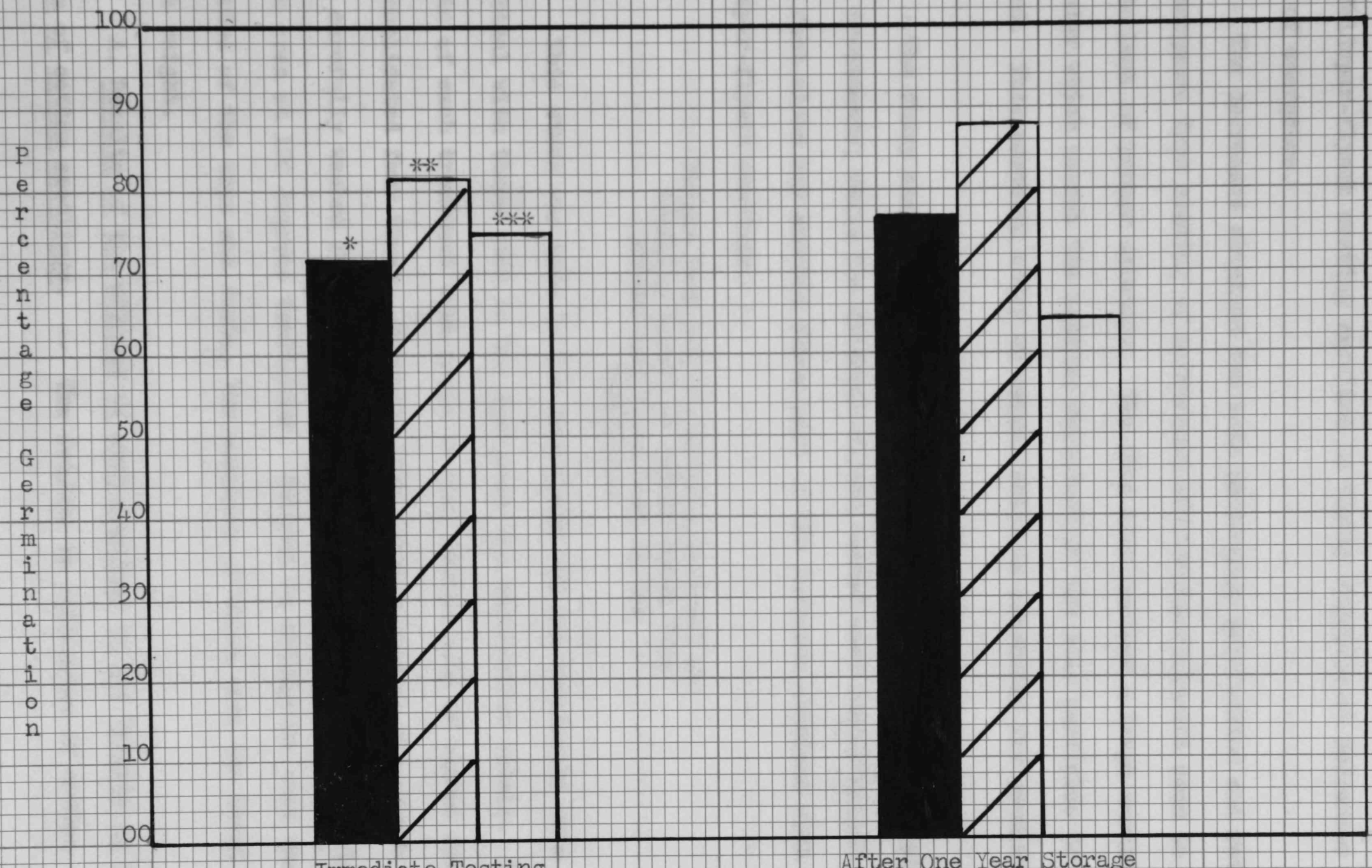
The addition of fertilizers (except four percent P_2O_5) to the montmorillonite coatings did not significantly change the percentage germination or the rate of germination. The addition of four percent P_2O_5 to the standard montmorillonite coating caused highly significant decreases in both percentage germination and the rate of germination.

Although the results were not analyzed statistically, the storage of seed for one-year tended to decrease the percentage germination of the montmorillonite treatments while the percentage germination of the feldspar-flyash and fuzzy seed treatments were slightly improved.

In like manner, the results in Table XVI indicate that there was a trend for decreases in rate of germination of the coated seed from storage for a period of one-year. This was probably due in part to inconsistency in counting of sprouted seedlings at the first count, since at the seventh day the seedlings are often at a stage of development where germination is not definite.

Coatings with montmorillonite, alone and in combination with the fertilizer and plant hormone treatments, resulted in highly significant decreases in the rates of germination of cottonseed.

Figure 17. A Comparison of Mean Percentage Germination of Cotton from Fuzzy Uncoated and Coated Cottonseed in the Germinator.



* Fuzzy seed treatment indicated by solid bar.
** Feldspar-Flyash treatments indicated by shaded bar.
*** Montmorillonite treatments indicated by clear bar.

The addition of 30 P.P.M. Terramycin and one percent Systox to the feldspar-flyash coating resulted in highly significant decreases in rate of emergence.

The decreases obtained for both percentage germination and rate of emergence from coating of cottonseed with montmorillonite seem to be due to lack of proper aeration. The fine clay imbibes a large amount of water which causes the lattice structure of the clay particles to expand. This prevents entry of oxygen which is necessary for germination.

The fuzzy seed check molded more severly than did the montmorillonite treatments; while the feldspar-flyash coated seed rarely molded. This fact alone may account for a part of the increase obtained with the feldspar-flyash coatings.

Weight Data and Statistical Analysis of Seedling Growth of Cotton Grown From Coated and Fuzzy Seed In the Greenhouse

This study was made in the greenhouse and the treatments were identical with those used in the emergence and germination trials. Ten plants of each treatment were grown in four gallon pots of washed sand and replicated four times. Fourteen days after emergence the plants were carefully washed free of sand by a series of soakings, then dried in an oven at 100 degrees Centigrade. Weights in milligrams were then recorded of the tops and roots, the sumation of which gave the total plant weight.

A. Results of the effects of seed coatings on the weights of the roots of cotton seedlings. -- The weights in milligrams of cotton

seedling roots from the various treatments are given in Table XXIII.

An analysis of variance was made of the weights and is given in Table XXIV. The results show that there was a highly significant difference between the coating treatments. To test further the importance of the differences, found in Table XXIII, a test for the least or minimum difference was made. A difference of 85.72 Mg. was required for significance and 113.84 Mg. for high significance.

The results show that the coating treatments of one percent Systox (added to the feldspar-flyash material) gave a highly significant increase in weight of roots over the fuzzy seed check. A significant but less marked increase was obtained from the standard montmorillonite plus one percent Rootone treatment.

A significant decrease in weight of cotton seedling roots resulted from the montmorillonite plus 0.5 percent Hyponex treatment.

The weight data for the treatments given in Tables XXIII and XXVII for all fertilizer and hormone treatments combined with montmorillonite clay (except the one ounce Rootone) indicates a trend toward depressing the weight of roots produced. The addition of 0.05 percent Hyponex gave a highly significant degrease in weight of roots produced when compared to the standard montmorillonite treatment. Significant decreases in root weights resulted from the treatments of montmorillonite plus additions of one percent Hyponex, 0.05 percent dried blood, 0.5 percent dried blood, and one-third ounce Rootone when compared to root weights of seedlings produced by the standard montmorillonite treated seed.

The weight of the roots from the one ounce Rootone treatment was

TABLE XXIII

WEIGHT IN MILLIGRAMS OF VARIOUS PARTS OF THE COTTON PLANT WHEN GROWN FROM COATED AND FUZZY SEED IN WASHED SAND IN THE GREENHOUSE[a]

Treatment Used	Weight of Tops	Weight of Roots	Weight of Entire Plant
Montmorillonite coating			
Standard	1097.53**	407.10	1504.60**
Plus 0.5% Hyponex	745.78	243.10**	988.87
Plus 1% Hyponex	911.32*	329.50	1240.82
Plus .05% Dried Blood	873.15	294.90	1171.02
Plus .5% Dried Blood	1008.35	309.40	1317.77**
Plus 4% P_2O_5	972.78**	46.20	1319.00
Plus 1 oz. Graino per bu.	879.25	29.40	1209.25
Plus 3 oz. Graino per bu.	849.25	80.20	1229.52
Plus 1/3 oz. Rootone per bu.	927.33*	305.92	1233.25
Plus 1 oz. Rootone per bu.	952.00**	446.50	1398.47**
Plus 1/3 oz. Rootone 10 per bu.	1036.13**	346.90*	1383.07**
Plus 1 oz. Rootone 10 per bu.	948.48**	338.80	1287.27
Plus 3 oz. Actmus per bu.	1012.98**	321.80	1334.80*
Plus 16 oz. Actmus per bu.	1054.68**	358.20	1412.87**
Plus 1% Catylitic Material	1117.70**	323.10	1460.80**
Feldspar-flyash coating			
Standard	978.08**	403.20	1353.77*
Plus 30 P.P.M. Terramycin	1082.60**	416.80	1499.40**
Plus 1% Systox	1034.77**	471.70**	1506.60**
Fuzzy seed check	773.58	353.80	1127.40

[a]Oven dry weights of 10 plants, two weeks after emergence.

