THE EFFECTS OF TRIFLURALIN AND RHIZOCTONIA SOLANI ON COTTON SEEDLINGS

by

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ABSTRACT

This study was conducted to determine the effects of 2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine (trifluralin) and Rhizoctonia solani on cotton seedlings in the greenhouse.

Trifluralin was incorporated into the soil at 1/2, 1, 2, 4, and 8 lb/A. Two isolates of R. solani were cultured and inoculated in sterilized soil. Pentachloronitrobenzine (PCNB) was included in some treatments to control the pathogen. Certain phases of the experiment were studied under two or more average temperatures.

A reduction in fresh weight of cotton seedlings was caused by low rates of trifluralin. Moderate root inhibition and stunting of seedlings were observed at 1 lb/A. Rates above 1 lb/A severely retarded plant size and inhibited root growth.

R. solani reduced seedling emergence, caused a high percent hypocotyl infection, and resulted in postemergence damping-off of cotton seedlings.

PCNB applied at 15, 30, 45, and 60 lb/A produced 90 to 100% control of R. solani and increased seedling emergence. A significant reduction in seedling weight was caused at all rates of PCNB.

Combined applications of R. solani with 1/2 and 1 lb/A trifluralin caused no significant increase in hypocotyl infection

compared to R. solani treatments without trifluralin. There was a significant increase in percent infection among four concentrations of R. solani, but no significant increase in the pathogenicity of the fungus when trifluralin was present.

The pathogenicity of R. solani was enhanced when low temperatures slowed development of cotton seedlings.

The severity of R. solani under these conditions emphasizes the importance of a fungicide at time of planting insures cotton stands and maintains the advantage of preplant and preemergence applications of herbicides.

INTRODUCTION

The economics of cotton (Gossypium hirsutum L.) farming require the grower to utilize techniques contributing to mechanization and reducing production costs. The use of soil-applied herbicides at planting has become an accepted practice that has contributed to the economy of cotton.

Stand establishment is a major problem in cotton production. There are many limiting factors in obtaining the stand; two of these factors are weed competition and soil-borne diseases.

Cotton culture in the southwestern United States often requires the grower to plant a portion of his acreage at sub-optimum growing conditions--specifically, when soil temperatures are below the optimum level for cotton germination and development. While the effects of low soil temperature and high soil moisture retard cotton seedling development, they favor the incidence of Rhizoctonia solani Kuehn, a major seedling disease of cotton in the western cotton-producing regions.

Under field conditions crop injury has been observed where 2, 6-dinitro-N, N-di-n-propyl-a, a, a-trifluoro-p-toluidine (trifluralin) was applied in the presence of a high incidence of Rhizoctonia solani. The question arises as to the possibility of an interaction between trifluralin-treated cotton plant and the fungus pathogen. Would plants growing in trifluralin-treated soil be more susceptible to the fungus as compared to plants growing in non-trifluralin treated soil, under otherwise similar conditions?

The purpose of this study was to evaluate a specific condition that might alter the performance of trifluralin. Before trifluralin was widely used in the field it was desirable that the interrelations between the herbicide, the disease, and a fungicide be studied with the objective of reducing potential crop injury. The investigations included specific studies of cotton seedlings grown in soil treated with trifluralin, Rhizoctonia solani, and pentachloronitrobenzine (PCNB). The combined effects of the respective treatments were also studied.

REVIEW OF LITERATURE

Literature on the effects of herbicides and diseases of crops is limited. The recent introduction of trifluralin restricts the number of reports on its performance. This review will be oriented towards the cotton plant, trifluralin, Rhizoctonia solani, and chemical control of R. solani.

In the literature review two papers were found on the combined effects of a herbicide and a disease. Boyle, Hauser, and Thompson (9) studied the effects of sodium 2, 4-dichlorophenoxyethyl sulfate (sesone), and different levels of R. solani and Sclerotium rolfsii on the emergence of peanuts (Arachis hypogaea L.). They also studied the effects of organic matter, soil moisture, and temperature on the two diseases.

They concluded that seedling emergence was more severely affected when the organisms were present with the herbicide than when the disease complex occurred alone. It was further stated that germination temperatures were probably the major environmental factor affecting the severity of the pathogens on peanut seedling emergence.

Boyle and Hauser (10) conducted an experiment to determine the relationship between sesone-induced injury on peanut seedlings when grown in a soil with a natural infection of R. solani. The peanut seedlings were evaluated soon after emergence and 8 to 9 weeks following emergence. Their results indicated that plants showing a high degree of sesone injury are likely to be attacked by root-rotting organisms. They concluded that with increasing rates of sesone the percent of diseased roots increased.

Development of the Cotton Seedling

The germination of cotton seed is dependent upon moisture. It is reported (11, 36) that the seed absorbs one-half or more of its weight, and that this absorption takes place rather slowly due to the thin waxy covering of the seed coat.

Soil temperatures may be a limiting factor in successful cotton seed germination. The optimum temperature as determined by Camp and Walker (12) is 94°F. Their studies further state that at 60°F germination was slow and at 57°F it stopped. Temperatures above 97°F tended to inhibit germination.

Soil salinity (22) and variety (6) were also factors that influenced the rate of cotton germination.

The cotton seedling develops very rapidly following the emergence of the primary root through the micropyle (34). Balls (5) described the tap root as growing without branching for the first 4 days, and at seven days it may be 5.5 inches long with prolific root hair development. During the extension of the primary root, but prior to emergence Walker (38) indicated that the optimum soil temperatures were 75° to 85°F. More recently Arndt (2) indicated that a profusion of primary root growth was observed at 93°F. Both workers essentially agree that growth of seedlings may be stopped at ranges of 53° to 57°F.

In additional studies, Arndt (2) determined that 93° to 97°F were the optimum temperatures for the development of the first 100 mm of the hypocotyl. Minimum temperatures during this growth period were 64°F, while the maximum temperatures tolerated were in excess of 100°F. In a comparable stage of development, the optimum temperature for primary root development was 93°F.

Arndt (2) pointed out the ecological significance in the differential temperature tolerance of the primary root and hypocotyl. The aforementioned optimum temperature for elongation of the primary root was 93°F for the first 3 to 4 days. This temperature optimum then shifted downward to 80°F; thus the root conveniently adapts to the fact that soil temperatures decrease with increasing depth.

As the development of the primary root adapted to cooler temperatures, the hypocotyl similarly adapted to warmer temperature. Following the first 4 to 5 days, it made its optimum growth at 97°F.

Following emergence of the cotton plant, and up to the first 14 days of growth, a shift in its temperature optimum was observed (2). The maximum length of top growth was reported at a constant temperature of 86°F, whereas the maximum tap root development occurred at 75°F.

Simultaneously with the emergence of the seedling, lateral root formation occurred under the conditions described above.

In 5-day-old seedlings, Spieth (34) observed that complete differentiation and secondary thickening were initiated in the lower hypocotyl region. In the upper limits of the same hypocotyl the maturation of the primary tissue was just beginning, and there seemed to be little differentiation of the vascular elements at the cotyledonary node.

Secondary thickening begins very early in the development of the primary root. As the root increases in size the cortical and epidermal cells stretch and ultimately disintegrated but the pericyle remains active and produces a multilayer periderm that serves as a protective covering for the mature root (18).

Growth of the terminal bud between the cotyledons develops into the main axis of the plant and the ultimate production of the first true leaves.

Rhizoctonia solani

Cotton is one of 230 reported hosts of the fungus, *Rhizoctonia solani* (37). The importance of this fungus as the cause of disease has been recognized since Atkinson (4) in 1892 isolated a fungus from cotton, later described as *R. solani*. This pathogen attacks the cotton seedlings causing a preemergence and postemergence disease called "damping-off" and "soreshin." On emerged seedlings, it attacks the subterranean part of the hypocotyl, causing deep, reddish-brown lesions, which may or may not coalesce and girdle the hypocotyl (29, 31).

Various workers (13, 14, 21, 24) have reported that the host plants to this disease are most susceptible in the early stages of seedling development. Infection occurring after secondary growth has been initiated is usually restricted to lesions and seldom causes the death of the plant.

In addition to the vulnerability of the young seedling, the parasitism of this fungus is greatly influenced by environmental factors. The disease is most severe under cool, moist conditions. Under these conditions preemergence and early postemergence damping-off is most severe. Soreshin (lesions that normally do not result in the death of the plant) is manifested at higher soil temperatures.

Richards (32) indicated that the optimum temperature for the maximum severity of infection of cotton by R. solani is 70° to 74°F. He also found that the optimum range for infection by another isolate attacking pea (Pisum sativum) to be 64° to 68°F. Conclusions from the work of LeClerg (28) indicated that the actual optimum temperature for the growth of many isolates of R. solani will depend upon its origin, its inherent pathogenicity, and the host.

It is evident from the above investigations (2, 12) that the optimum temperature range for the growth of cotton is outside the temperature range for severe pathogenic action of the fungus, and relatively high temperature would permit cotton to grow rapidly, practically uninjured (24, 27). One can raise the question of whether the dominant influence of temperature was through the pathogen, the host, or both? Richards (32) reported that the temperature requirement for the pathogen on its various host is a fixed inheritable characteristic of the fungus, and is more or less independent of temperature relations of the host on which it becomes parasitic. Leach (27) states that the severity of preemergence damping-off appeared to be closely related to the growth rate of the host and to the growth rate of the pathogen. This concept explains why crops like cotton are more subject to pre-emergence and postemergence damping-off at low than at high temperatures.

The question of soil temperature becomes more complex when considering the high degree of variability between the numerous isolates (21, 24, 29) studied in a given area. Variability among the numerous strains isolated from diseased cotton seedlings was evaluated by Maier and Staffeldt (29). Some 245 isolates were collected and studied for variable characteristics. Ten types of growth patterns were found among the isolates studied. They further evaluated pathogenicity of members of the 10 groups and determined this to range from a high degree to none. Their studies indicated 10 strains or races could be distinguished based on pathogenicity and growth characteristics. Various workers (20, 29) generally rate and group the strains into 3 categories (slightly, moderate, and highly virulent) based on their pathogenicity.

When the virulence variations of the strains were examined under temperature variables, certain strains expressed a greater degree of pathogenicity over a broader temperature range than others (3).

Infection of seedlings by this pathogen is also dependent on soil pH (8), the optimum range being 6.5 to 8. Extremely acid or alkaline pH levels inhibit most isolates.

The soil organic content is reported by Sanford (35) to affect the rate of growth of the fungus. His studies indicated that *R. solani* produced more infection in a sandy soil, with a low organic matter than did the same treatments on a clay loam with higher organic matter.

Other factors often reported influencing *R. solani* are carbon dioxide concentrations, light, and soil fertility, but these conditions are highly variable (8).

Infection of the Seedling

Histological studies (13, 25) revealed that within 48 hours of the initial contact with the cotton hypocotyl by the fungus, the infected portion completely disintegrated. Actual penetration by the fungus was predisposed by the formation of an infection cushion. The infection cushions were initiated when the hyphae came in contact with the hypocotyl. Khadga, Sinclair, and Exner (25) described the infection cushion as an aggregation of the hyphae, or a single hyphae giving rise to several branches which in turn form a tuft of short stubby branches. Regardless of the method of formation, the infection cushion is pictured as a dome-shaped structure.

Following the formation of infection cushions, the swollen hyphae tips produce infection pegs which penetrate the cuticle and epidermal cell walls. The infection cushion appears to act as a fulcrum against which a force is exerted during penetration.

The lack of apparent discoloration or death of cells prior to and just after penetration (13, 25) suggest that infection was brought about by the mechanical pressure of the infection peg on the host surface and that no enzyme action is involved. Upon entry the mycelium grows and develops intercellularly in epidermal and cortical tissue, branching in all directions. Often the tissue in advance of invading hyphae showed granulation (25) and loosening of the middle lamella in the cortical region attributable to enzymes (13, 25) produced after infection. Bateman (7) has shown that the fungus produced pectolytic and cellulolytic enzymes.

Other factors that are reported (25) to increase hypocotyl infection of cotton by _R. solani_ are glandular hairs, lysigenous oil cells, and mechanical wounds. Invasion through stomata was not considered to be important with this fungus.

Chemical Control of Rhizoctonia solani

Recent investigations (29, 33) have been undertaken on the control of cotton seedling diseases with fungicides. Major emphasis has been placed on chemical control because of the wide host range of *R. solani* and because the cropping patterns of the major cotton-producing regions limit the use of cultural practices in controlling this pathogen.

Fungicidal applications have been directed toward an inhibiting action on the pathogen providing a disease-free environment for the young cotton seedling. It is believed (20) that most fungicides used today act directly on the fungus cell. Consequently, the fungicide, or its fumes, must come in direct contact with the cells they affect, and in most instances enter these cells. PCNB applied to the soil is a vapor-phase fungistat which does not prevent spores from germinating but stops hyphae growth.

The widespread distribution of this fungus and the economics involved have limited control measures to a band or "in-the-seed-furrow" treatment. Earlier attempts (29) to treat the seed or apply the fungicide in the planter box have provided poor to mediocre control in the field.

Comparing application methods, Maier and Staffeldt (29) found in-the-seed-furrow treatments superior to planter-box applications. They found in-the-seed-furrow, low-volume sprays superior to in-the-seed-furrow dusts.

There are many fungicides being tested in the United States. In tests of new fungicides PCNB is often used as a standard or in combination with the newer compounds. The use of PCNB as an effective fungicide has been demonstrated by a number of experiments (29, 33). PCNB alone or in combination (29) resulted in significant increases in cotton stands and higher yields when compared to the untreated control.

Trifluralin on Cotton

Trifluralin has been registered for used in cotton as a soil-applied herbicide. It has been tested in all major cotton-producing regions of the United States. Its recommended use is a soil-incorporated application. The incorporation techniques used are extremely varied. Certain investigators (17) are currently evaluating the compound as a layby treatment, but for the purpose of this review only preplant and pre-emergence applications will be considered.

In describing the mode of action of a selective herbicide one can only generalize, due to the limitations of specific knowledge.

Plants absorb most soil-applied herbicides through the roots, although certain compounds are absorbed by the growing point. Trifluralin is believed to be absorbed only through the roots of plants.

The selectivity of soil-applied herbicides is based primarily on the physiological differences in the crop's and weed's ability to tolerate or metabolize the chemical. This is especially true when the herbicide is mixed throughout a given depth of soil in which the crop and weed seeds are germinating. Many of the present pre-emergence herbicides are effective only on germinating seeds or young seedlings.

Another method in obtaining selectivity is through application practices and the chemical-physical properties of the herbicide. Under specific conditions, a herbicide may be placed above or beside crop seed allowing the crop roots to develop in a herbicide-free zone.

It is believed that the former method is more important with trifluralin. Physiological tolerance by a specific crop, such as cotton, to a given herbicide is extremely important, as this means of selectivity allows for a greater safety margin under varying application methods, environmental conditions, and soil structure.

Trifluralin applied to the soil and incorporated by rotovating resulted in an eight-fold increase in activity compared with surface applications (30). Soil incorporation can increase the effectiveness of this compound, subsequently reducing the rate applied to the crop.

Soil texture (19) also influences the activity of trifluralin. In certain instances a 1/2 lb/A rate in a sandy loam soil was as effective as 1 lb/A on a silt loam soil.

The exact soil-chemistry functions involved in this phenomenon are not clearly defined, but the adsorption properties of the clay colloid are known to have a strong attractant force (26), which presumably has an effect on the trifluralin molecule. If the adsorption capacity of a given clay colloid is great, there is a lesser amount of the chemical immediately available for root absorption. The adsorptive capacity and thus exchange capacity is closely associated with the inorganic and organic colloids of the soil (39). Cationic adsorption (39) appears to have little influence on the availability of the compound to germinating seeds. Adsorption by anion exchange resins (39) tend to retain the compound against solution on soils of higher clay-organic content due to a temporary "fixation" of the herbicide.

In 1961, Hicks and Fletchall (19) reported trifluralin selectively controlled annual weeds in cotton. These workers reported that 2 to 8 lb/A as a pre-emergence application gave excellent weed control and did not affect cotton.

Early field reports from western cotton workers (16) indicated that trifluralin showed considerable promise as a selective herbicide in irrigated cotton.

Arle and Hamilton (1) reported preplant application of 1 lb/A of trifluralin did not affect the emergence of the cotton seedlings. Ten days after emergence the seedlings of cotton treated with trifluralin were stunted. Trifluralin provided early and late season weed control, but was more effective in controlling grasses than broadleaved weeds.