446.5 Mg., while that of the standard was 407.1 Mg. This was the only treatment in which the addition of a hormone to the montmorillonite clay resulted in a weight advantage over the standard montmorillonte treatment.

TABLE XXIV

ANALYSIS OF VARIANCE OF THE EFFECTS OF SEED COATINGS ON THE ROOT GROWTH OF COTTON SEEDLINGS IN GREENHOUSE

Variation Due to	Degree of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	9,652.14	3,217.38		
Treatment	18	220,394.91	12,244.16	3.36	
Error	54	196,431.17	3,637.61		
Total	75	426,478.21	5,686.48		

The results show that a highly significant increase in weight of roots over that produced by the fuzzy seed check was obtained from the feldspar-flyash plus one percent Systox. It was not however significant over the other two feldspar-flyash treatments.

Considerable visual difference can be seen in the development of the roots from the different treatments, from the photographs at the end of this section. It may be noted that the oven dry weights did not show as marked a difference between the treatments as can be observed from the photographs. The addition of four percent P_2O_5 seemed to stimulate development of laterals more so than other treatments, though the total weight from this treatment was not significantly different from the fuzzy seed check.

The addition of 30 P.P.M. Terramycin and one percent Systox to

the feldspar-flyash treatment seemed to increase the development of roots as shown in the photographs. This is verified by the weights given in Table XXIII.

B. The effects of seed coatings on the top growth of cotton seedlings in the greenhouse. -- The weights of the cotton seedling tops from the various treatments are given in Table XXIII.

An analysis of variance test was made on the weights and is given in Table XXV.

TABLE XXV

ANALYSIS OF VARIANCE OF THE EFFECTS OF SEED COATINGS ON THE WEIGHT IN MILLIGRAMS OF THE TOPS OF COTTON SEEDLINGS IN GREENHOUSE

Variation Due to	Degree of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	29,633.90	23,211.300	2.71	
Treatment	18	781,377.64	43,409.868	5.08**	
Error	54	461,318.13	8,542.920		
Total	75	1,312,329.67	17,497.72		

The results in Table XXIII show that there was a highly significant difference in weights of tops due to treatments. A test for the minimum difference was made in the same manner as for the roots. A minimum difference of 131.37 Mg. was required for significance and 174.50 Mg. for high significance.

In analyzing further the results in Table XXIII it was found that highly significant increases in weight of the tops over the uncoated fuzzy seed were obtained from the standard montmorillonite, standard montmorillonite plus: 0.5 percent dried blood, one ounce

Rootone, one-third ounce Rootone 10, one ounce Rootone 10, three ounces Actmus, 16 ounces Actmus, one percent special Catylitic material, four percent P_2O_5, and all the treatments with the feldspar-flyash base.

Significant but lesser increases in weight of tops were obtained from montmorillonite plus .05 percent dried blood and one-third ounce Rootone.

When the weight of tops from treatments receiving fertilizers and hormones incorporated with the montmorillonite clay are compared to the weight of tops from the standard montmorillonite coating (1408.6 Mg.), highly significant decreases (of at least 174.5 Mg.) resulted from: 0.5 percent Hyponex, one percent Hyponex, .05 percent dried blood, and one ounce Graino. Significant decreases resulted from the one-third ounce Rootone, one ounce Rootone, one ounce Rootone 10, and four percent P_2O_5 treatments.

Highly significant increases in weight of tops over the fuzzy seed were obtained from all feldspar-flyash treatments. The addition of 30 P.P.M. Terramycin and one percent Systox to the standard feldspar-flyash gave no significant differences.

C. Effect of coating treatments on the total plant weights. -- The weights of the total cotton plants from the various treatments are given in Table XXIII.

An analysis of variance test was made on the weights and is given in Table XXVI.

A test for the minimum difference needed for significance between treatments was made as before. The minimum difference needed for significance was 179.17 Mg., and 238.00 Mg. for high significance.

TABLE XXVI

ANALYSIS OF VARIANCE OF THE EFFECTS OF COATING TREATMENTS ON THE TOTAL SEEDING GROWTH OF COTTON IN GREENHOUSE[a]

Variation Due to	Degree of Freedom	Sum of Squares	Mean Square	F Value	s
Replications	3	8,2181.1	27,393.70	1.72	
Treatments	18	1,391,192.25	77,288.458	4,856**	
Error	54	858,141.34	15,891.50		133.1965
Total	75	2,257,552.00	30,100.693		

The results show that highly significant increases in weight of the cotton seedlings over that of the fuzzy seed check were obtained from: the standard montmorillonite, montmorillonite plus; one ounce Rootone, one-third ounce Rootone 10, 16 ounces Actmus, one percent Catylitic material, and feldspar-flyash plus 30 P.P.M. Terramycin, feldspar-flyash plus one percent Systox.

Treatments giving an increase of at least 179.17 Mg. were montmorillonite plus: one ounce Graino, three ounces of Actmus, four percent P_2O_5, and the standard feldspar-flyash treatment.

There was a trend for weights of plants from all other coating treatments (except the montmorillonite plus 0.5 percent Hyponex) to be higher but not significantly increased over the fuzzy seed check.

The results further show that highly significant decreases in weight of the plants over the montmorillonite standard occured from the seed having additions of the following to the clay coating: 0.5 percent Hyponex, one percent Hyponex, .05 percent dried blood, three ounces of Graino, and one-third ounce Rootone. Significant decreases resulted

TABLE XXVII

PERCENTAGE DEVIATION IN ROOT, TOPS AND TOTAL WEIGHTS OF COTTON SEEDLING GROWN IN POTS OF SAND IN THE GREENHOUSE

Treatment Used	Percent Deviation Due to Coating Treatments		
	Tops	Roots	Total
Montmorillonite coating			
Standard	41[a]	15	33
Plus 0.5% Hyponex	- 4	132	-12
Plus 1.0% Hyponex	18	- 7	10
Plus .05% Dried Blood	13	-17	4
Plus .5% Dried Blood	30	-13	17
Plus 4% P_2O_5	26	- 3	17
Plus 1 oz. Graino per bu.	14	- 7	7
Plus 3 oz. Graino per bu.	10	7	9
Plus 1/3 oz. Rootone per bu.	20	-13	9
Plus 1 oz. Rootone per bu.	23	26	24
Plus 1/3 oz. Rootone 10 per bu.	34	- 2	23
Plus 1 oz. Rootone 10 per bu.	23	- 4	14
Plus 3 oz. Actmus per bu.	31	- 9	18
Plus 16 oz. Actmus per bu.	36	1	25
Plus 1% Catylitic material	44	- 3	30
Feldspar-flyash coating			
Standard	26	14	20
Plus 30 P.P.M. Terramycin	40	18	33
Plus 1% Systox	34	33	34

[a]Unless indicated, the number indicates an increase.

from 0.5 percent dried blood, one ounce of Rootone 10, and four percent P_2O_5 treatments.

The results show that no coating treatments with hormones or fertilizers with montmorillonite equaled or exceeded the weight of cotton seedlings from the standard montmorillonite coating. The standard montmorillonite treatment yielded the second highest total plant weight (1504.60 Mg.) being exceeded only by the feldspar-flyash plus one percent Systox treatment, which yielded 1506.60 grams.