Researchers in Arkansas and Mississippi (15) evaluated the effects of soil texture, rates, and application methods of trifluralin on cotton. Preplant, incorporated treatments were superior in their consistency of performance and gave longer duration of weed control. Stunting of cotton was reported with 1.5 and 3 lb/A of trifluralin.

Preplant applications with 1 lb/A of trifluralin in Arizona (16) during 1962 significantly increased cotton yields. The herbicide was disked in and the area furrowed-out for the preplant irrigation. Seedling retardation was observed but after six weeks differences between treated and untreated plants were no longer evident.

In additional research by the above workers (17) preplant treatments were applied in March of 1963 and the cotton was seeded into moist soil with a dry mulch. The 1 lb/A treatments caused a temporary stunting of the cotton seedlings for 4 to 5 weeks. These workers indicated that trifluralin increased the susceptibility of cotton seedlings to the *Rhizoctonia* disease. Seedling stands from experiment were reduced 15 to 25 percent by *Rhizoctonia* where trifluralin was used as a preplant application.

METHODS AND MATERIALS

These experiments were conducted in the greenhouse at Tucson, Arizona. The study was initiated October 1963 and completed in July 1964. The work was divided into several phases to study (1) the effects of varying rates of herbicide on cotton seedlings, (2) *R. solani* concentrations on cotton seedlings, (3) PCNB rates on germination of cotton, (4) the effect of trifluralin and *R. solani* on cotton seedlings, and (5) the effect of trifluralin, *R. solani*, and PCNB on cotton seedlings.

A sandy loam soil was collected from the 0 to 6 inch level of the University of Arizona's Casa Grande Highway Farm. Analysis of the soil showed it to be 12% clay, 35% silt, 53% sand, and 1.2% organic matter. The soil was sifted through a 1/4-inch screen and then autoclaved at 249°F at 15 psi for 10 hours.

The cotton variety, Acala 44-10, was used throughout the experiment. The cotton plants were grown in plastic trays 7" x 7" x 2-1/2". Twenty-five seeds were planted per tray, in three rows, at a depth of one inch.

Trifluralin and PCNB were applied with a single nozzle sprayer. A 6501 nozzle tip was used and the solution applied at 30 psi. The inoculum was applied with similar apparatus but due to the nature of the material an 8003 nozzle tip was used. The soil contents of each tray (2600 ml) was spread over an 18" x 26" area and sprayed with the respective treatments. Following the spray application, the soil was mixed for 20 seconds, which incorporated the treatment throughout the soil.

All trays were placed in shallow pans for the duration of each study and sub-irrigated for germination. Subsequent irrigations were applied in a similar manner to maintain adequate soil moisture levels.

Plants were harvested 10 or more days after 50 percent of the seedlings had emerged. Emerged seedlings were counted each day, and the number of dying plants were recorded. Damping-off of seedlings was calculated as the percent of those plants that died prior to harvest based on the maximum germination.

At the conclusion of the growth period, the plants were removed from the soil by washing the soil from the roots. The plants were dried between blotters and fresh weight immediately recorded. The seedlings were rated for Rhizoctonia solani infection as clean, slight, moderate, severe, and dead.

Statistical analyses were conducted on certain specific data and are presented in tabular form under the respective experiment.

Soil and air temperatures were recorded throughout the experiment.

R. solani Culture and Inoculation

Two isolates[1] of Rhizoctonia solani were used in the experiment. The strains were originally isolated from infected cotton collected in commercial fields in Arizona. The organism was transferred from pure culture slants and increased on potato dextrose agar (12-15 ml/petri plate). The fungus was grown at 72° to 73°F until sclerotia were evident, a 7- to 10-day period.

The fungus growth and agar were removed from 6 petri plates and mixed with 150 ml of sterile distilled water in a Waring blender for 15 seconds. This mycelium-sclerotia-agar mixture represented the stock solution. A 1 ml sub-sample was taken for mycelium fragment and sclerotia counts. The counts were used to maintain uniform application of inoculum between tests.

Four concentrations of R. solani were established. Each concentration can be expressed as (1) ml of stock solution per 1000 ml of water, and (2) fragment-sclerotia counts per 1000 ml of sprayed emulsion. N concentration represented the maximum level, 35 ml of the stock solution per 1000 ml of water, or 70,000-105,000 fragment-sclerotia counts/1000 ml of water. N/4 levels was 17,500-26,250 fragment-sclerotia counts/1000 ml water. N/16 level was 4,370-6,560

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[1] Isolates I and II were provided by Dr. Alice Boyle, Department of Plant Pathology, University of Arizona.

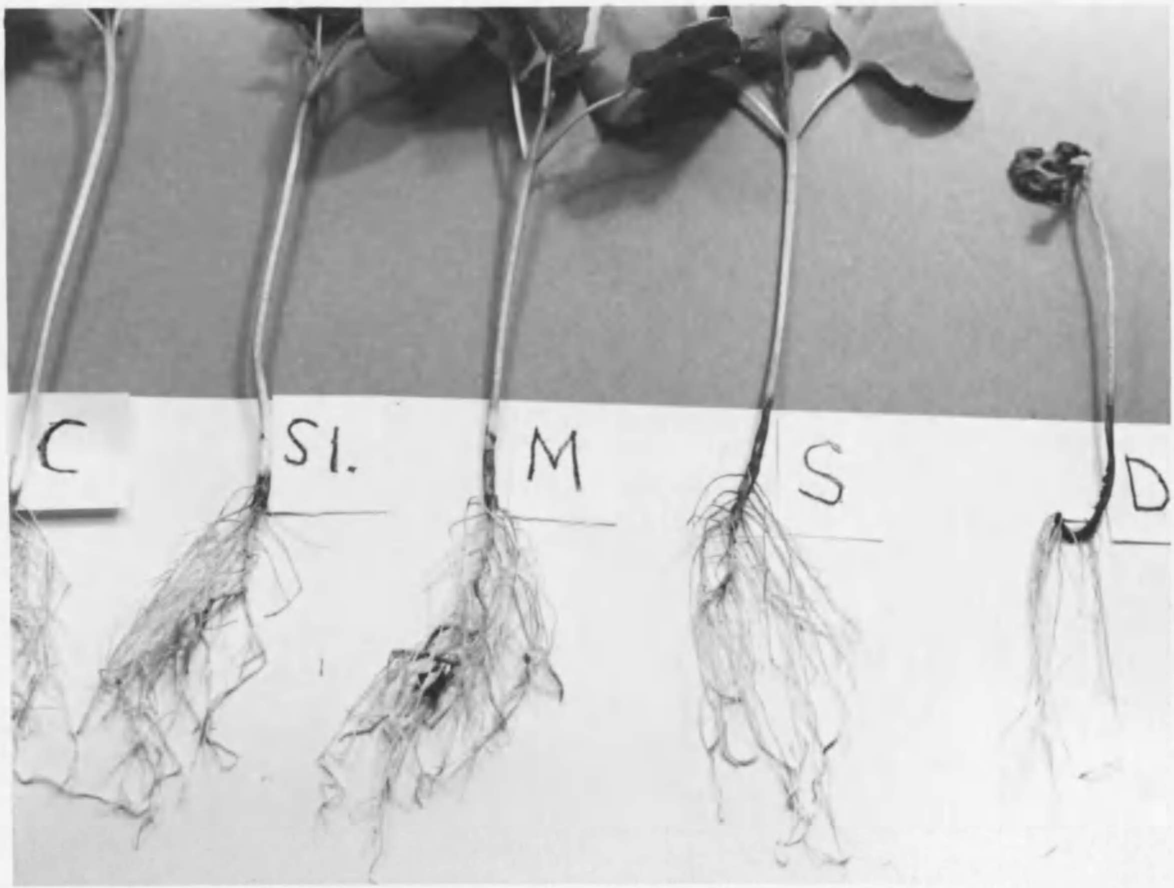

Figure 1.--Five classes of hypocotyl infection used to evaluate the pathogenicity of R. solani. (C) clean, (Sl) slight, (M) moderate, (S) severe, and (D) dead.

Figure 2.--Mycelium and sclerotia of 10-day-old R. solani culture prior to soil inoculation with the mycelium-agar-sclerotia mixture.

fragment-sclerotia counts/1000 ml water. N/64 level was 1,090-1,650 fragment-sclerotia counts/1000 ml water.