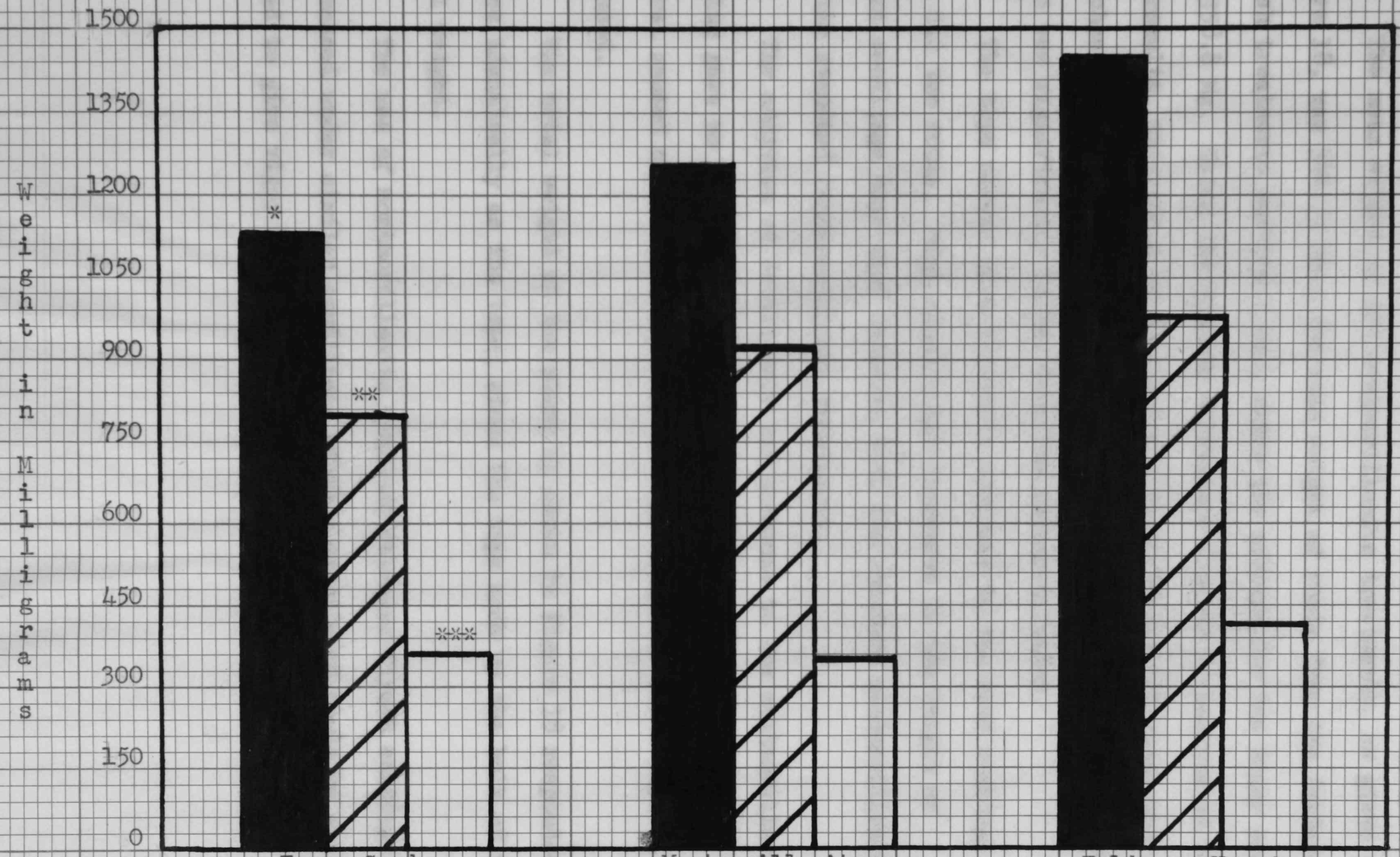
It can be seen from examining Figure 18 that the trends in total plant growth is in favor of the feldspar-flyash treatments followed by the montmorillonite treatments with the yield of the fuzzy seed being the lowest.

D. General conclusions of the effect of seed coatings on the seedling growth of cotton in the greenhouse. -- The coating of cotton-seed with a feldspar-flyash inert material, plus one percent Systox resulted in highly significant increases in the root weight of cotton seedlings grown to an age of two weeks.

The coating of cottonseed with montmorillonite clay plus one-third ounce of Rootone 10 resulted in a significant increase in the root weight of cotton seedlings. A significant decrease in weight of roots was obtained from seed coated with montmorillonite, plus 0.5 percent Hyponex, a mixed fertilizer.

Since roots are very low in specific gravity, the author is of the opinion that some method that would measure the total root surface would be a better measure than weights. It will be noted from the pictures at the end of this section that visible differences in the

Figure 18. A Comparison of the Mean Weights of Cotton Seedlings Grown in the Greenhouse from Fuzzy and Coated Seed.



* Weight of entire plants indicated by solid bar.
** Weight of tops indicated by shaded bar.
*** Weight of roots indicated by clear bar.

extent of roots growth are not always reflected in the weights.

The mean weight of all montmorillonite treatments, as given in Figure 18, was 344.73 Mg.; the mean weight of roots from the feldspar-flyash treatments was 430.6 Mg., while the average for the fuzzy seed was 358.8 Mg. Using the minimum difference figures as calculated in the results, this means that no overall significant difference over the check was obtained; however, the mean of the feldspar-flyash treatments was significantly higher than the montmorillonite.

The tops showed more favorable response to the seed coatings than did the roots. High significant increases in the weight of cotton seedlings tops were obtained with the standard montmorillonite and the standard feldspar-flyash treatments.

The addition of fertilizers and hormones to the montmorillonite coating gave no increase above that produced by the standard, but several caused significant decreases in the weight of plant tops produced.

The total weight of the plant as shown in Figure 18 responded almost identically as the tops, since the tops made up the bulk of the total weight.

The use of montmorillonite clay and feldspar-flyash coatings on cottonseed under similar conditions of this experiment could be expected to give vigor and increase the growth of cotton seedlings.

Figure 19. A View of Cotton Seedlings Showing Typical Variations in Root and Top Growth from Replications within a Treatment.

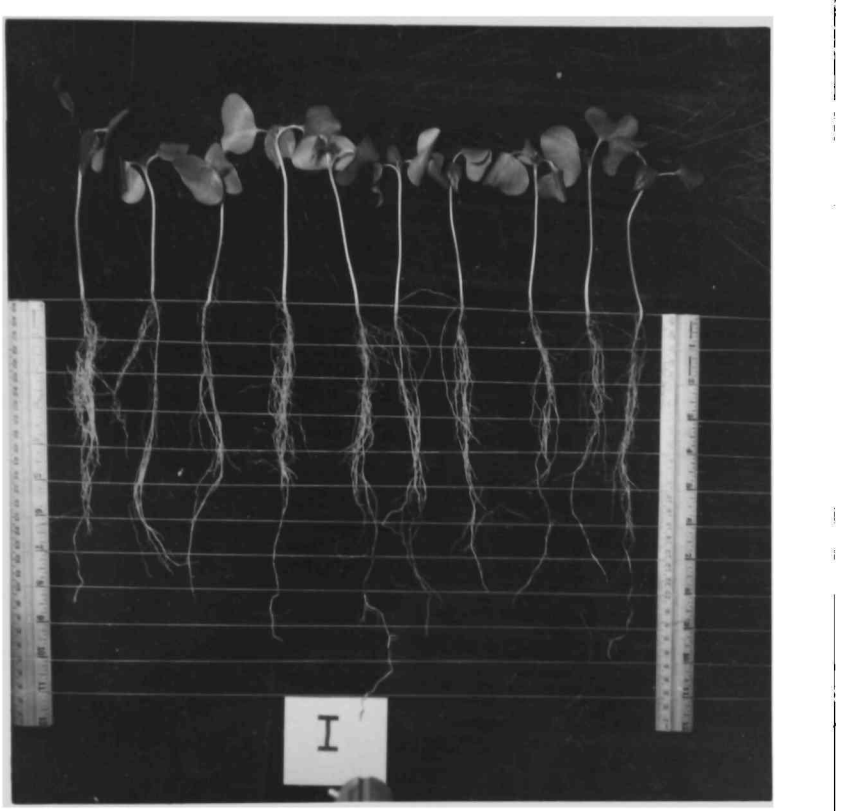


Figure 20. Root Growth of Cotton from Seed Coated with Montmorillonite.