One hundred ml of a given concentration of inoculum mixture was applied to 2600 ml of soil.

Trifluralin Treatments

A study on the effects of six rates of trifluralin was established in a latin square design. Treatments were at the following rates: 0, 1/2, 1, 2, 4, and 8 lb/A of trifluralin. The rates were calculated on the basis of treated surface area.

The herbicide used contained 4 lb/gal of trifluralin formulated as an emulsifiable concentrate.

Evaluation was made on the percent and rate of emergence, fresh weight of plants, topgrowth, and roots.

The experiment was repeated twice at mean soil temperatures of 73° and 84°F.

PCNB Treatments

The PCNB rate of study involved six treatments arranged in a latin square. Sterilized soil was inoculated with the fungus at the N concentration. The fungicide was applied at 0, 15, 30, 45, and 60 lb/A. All rates were calculated on the basis of treated surface area.

The formulation of PCNB contained 2 lb/gal as an emulsifiable concentrate.

Plant evaluations were made on percent emergence, hypocotyl infection, and fresh plant weight.

The experiment was repeated twice at mean soil temperatures of 80° and 83°F.

Trifluralin, R. solani and PCNB

A completely randomized block design with 12 treatments and 4 replications was used in this study.

The N concentration rate of fungus inoculum was used. Trifluralin was applied at 1/2 and 1 lb/A and PCNB at 40 lb/A.

Data collected from these experiments were percent emergence, hypocotyl infection, and fresh plant weights.

Two experiments were conducted at mean soil temperatures of 73° and 82°F.

Trifluralin and Concentrations of R. solani

A completely randomized block experiment involving 15 treatments and 4 replications was used in this study. *R. solani* was applied at N, N/4, N/16, and N/64 levels. Trifluralin was applied at 1/2 and 1 lb/A.

Plants responses were obtained on percent emergence, hypocotyl infection, percent damping-off, and fresh plant weight.

Three experiments were conducted at mean soil temperatures of 74°, 80° and 85°F.

RESULTS AND DISCUSSION

Trifluralin on Cotton Seedlings

Percent emergence at three dates after planting and fresh weight of the entire plant, tops, and roots of cotton seedlings treated with trifluralin are summarized in tables 1 and 2. The data presented represent the results from two experiments, text I six rates of trifluralin at a mean temperature of 73°F. and test II six rates, at 84°F.

In test I there was no significant difference between the top, root, or plant weights from the 1/2 lb/A treatments and these weights from the untreated checks. Top, root, and plant weights from the 1 lb/A treatments were significantly less than from the 1/2 lb/A treatment. There was no significant difference in roots, tops, or plant weights between the 2, 4, and 8 lb/A rates. With the exception of the 1 lb/A rate on roots, the weights from 2, 4, and 8 lb/A rates were all significantly less than the weights from 0, 1/2 and 1 lb/A rate.

In test II the top, root, and plant weights from the 1/2 lb/A treatment were significantly less than these weights from the untreated check. Weight of plants, tops, and roots treated with 1 lb/A of trifluralin were significantly reduced from those of the 1/2 lb/A rate and the control.

TABLE 1.--Percent emergence, fresh weights of tops, roots, and entire plant of cotton seedlings grown at a mean soil temperature of 73°F following soil applications of trifluralin (test I).

Treatment trifluralin lb/A	Percent emergence			Average weight (grams) of plants at harvest		
	12 days	16 days	21 days	Tops*	Roots*	Plants*
0	16	48	67	1.51 a	0.65 a	2.16 a
1/2	13	49	65	1.56 a	0.66 a	2.22 a
1	17	42	63	1.06 b	0.40 b	1.46 b
2	15	37	55	0.73 c	0.32 bc	1.05 c
4	11	36	54	0.62 c	0.29 c	0.91 c
8	9	41	53	0.60 c	0.29 c	0.89 c

*Values with the same subscript letter are not significantly different.

TABLE 2.--Percent emergence, fresh weights of tops, roots, and entire plant of cotton seedlings grown at a mean soil temperature of 84°F following soil applications of trifluralin (test II).

Treatment trifluralin lb/A	Percent emergence			Average weight (grams) of plants at harvest		
	6 days	9 days	14 days	Tops*	Roots*	Plant*
0	67	81	84	1.60 a	1.09 a	2.69 a
1/2	57	83	85	1.27 b	0.66 b	1.93 b
1	59	85	87	1.00 c	0.37 c	1.37 c
2	61	79	81	0.70 d	0.36 c	1.06 d
4	51	80	82	0.67 d	0.29 c	0.96 d
8	42	71	75	0.68 d	0.32 c	1.00 d

*Values with the same subscript letter are not significantly different.

The 1 lb/A rate of trifluralin reduced growth of cotton seedlings harvested 21 days after planting. The reduced weight of the cotton seedlings is in agreement with Hamilton and Arle (1, 17), who reported that 1 lb/A treatments in the field caused a temporary stunting for 4 to 5 weeks. Guse and Schwer (15) reported a slight stunting caused by 1 and 1.5 lb/A trifluralin. No significant yield reduction was reported (15, 17) from the 1 lb/A application of trifluralin indicating the temporary effects of stunting in cotton seedlings.

Emergence data in test I showed no difference due to trifluralin treatments although the 2, 4, and 8 lb/A treatments averaged 10 percent less than the untreated check.

The percent emergence for all treatments was considerably higher in test II than in test I. The soil temperatures in test II were more conducive for cotton germination, approaching the optimum range described by Walker (38).

Visual examination of the harvested plant roots revealed the reduction of secondary roots by the 1, 2, 4, and 8 lb/A treatments. The exact relationship of root inhibition to the duration of seedling stunting was not established. It appears from work now in progress[1]

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[1] Luc Vannoorbeeck, M. S. thesis, University of Arizona, 1964.

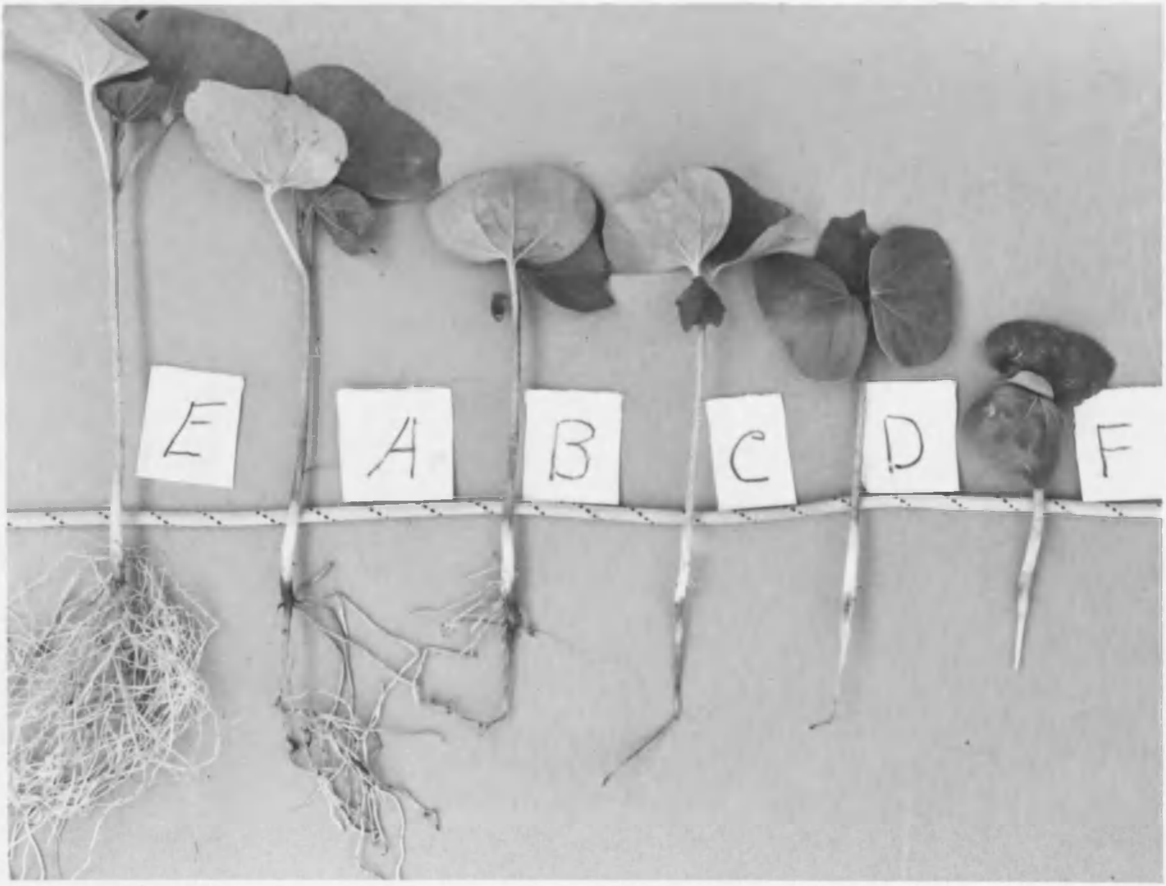

Figure 3.--Root inhibition on 15-day-old cotton seedlings following soil application of trifluralin. (E) 0, (A) 1/2, (B) 1, (C) 2, (D) 4, (F) 8 lb/A.

that trifluralin only inhibits root development in the treated zone and once roots extend through the treated zone normal secondary root development begins.