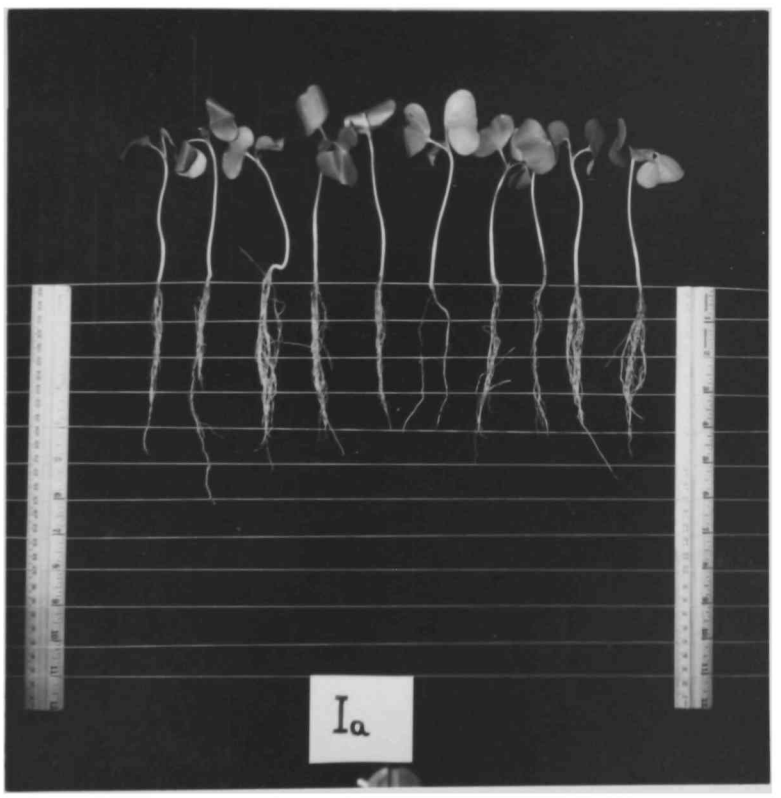


Figure 21. Root Growth of Cotton from Seed Coated with Montmorillonite Plus 0.5 Percent Hyponex.

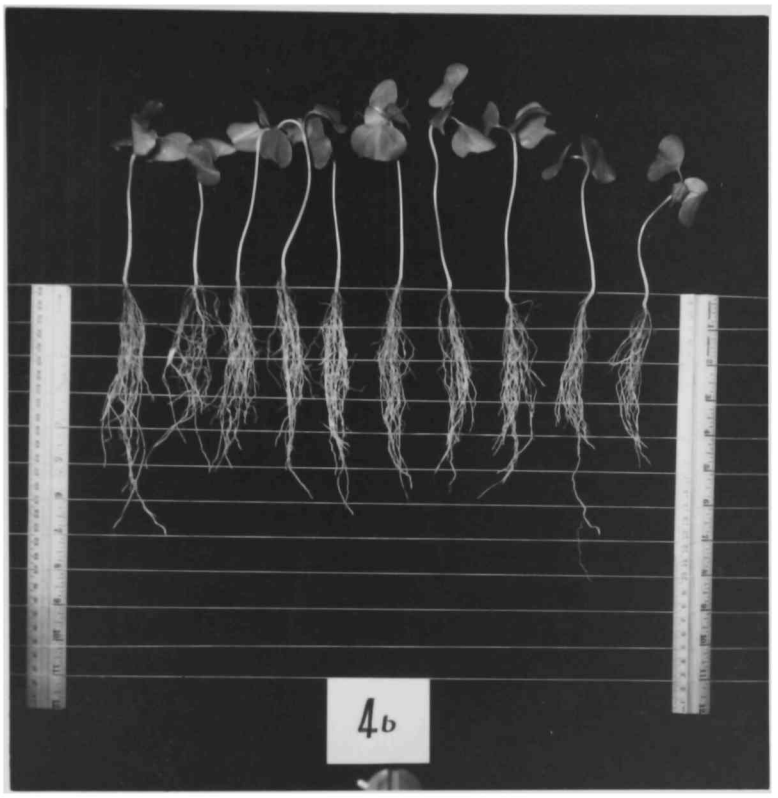


Figure 22. Root Growth of Cotton from Seed Coated with Montmorillonite Plus One Percent Hyponex.

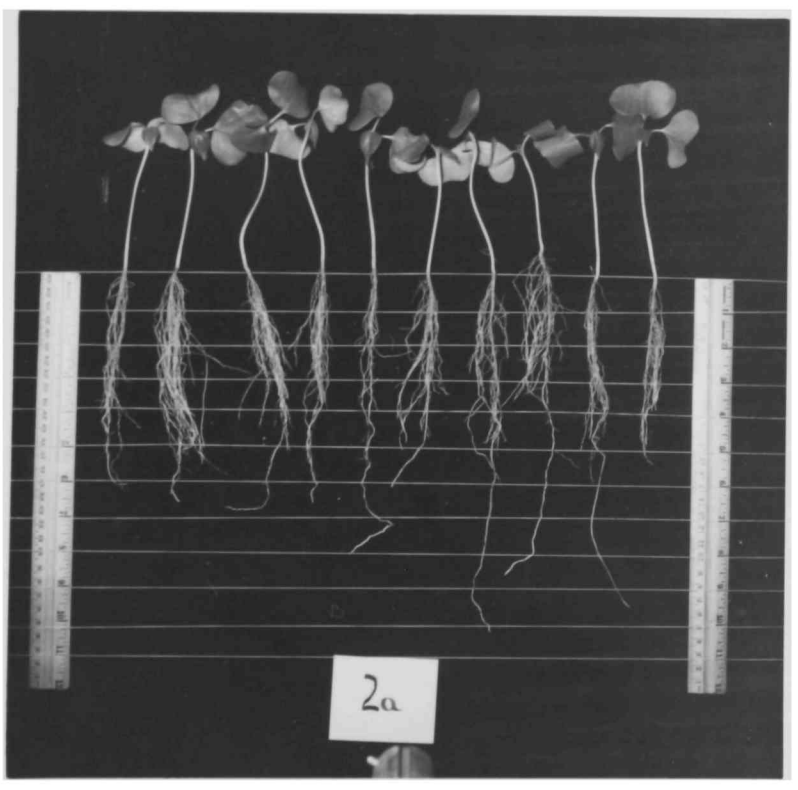


Figure 23. Root Growth of Cotton from Seed Coated with Montmorillonite Plus .05 Percent Dried Blood.

Figure 24. Root Growth of Cotton from Seed Coated with Montmorillonite Plus 0.5 percent Dried Blood.

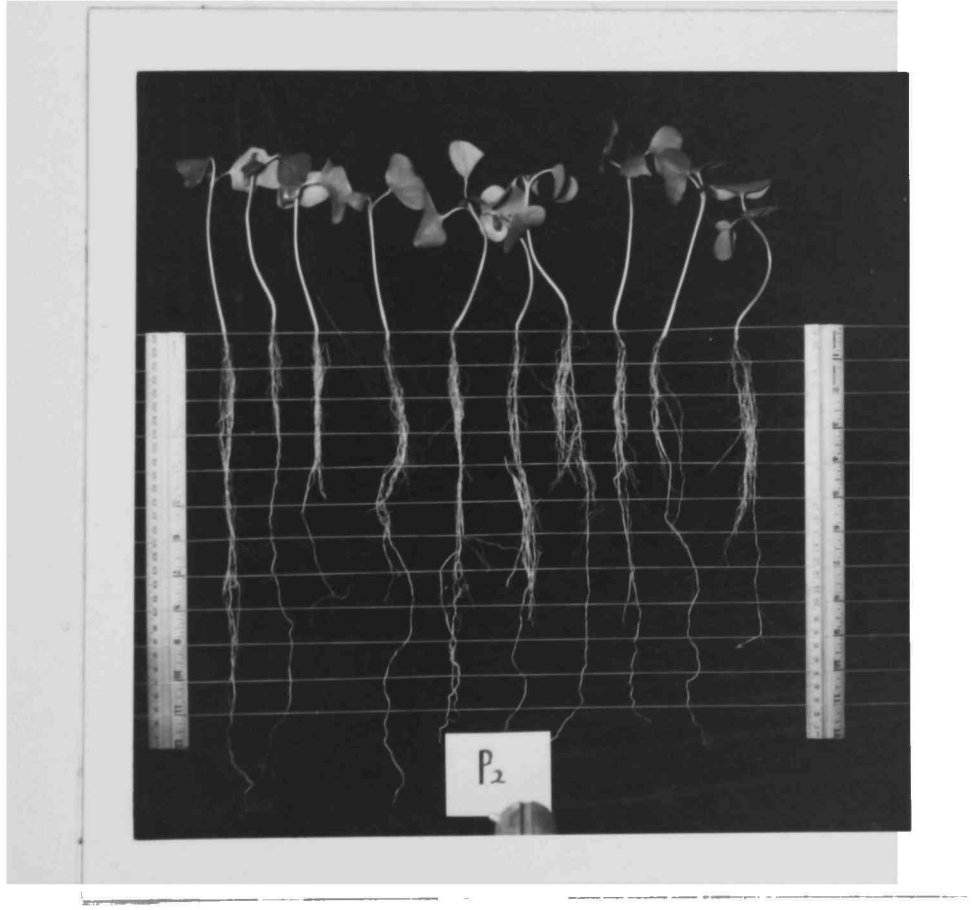


Figure 25. Root Growth of Cotton from Seed Coated with Montmorillonite Plus Four Percent P_2O_5.

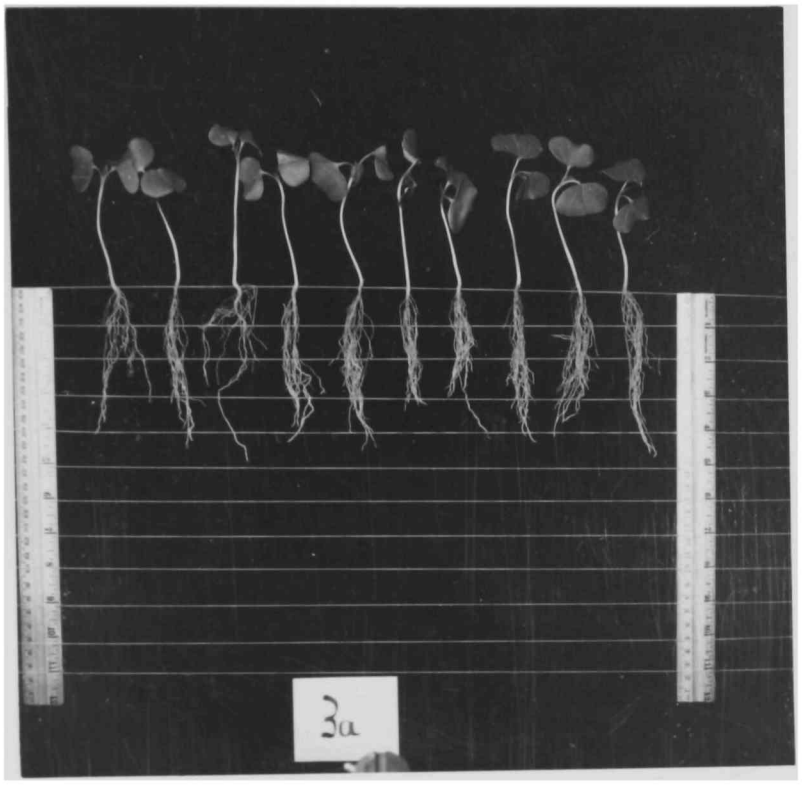


Figure 26. Root Growth of Cotton from Seed Coated with Montmorillonite Plus One Ounce graino per Bu.

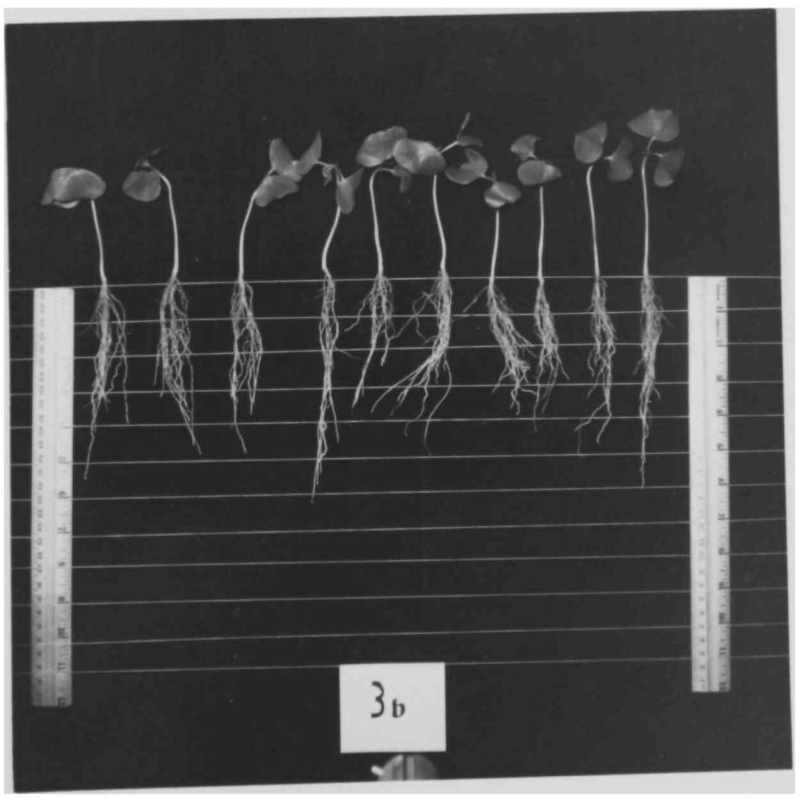


Figure 27. Root Growth of Cotton from seed coated with Montmorillonite Plus Three Ounces Graino per Bu.

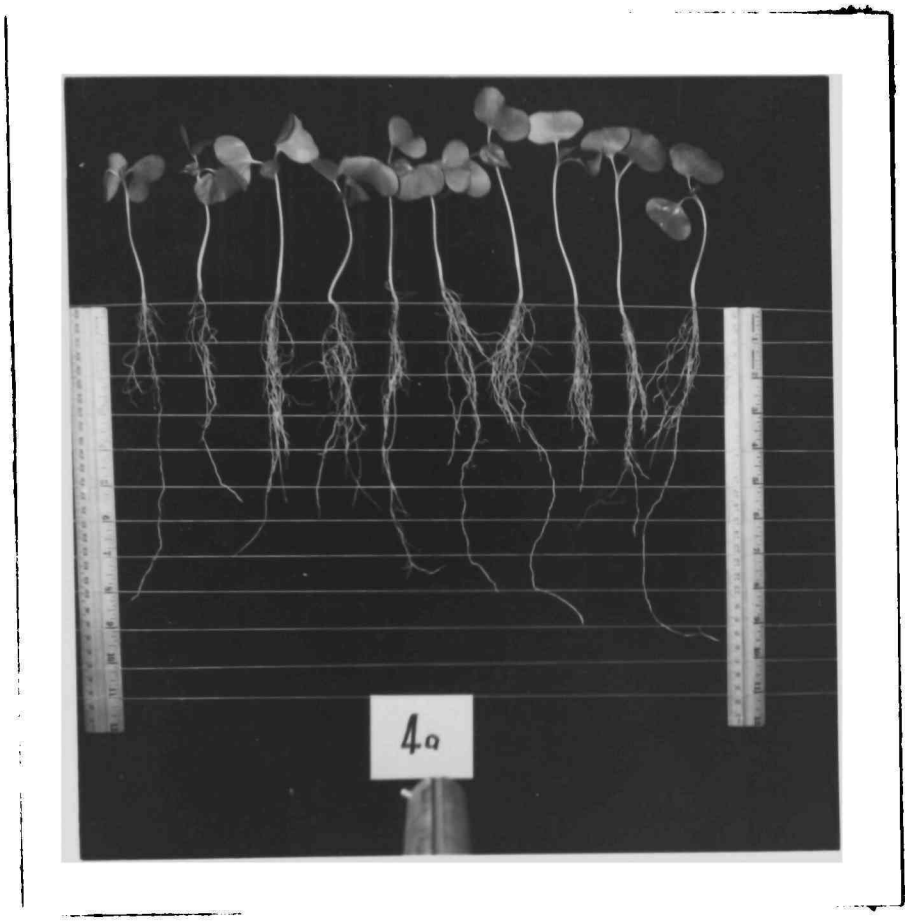


Figure 28. Root Growth of Cotton from Seed Coated with Montmorillonite Plus 1/3 Oz. Rootone per Bu.