Another symptom of roots grown in trifluralin-treated soil was extreme brittleness.

Various workers (13, 25) have commented on the maturation of the hypocotyl and its susceptibility to R. solani. It is possible that abnormal root development may affect the suceptibility of the cotton plant to this disease.

PCNB on Cotton Seedlings

Seedling emergence at three dates after planting, hypocotyl infection and fresh plant weight following soil applications of PCNB and R. solani are summarized in tables 3 and 4.

Seedling emergence data from two tests indicated no significant difference between the six treatments. This is in agreement with similar experiments conducted by several workers (29, 33).

The data on hypocotyl infection on plants grown in soil inoculated with the fungus indicated a greater percent infection in test IV (six rates of PCNB at 83°F) than in test III (six rates of PCNB at 80°F). The results from test III denote the complete control of the pathogen by PCNB at all rates, whereas complete control of the

TABLE 3.--Percent emergence, hypocotyl infection, and fresh weights of cotton seedlings grown at a mean soil temperature of 80°F following soil applications of PCNB and R. solani (test III).

Treatments		Percent emergence			Hypocotyl infection at harvest (percent)	Average weight of plant at harvest (grams)*
PCNB lb/A	R. solani level	6 days	9 days	14 days		
0	0	66	71	73	0	2.26 a
0	N	65	69	73	52	2.21 a
15	N	67	78	78	0	2.03 b
30	N	63	75	76	0	2.00 b
45	N	61	69	77	0	1.95 b
60	N	69	72	79	0	1.91 b

*Values with the same subscript letter are not significantly different.

TABLE 4.--Percent emergence, hypocotyl infection, and fresh weights of cotton seedlings grown at a mean soil temperature of 83°F following soil applications of PCNB and R. solani (test IV).

Treatments		Percent emergence			Hypocotyl infection at harvest (percent)	Average weight of plant at harvest (grams)*
PCNB lb/A	R. solani level	8 days	10 days	14 days		
0	0	55	61	71	0	3.88 a
0	N	71	73	74	89	3.48 b
15	N	55	69	74	11	3.40 b
30	N	61	71	81	11	3.26 b
45	N	49	62	71	10	3.26 b
60	N	48	59	67	10	3.26 b

*Values with the same subscript letter are not significantly different.

Figure 4.--Left trays: 15-day-old cotton seedlings exhibiting severe damping-off symptoms from *R. solani* and 1/2 lb/A trifluralin, without PCNB. Right trays: complete control of *R. solani* when PCNB added to the treatment.

fungus in test IV was not obtained with any of the treatments. However, PCNB treatments reduced the percent infection about 90 percent.

The plant weight data obtained from the two tests were similar. In test III there was no significant difference in plant weight between the untreated plants and plants inoculated with *Rhizoctonia solani*, whereas in test IV these plant weights were significantly different. A possible explanation is the difference in percent infection caused by these treatments in the two tests.

A significant difference in plant weights between all rates of PCNB and the untreated check was observed in both tests.

The reduced plant weight caused by the PCNB treatments was probably unimportant if one considered the severity of the pathogen. It appeared that the reduction in seedling weight was only temporary. Many field investigations (29) have shown significant yield increases when *R. solani* was controlled with PCNB.

Trifluralin, R. solani, and PCNB on Cotton Seedlings

Cotton seedlings were evaluated for percent emergence at three dates after planting, hypocotyl infection, and fresh weight following soil applications of trifluralin, *R. solani*, and PCNB.

Two tests were conducted to study the above treatments, test V at mean soil temperature of 73°F and test VI at 82°F. These data collected from test V are summarized in table 5 and data from test VI are presented in table 6.

Percent emergence was significantly reduced in test V with the R. solani treatments which did not include a PCNB application. At the conclusion of this experiment it was confirmed by reisolation procedures that the non-emerged seedlings were infected with R. solani. Optimum temperature for the pathogen (3, 38), adverse temperature for cotton emergence (2, 12) and the lack of R. solani control accounted for the high degree of preemergence damping-off. These results are in agreement with Leach (27), who indicated that other factors being constant, the relative growth rates of the host and the pathogen will often determine the severity of preemergence infection at different temperatures.

There was no significant difference between comparable treatments in test VI, which was grown at temperatures enhancing cotton seedling development.

Hypocotyl infection results from the two tests were the same. All seedlings grown in R. solani treatments without PCNB were infected. The incidence of postemergence damping-off was much greater in test V. In test V, 98 percent of those seedlings included in the infected category were damped-off at harvest, as compared to 50 percent in test VI.

TABLE 5.--Percent emergence, hypocotyl infection, and fresh plant weights of cotton seedlings grown at a mean soil temperature of 73°F following soil applications of trifluralin, R. solani and PCNB (test V).

Treatments			Percent emergence			Hypocotyl infection at harvest (percent)	Average weight of plant at harvest* (grams)
Tri-fluralin lb/A	R. solani level	PCNB lb/A	13 days	21 days	24 days*		
0	0	0	38	68	73 a	0	2.22 a
0	0	40	34	53	66 a	0	1.98 a
0	N	0	34	42	45 b	100	0.95 b
0	N	40	45	61	69 a	0	1.80 a
1/2	0	0	30	63	71 a	0	2.30 a
1/2	0	40	32	53	69 a	0	1.80 a
1/2	N	0	21	32	33 b	100	0.32 b
1/2	N	40	57	74	84 a	0	1.88 a
1	0	0	31	48	67 a	0	2.10 a
1	0	40	47	69	73 a	0	1.75 a
1	N	0	25	45	47 b	100	0.85 b
1	N	40	62	79	80 a	0	1.72 a

*Values with the same subscript letter are not significantly different.

TABLE 6.--Percent emergence, hypocotyl infection, and fresh plant weights of cotton seedlings grown at a mean soil temperature of 82°F following soil applications of trifluralin, R. solani, and PCNB (test VI).

Treatments			Percent emergence			Hypocotyl infection at harvest (percent)	Average weight of plant at harvest* (grams)
Tri-fluralin lb/A	R. solani level	PCNB lb/A	7 days	11 days	15 days*		
0	0	0	64	73	86 a	0	1.70 a
0	0	40	65	76	84 a	0	1.58 a
0	N	0	74	82	83 a	100	1.50 a
0	N	40	73	88	88 a	0	1.43 a
1/2	0	0	73	79	82 a	0	1.65 a
1/2	0	40	67	74	83 a	0	1.58 a
1/2	N	0	67	72	72 a	100	1.45 a
1/2	N	40	75	82	86 a	0	1.48 a
1	0	0	73	83	88 a	0	1.58 a
1	0	40	74	82	87 a	0	1.48 a
1	N	0	72	77	80 a	100	1.63 a
1	N	40	73	88	89 a	0	1.53 a

*Values with the same subscript letter are not significantly different.

Figure 5.--Hypocotyl symptoms of R. solani and 1 lb/A trifluralin without PCNB (9); with PCNB (12).

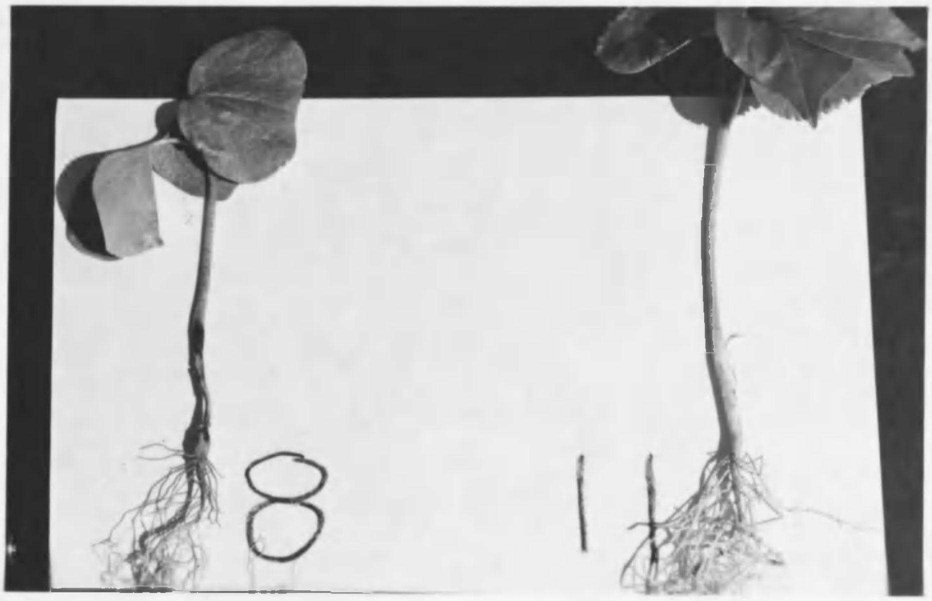

Figure 6.--Hypocotyl symptoms of R. solani and 1/2 lb/A trifluralin without PCNB (8); with PCNB (11).

In test V there was a significant difference in plant weight between those treatments where *R. solani* was applied without PCNB as compared to *R. solani* treatments with PCNB. The observed stunting and severity of infection of the seedlings grown in these treatments was reflected in the reduced plant weights. Similar treatments in test VI did not show a significant difference in plant weight.

The plant weights from the remaining treatments in the two tests are in agreement. There was a difference in average plant weight between the two tests. Differences between the two growth periods were assumed to be the major factor for differences in plant weight.

There were no significant differences in hypocotyl infection or plant weights in the trifluralin treatments, when *R. solani* was controlled. In test V there were significant differences in plant weights when *R. solani* was not controlled, but they occured irrespective of trifluralin treatment.

Trifluralin and Four Concentrations of Rhizoctonia solani on Cotton Seedlings

Data was obtained from three experiments on percent emergence at three dates after planting, hypocotyl infection, and fresh weight of cotton seedlings grown in soil treated with four levels of *R. solani* and two rates of trifluralin. Data from tests (VII, VIII, and IX) are summarized in tables 7, 8, 9, and 10. Damping-off percentages were calculated from test VII and are presented in figures 8, 9, and 10.

Results from test VII indicated a significant reduction in emergence 18 days after planting with the N and N/4 R. solani concentrations when no trifluralin was applied. This trend was not significant when trifluralin was present.

In tests VIII and IX there were no significant differences in the percent emergence data. The higher emergence obtained in these tests were attributed to the increased mean temperature (2, 12) as compared to that of test VII.

There was a general tendency in the three tests for increasing seedling emergence with decreasing concentrations of R. solani regardless of herbicide treatment.

The hypocotyl infection data showed a direct relationship between R. solani concentration and the degree of infection. There were reductions in percent infection with decreasing levels of R. solani. The hypocotyl infection data indicated no interaction between rates of trifluralin and concentration of R. solani.

The damping-off data (figures 8, 9, and 10) indicated an increased damping-off with increased R. solani concentrations. The maximum incidence of damping-off was obtained at the N level of R. solani regardless of trifluralin treatment. At the N/4 level the

TABLE 7.--Percent emergence, hypocotyl infection, and fresh weights of cotton seedlings grown at a mean soil temperature of 74°F following soil applications of trifluralin and R. solani (test VII).

Treatments		Percent emergence			Hypocotyl infection at harvest* (percent)	Average weight of plant at harvest* (grams)
Trifluralin lb/A	R. solani level	9 days	14 days	18 days*		
0	N	23	29	29 d	100 a	0.95 def
0	N/4	25	39	42 cd	97 ab	1.03 def
0	N/16	39	59	70 abc	88 abcd	1.68 bc
0	N/64	65	75	78 a	80 d	2.38 a
0	0	51	63	73 ab	0 e	2.65 a
1/2	N	46	51	58 abc	100 a	0.78 e
1/2	N/4	46	60	61 abc	100 a	0.65 f
1/2	N/16	34	56	64 abc	89 abcd	1.00 cdef
1/2	N/64	60	67	71 abc	86 abcd	1.35 cde
1/2	0	41	58	68 abc	0 e	2.23 ab
1	N	38	43	46 bcd	100 a	0.63 f
1	N/4	26	40	47 bcd	100 a	0.88 ef
1	N/16	54	70	77 a	93 abc	1.13 cdef
1	N/64	47	59	65 abc	83 cd	1.33 cde
1	0	15	34	58 abc	0 e	1.53 cd

*Values with the same subscript letter are not significantly different.

TABLE 8.--Percent emergence, hypocotyl infection and fresh weights of cotton seedlings grown at a mean soil temperature of 80°F following soil applications of trifluralin and R. solani (test VIII).

Treatments		Percent emergence			Hypocotyl infection at harvest* (percent)	Average weight of plant at harvest* (grams)
Trifluralin lb/A	R. solani level	5 days	10 days	17 days*		
0	N	22	69	72 a	64 b	2.25 b
0	N/4	27	75	82 a	50 c	2.50 a
0	N/16	26	76	79 a	24 ef	2.70 a
0	N/64	28	74	79 a	15 f	2.60 a
0	0	22	65	82 a	6 g	2.58 a
1/2	N	23	73	74 a	66 ab	1.80 c
1/2	N/4	28	82	85 a	32 de	1.48 d
1/2	N/16	15	72	83 a	21 ef	1.75 c
1/2	N/64	44	88	93 a	10 f	1.90 c
1/2	0	22	76	85 a	0 g	1.93 c
1	N	29	77	82 a	71 a	1.38 d
1	N/4	27	77	84 a	42 c	1.53 d
1	N/16	25	83	89 a	19 ef	1.43 d
1	N/64	39	80	88 a	6 g	1.48 d
1	0	18	68	73 a	0 g	1.43 d

*Values with the same subscript letter are not significantly different.

TABLE 9.--Percent emergence, hypocotyl infection, and fresh weights of cotton seedlings grown at a mean soil temperature of 85°F following soil applications of trifluralin and R. solani (test IX).

Treatments		Percent emergence			Hypocotyl infection at harvest* (percent)	Average weight of plant at harvest* (grams)
Trifluralin lb/A	R. solani level	6 days	9 days	16 days*		
0	N	71	72	76 a	30 a	3.45 a
0	N/4	62	66	69 a	19 b	3.33 a
0	N/16	70	78	78 a	5 d	3.35 a
0	N/64	68	70	71 a	1 d	3.38 a
0	0	72	74	78 a	0 d	1.73 e
1/2	N	81	84	88 a	14 b	2.13 c
1/2	N/4	69	72	72 a	8 cd	2.25 bcd
1/2	N/16	65	68	71 a	6 cd	2.28 bcd
1/2	N/64	74	79	80 a	0 d	2.35 bc
1/2	0	72	77	78 a	0 d	2.50 b
1	N	78	81	81 a	17 b	1.73 e
1	N/4	75	79	80 a	4 d	1.78 e
1	N/16	80	81	82 a	1 d	1.78 e
1	N/64	70	82	82 a	0 d	1.73 e
1	0	72	77	79 a	0 d	1.93 de

*Values with the same subscript letter are not significantly different.

TABLE 10.--Hypocotyl infection of cotton seedlings grown at three temperatures in soil treated with R. solani and trifluralin.

Treatments		Percent infection*		
		Mean temperature of experiment		
Trifluralin lb/A	R. solani level	74°F	80°F	85°F
0	N	100 a	64 b	30 a
0	N/4	97 ab	50 c	19 b
0	N/16	88 abcd	24 ef	5 d
0	N/64	80 d	15 f	1 d
0	0	0 e	6 g	0 d
1/2	N	100 a	66 ab	14 b
1/2	N/4	100 a	32 de	8 cd
1/2	N/16	89 abcd	21 ef	6 cd
1/2	N/64	89 abcd	10 f	0 d
1/2	0	0 e	0 g	0 d
1	N	100 a	71 a	17 b
1	N/4	100 a	42 c	4 d
1	N/16	93 abc	19 ef	1 d
1	N/64	83 cd	6 g	0 d
1	0	0 e	0 g	0 d

*Values with the same subscript letter are not significantly different.