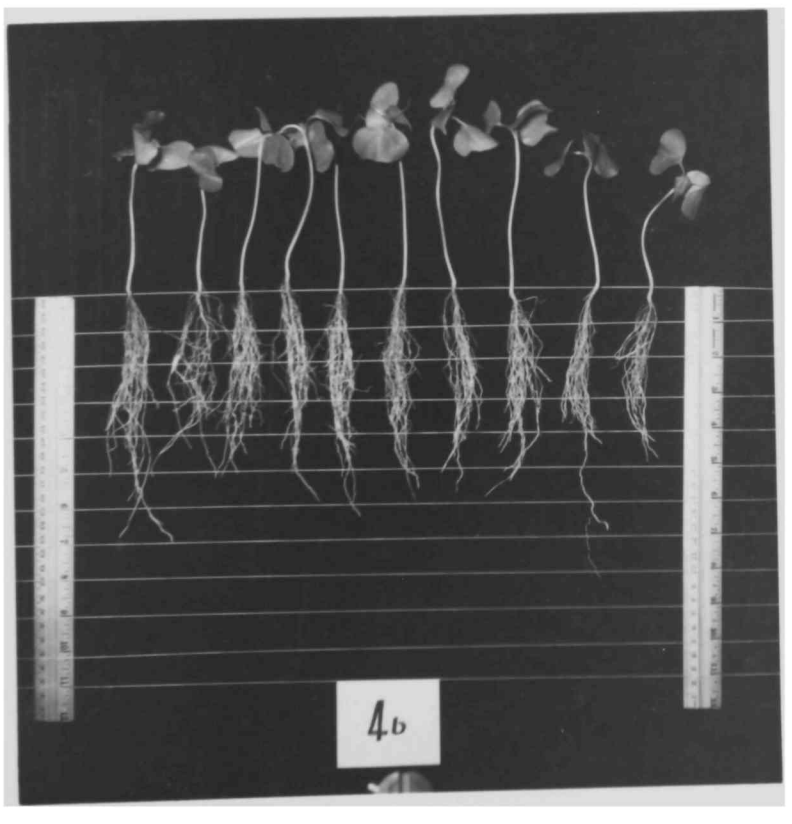


Figure 29. Root Growth of Cotton from Seed Coated with Montmorillonite Plus One Oz. Rootone per Bu.

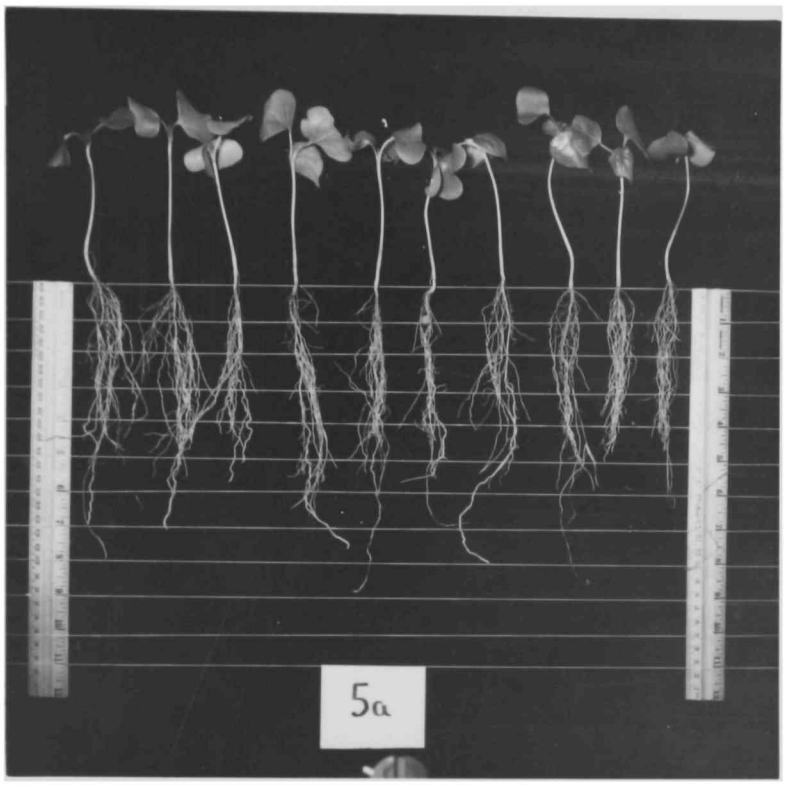


Figure 30. Root Growth of Cotton from Seed Coated with Montmorillonite Plus 1/3 Oz. Rootone 10 per Bu.

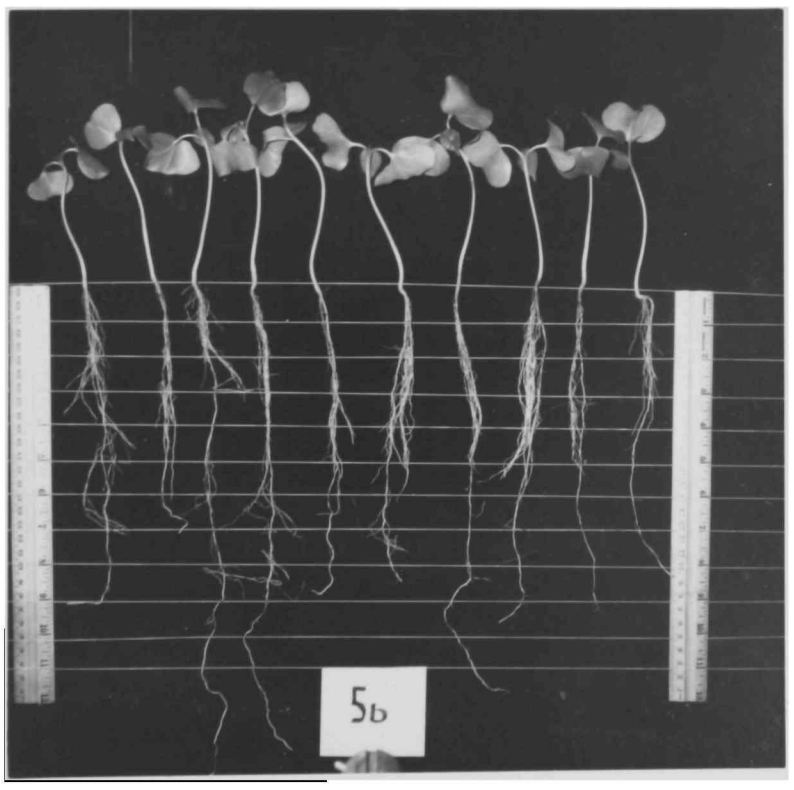


Figure 31. Root Growth of Cotton from Seed Coated with Montmorillonite Plus One Oz. Rootone 10 per Bu.

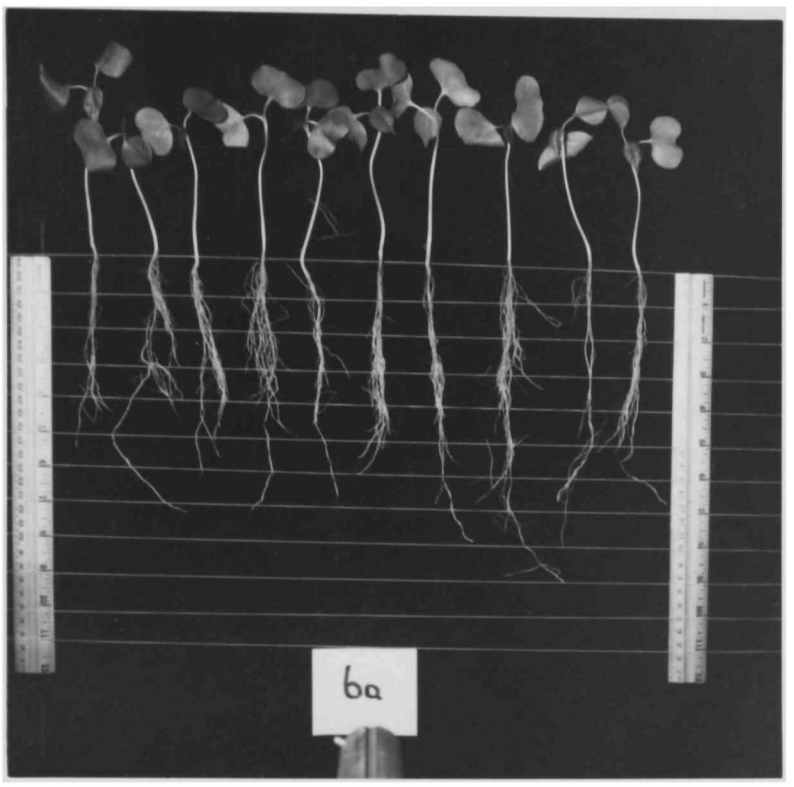


Figure 32. Root Growth of Cotton from Seed Coated with Montmorillonite Plus Three Oz. Actmus per Bu.