Figure 7.--Soreshin symptoms on cotton seedlings following soil applications of five concentrations of R. solani and 1/2 lb/A trifluralin. (6) 0 level, (9) N level, (10) N/4 level, (11) N/16 level, (12) N/64 level.

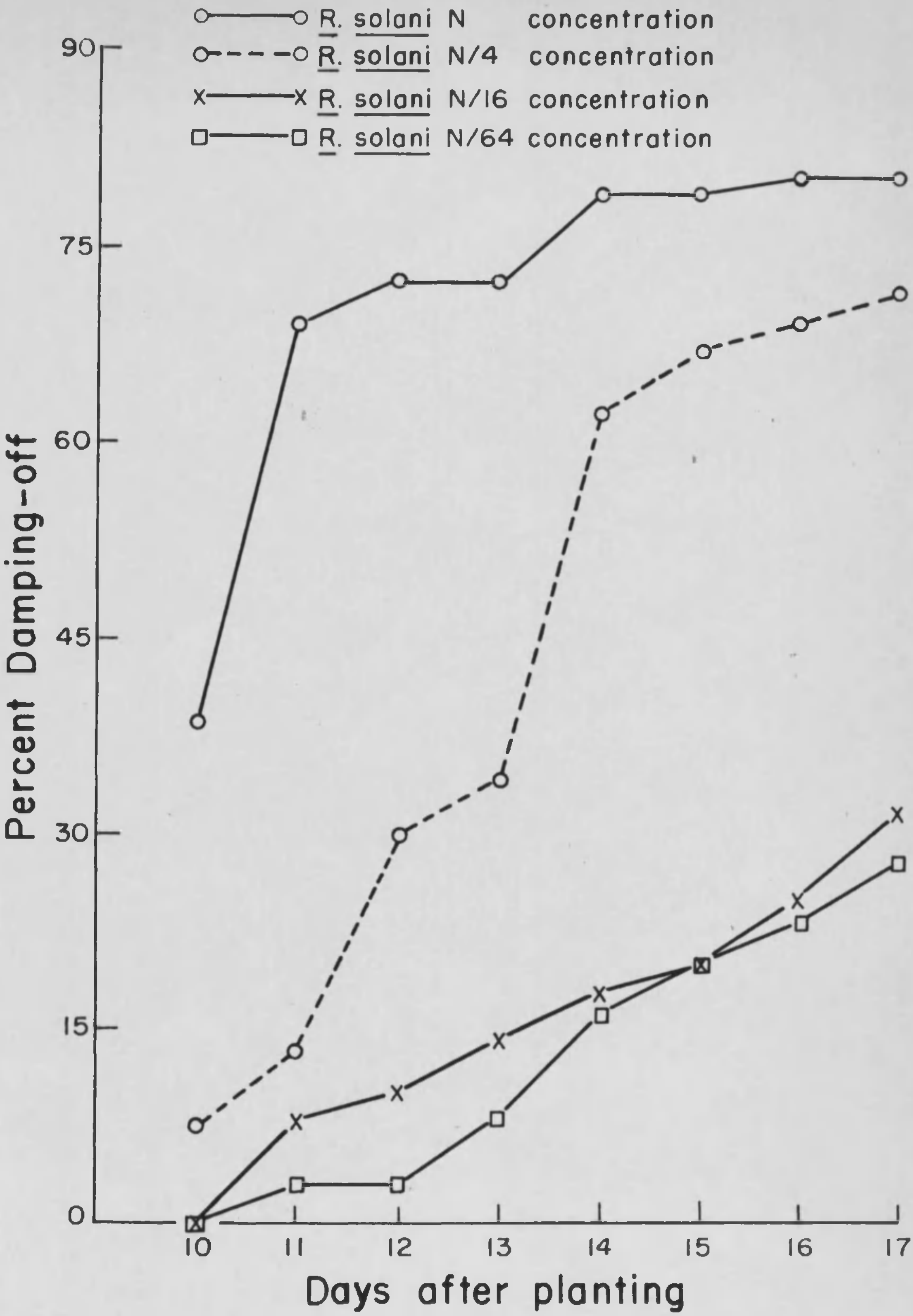

Figure 8. --Damping-off of cotton seedlings grown in soil treated with four concentrations of R. solani.

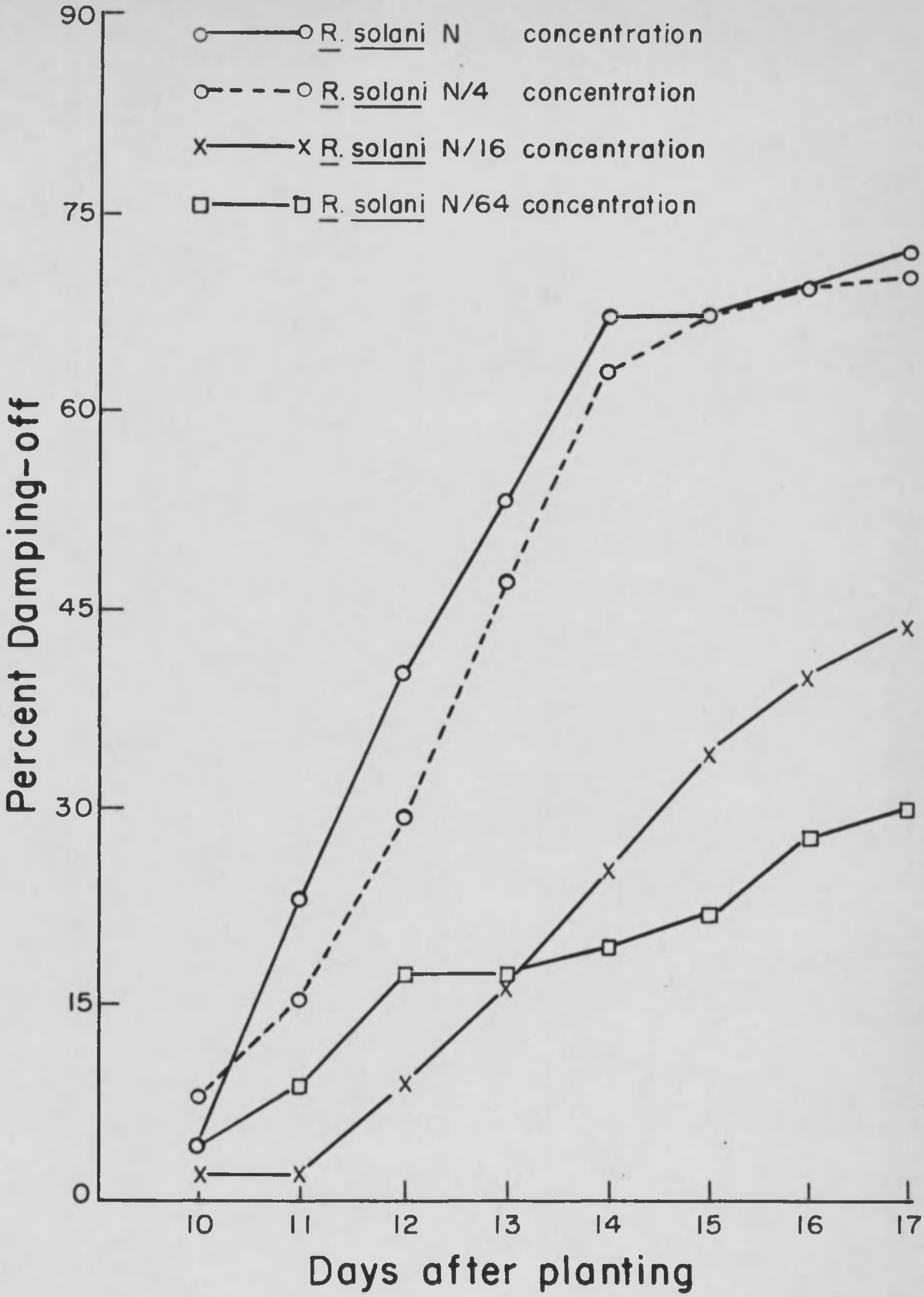

Figure 9.--Damping off of cotton seedlings in soil treated with 1/2 lb/A trifluralin and four concentrations of *R. solani*.