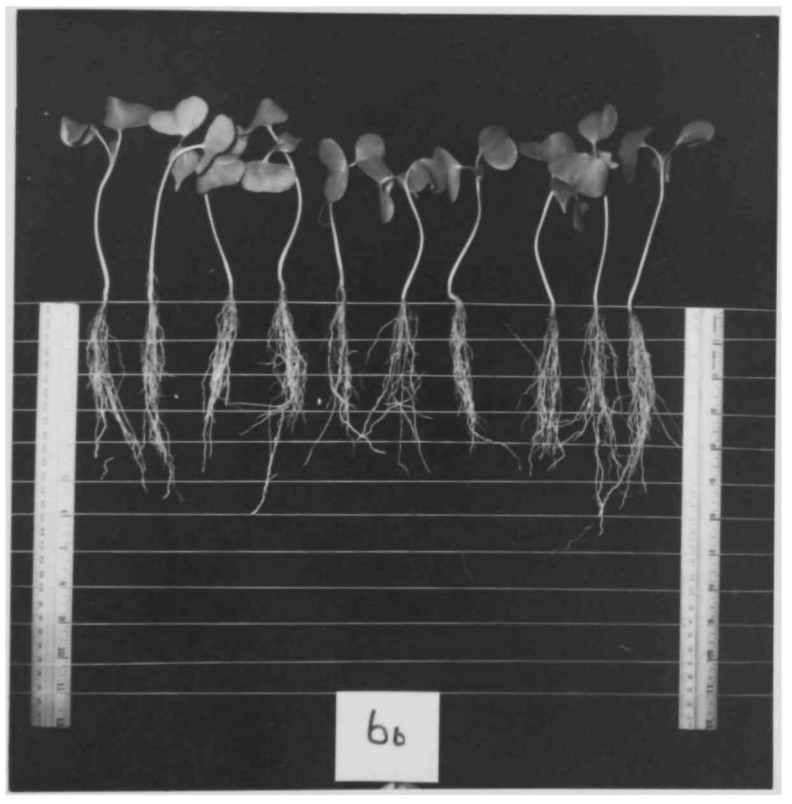


Figure 33. Root Growth of Cotton from Seed Coated with Montmorillonite Plus 16 Oz. Actmus per Bu.

Figure 34. Root Growth of Cotton from Seed Coated with Montmorillonite Plus One Percent Catylitic.

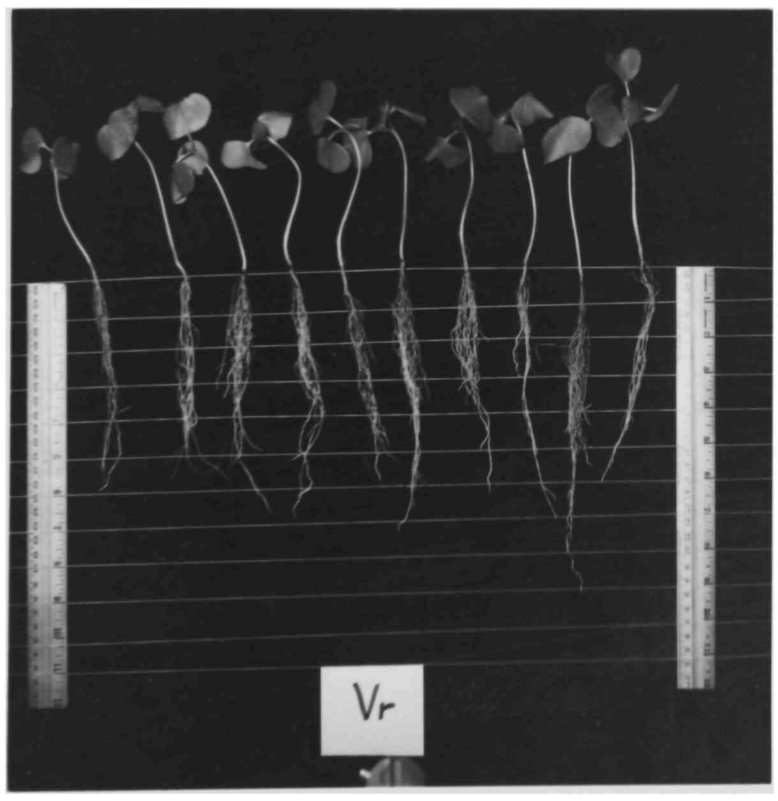


Figure 35. Root Growth of Cotton from Seed Coated with Feldspar-Flyash.

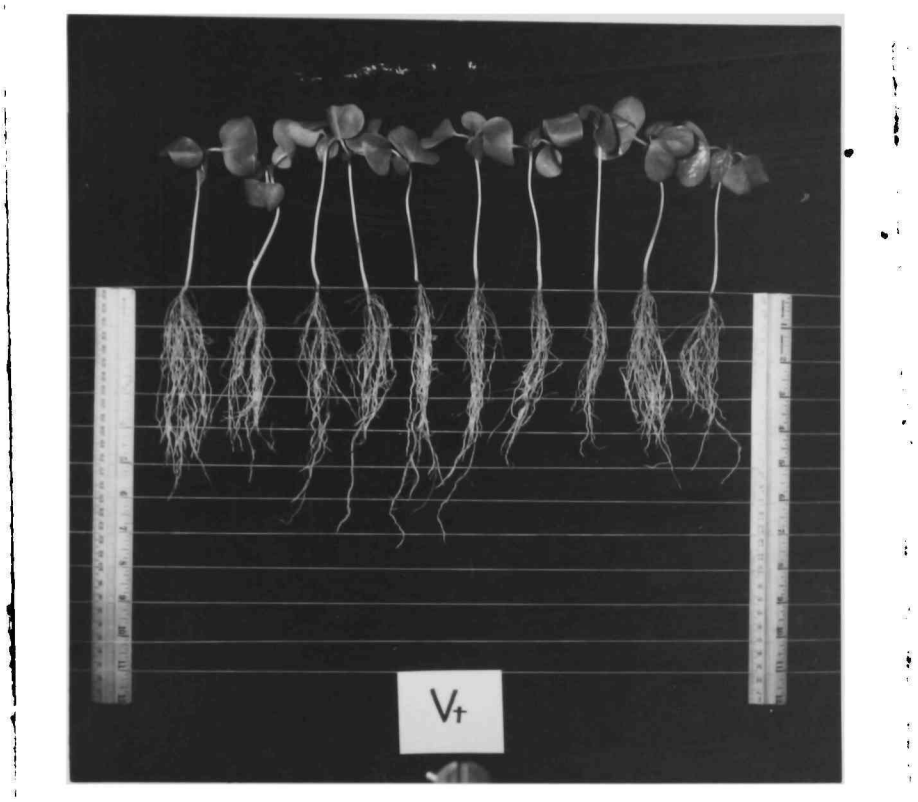


Figure 36. Root Growth of Cotton from Seed Coated with Feldspar-Flyash Plus 30 PPM Terramycin.

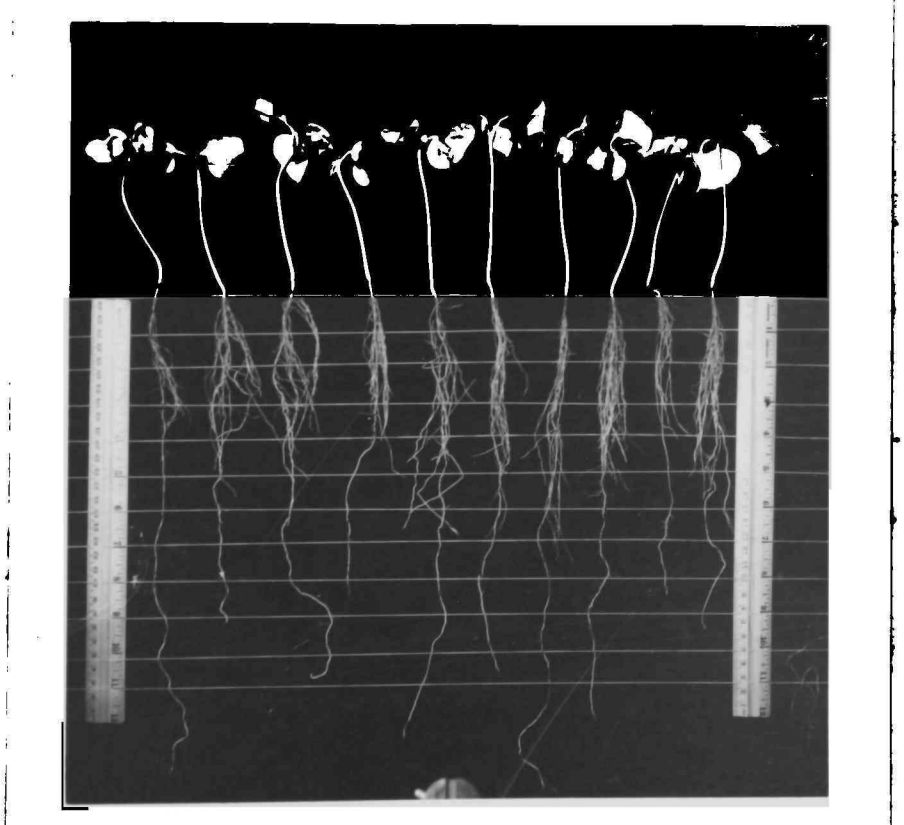


Figure 37. Root Growth of Cotton from Seed Coated with Feldspar-Flyash Plus One Percent Syston.

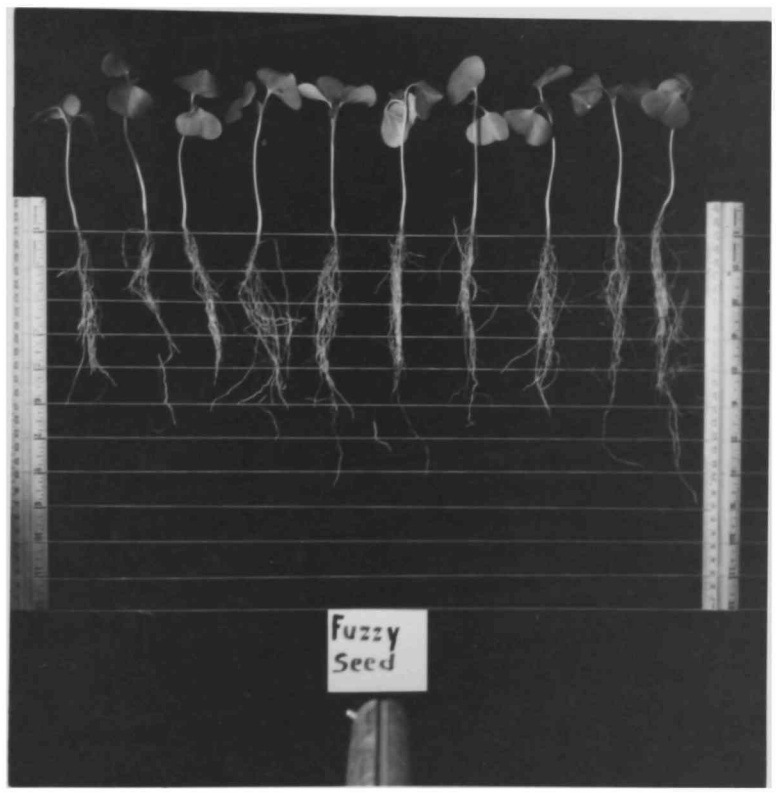


Figure 38. Root Growth of Cotton from Untreated Fuzzy Seed.

CHAPTER VI

SUMMARY AND CONCLUSIONS

1. Because of the importance of cotton on the South Plains of Texas, studies were conducted during 1953 and 1954 at Lubbock, Texas, on the germination and emergence of cotton from seed coated with various inert materials; singly, and combined with certain fertilizers and growth substances.

2. Percentage emergence and rate of emergence trials were made in the field and greenhouse. Germination studies were made in the State Seed Laboratory by placing the cottonseed between rolled towels in the germinator.

3. When compared with the fuzzy seed, cottonseed coated with the standard montmorillonite clay showed no significant difference in percentage emergence on the college farm nor in percentage germination in the germinator, except in one trial; namely, when placed in the germinator immediately after coating. In this case, a highly significant increase resulted.

4. Cottonseed coated with standard montmorillonite showed highly significant decreases in the rate of emergence in the field and greenhouse and in rate of germination in the laboratory when compared to that of fuzzy seed.

5. There was a trend towards lower percentage emergence and rate of emergence of cotton when plant growth hormones and certain fertilizers were added to the standard montmorillonite coating. In no

instance was there a significant increase over the standard when the above materials were added. The effects of these materials on the percentage emergence and rate of emergence when compared with that of the standard montmorillonite were:

a. In the field trials, highly significant reductions in percentage emergence resulted from treatments of four percent P_2O_5, one-third and one ounce Rootone, and one-third ounce of Rootone 10. A significant decrease resulted when one ounce of Graino was added to the montmorillonite coating. Only one treatment reduced the rate of emergence in the field trials, namely, the four percent P_2O_5, which gave a highly significant decrease.

b. Significant decreases in percentage emergence in the greenhouse trials resulted from treatments of 0.5 percent Hyponex and 16 ounces of Actmus. The rate of emergence was highly significantly decreased by the addition of one-third ounce of Rootone. Significant decreases resulted from 0.5 percent Hyponex, one ounce of Rootone 10, three ounces of Actmus, and four percent P_2O_5 to the standard montmorillonite.

c. In the germinator, highly significant decreases in percentage germination resulted from treatments of four percent P_2O_5, one-third ounce of Rootone 10, and one percent special Catylitic material. Significant decreases resulted from treatments of three ounces of Graino, one

ounce or Rootone, one-third ounce of Rootone 10, and three ounces of Actmus. The rate of emergence in the germinator was decreased to the point of high significance by treatments of one and three ounces of Graino, one-third and one ounce of Rootone, and one ounce of Rootone 10; three and 16 ounces of Actmus, and four percent P_2O_5. Significant decreases resulted from one-third ounce of Rootone 10 and one percent special Catylitic material.

6. When compared to the emergence of the fuzzy seed check, standard feldspar-flyash coatings on cottonseed resulted in no significant differences in the percentage emergence in the field or greenhouse except in the trial on the Rhodes farm where a significant decrease resulted. A highly significant increase in percentage germination resulted from this treatment in the State Seed Laboratory.

7. The rate of emergence of the feldspar-flyash coated seed in the field, greenhouse or germinator trials was not significantly different from that of the fuzzy seed.

8. The addition of 30 P.P.M. Terramycin and one percent Systox to the standard feldspar-flyash coating gave variable results when compared to the percentage emergence or germination and rate of emergence or germination of the standard feldspar treatment. A summary of the results is as follows:

a. The addition of 30 P.P.M. Terramycin resulted in a highly significant increase in percentage emergence in the field trial. No significant difference from

that of the standard feldspar-flyash resulted in the greenhouse or germinator except in one trial, namely, in the germinator immediately after coating when a significant decrease in percentage germination resulted. No significant difference in rate of emergence resulted from the 30 P.P.M. Terramycin treatment in the field or greenhouse. However, a highly significant decrease in rate of germination in the laboratory resulted from the 30 P.P.M. Terramycin treatment after a one-year storage period.

b. When compared with the standard feldspar-flyash treatment, the addition of one percent Systox gave significant decreases in the percentage emergence in the greenhouse trials and in the percentage germination of the immediate trial in the germinator. There was no significant difference in the rate of emergence from the one percent Systox treatment in the field or greenhouse trials. In the laboratory trials, no significant difference in rate of germination resulted in the immediate test, but a highly significant decrease resulted in tests made after a one-year storage period.

9. The growth of cotton from coated and fuzzy seed in the greenhouse provide the following results:

a. Seedlings grown from seed coated with the standard montmorillonite clay showed highly significant increases in weight of seedling tops and total plant but no sign-

ificant difference in weight of roots when compared to those of the fuzzy seed.

b. The weight of cotton seedling roots was significantly decreased from that of the fuzzy seed and highly significantly decreased from that of the standard montmorillonite when 0.5 percent Hyponex was added to the montmorillonite.

c. When compared with those from fuzzy seed, the seedlings from the standard feldspar-flyash treatments showed highly significant increases in weight of tops and total plant, but no significant difference in weight of roots.

d. The addition of 30 P.P.M. Terramycin and one percent Systox to the feldspar-flyash coating did not result in significant differences in the weights of roots, tops, or total plant.

10. With the present known results, the following conclusions seem justified:

a. Cottonseed coated with montmorillonite can not be recommended to cotton growers on the South Plains of Texas because they are inferior to fuzzy seed with regard to: (1) rate of emergence and (2) percentage emergence.

b. Cottonseed coated with standard feldspar-flyash do not appear to have a clear cut advantage over fuzzy seed except in the laboratory trials. On the

basis of field tests the use of seed coated with feldspar-flyash cannot be recommended. The increase in germination in the germinator can possible be explained by better aeration than was had in the field.

c. The addition of fertilizers, or "growth substances", to the coatings gives inferior results except in the case of the 30 P.P.M. Terramycin treatment, which tended to give increases in germination over the standard coating in the field test.

d. Cotton seedlings from seed coated with montmorillonite and feldspar-flyash grow faster and have more vigor than those from fuzzy seed as indicated by increased plant weight. The addition of fertilizers and growth substances gives no further advantage and in one instance, a significant decrease in seedling growth was obtained.

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