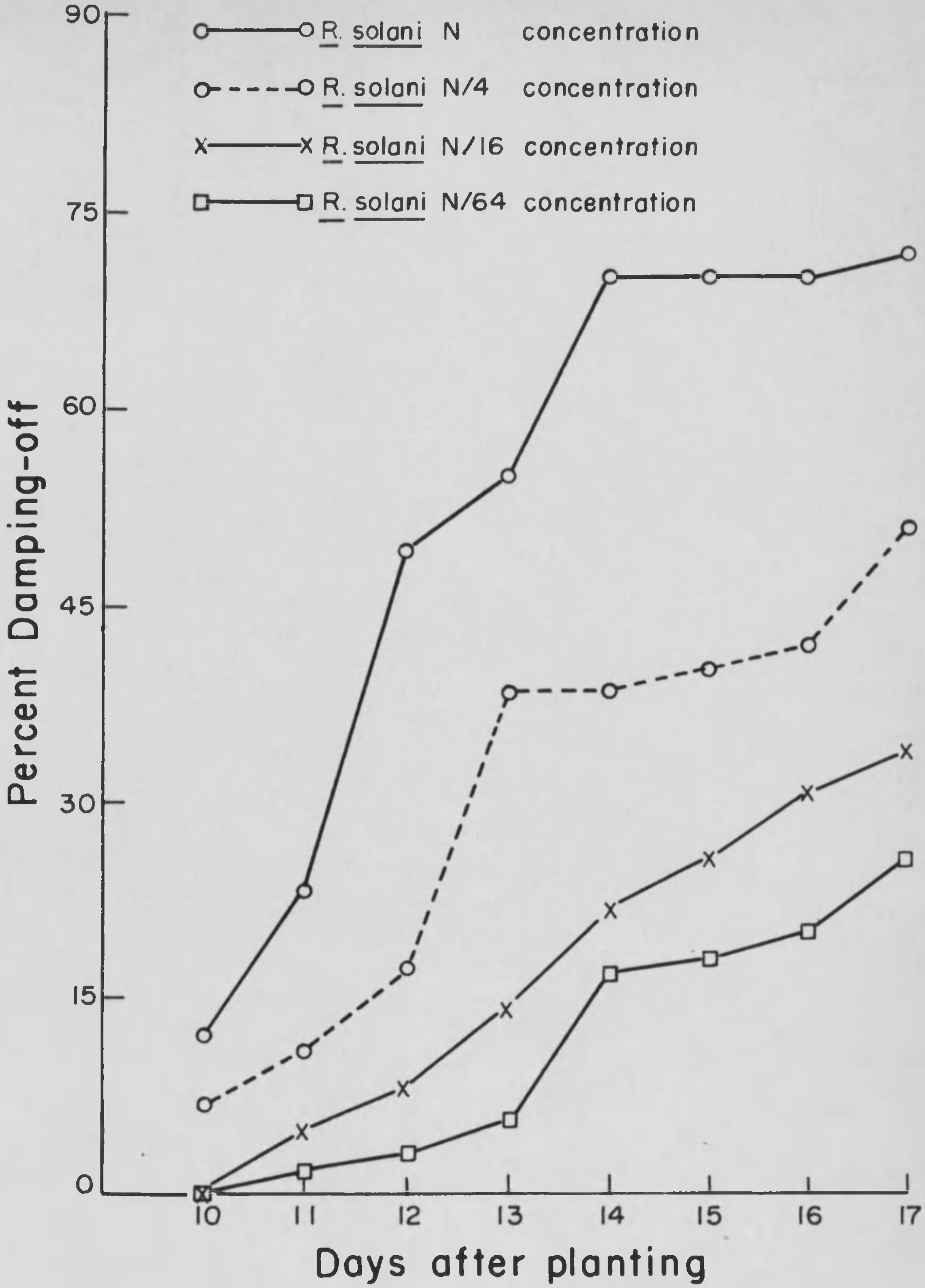

Figure 10. --Damping-off of cotton seedlings grown in soil treated with 1 lb/A trifluralin and four concentrations of R. solani.

Figure 11.--Fifteen-day-old cotton seedlings following soil applications of trifluralin and R. solani resulting in severe damping-off when the disease was not controlled. Left tray: R. solani. Right tray: 1/2 lb/A trifluralin and R. solani.

damping-off results were the same at the 0 and 1/2 lb/A trifluralin rates, whereas the 1 lb/A treatment was about 20 percent less. The percent damping-off for the N/16 and N/64 levels were in close agreement irrespective of herbicide treatment.

The fresh weight data from these tests were in relative agreement with tests V and VI. There was a significant difference in plant weight between the untreated checks and herbicide treatments.

The plant weights from the four R. solani concentrations of test VII indicated increased plant weight with decreasing fungus concentrations. This same trend existed when the R. solani levels are present with the herbicide treatments.

In test IX, the fungus treatments with 0, 1/2, and 1 lb/A trifluralin indicated no significant difference between the individual levels of inoculum. This may have been due to the low degree of infection in this test.

The emergence and development of a cotton seedling is a complex process influenced by many factors (6, 12, 22). The presence of seedling diseases, herbicides, and fungicides adds to the complexity of this process. In the study of the effects of R. solani, trifluralin, and PCNB on cotton seedlings, each of these factors should be considered under specific conditions and subsequently examined in combined treatments.

Cotton is a warm season crop, with temperature being a major factor limiting its geographical distribution (11, 12). Temperature is also directly related to the pathogenicity of R. solani and its specific host relations (3, 21, 23, 35).

In these studies, trifluralin reduced the weight of cotton seedlings. As the rates were increased from 1/2 to 8 lb/A, severe reductions in secondary root development and plant size were evident. Trifluralin also caused extreme brittleness of the primary and secondary roots.

It has been established that temperature greatly influence the pathogenicity of R. solani at ranges of 60° to 77°F. This temperature range compares quites closely to the soil temperatures of early-planted cotton. Since optimum germinating temperatures are in the 80° to 97°F range, it is feasible to assume that the temperature range during early plantings would enhance the disease and restrict the development of the cotton seedling. The increased pathogenicity of R. solani was evident by the reduction in seedling emergence and the increased severity of damping-off when cotton seedlings were grown at average temperatures of 73° and 74°F. It was also found that the degree of infection was not significantly altered by the trifluralin treatment, when compared at these two temperatures.

It has been indicated that there are many other factors involved that may affect the pathogenicity of R. solani or influence the susceptibility of the cotton seedling to this disease. The restricted root development of cotton seedlings grown in trifluralin-treated soil may be one of these factors. Boyle and Hauser (10) concluded from their work that herbicide injury to the roots of peanuts increased R. solani infection.

Although it is quite evident that trifluralin influenced root development, there was no evidence in these studies to indicate that the cotton plants were more susceptible to any of the concentrations of R. solani following soil applications of the herbicide.

There are two possibilities that might explain the lack of agreement between these tests. Boyle and Hauser (10) indicated a necrotic injury of the roots from sesone applications. Roots examined from the trifluralin treatments showed secondary root inhibition, but no apparent tissue injury from the herbicide. It is reported (13, 25) that hypocotyl and root epidermal wounds will enhance the invasion by R. solani.

It is also suggested that sesone (a phenoxy compound) may have stimulated secondary or adventious root development in the peanuts, whereas trifluralin inhibited secondary root development.

Arndt (3) states that "any environmental condition that delays the formation of a complete periderm greatly predisposes the seedling to infection by fungi." Since the periderm cannot form a complete protective cylinder, for some time, after the cortex is ruptured by secondary roots, there is the possibility of this lower hypocotyl region being more susceptible to R. solani infection.

The limits of this study can hardly attempt to account for any anatomical differences in the hypocotyl region of the cotton plant when grown in trifluralin-treated soil. The possibility of the above assumption can only be ascertained by thorough microscopic and histological evaluation.

When R. solani, PCNB, and trifluralin were studied, temperature was the primary factor in the reduction of seedling emergence when R. solani was not controlled. These results were in agreement with Boyle et al. (9) work with peanuts. The increased seedling emergence under sub-optimum growing conditions indicated the effectiveness of PCNB to control the pathogen under these conditions.

Although a significant reduction in seedling plant weight was measured from all PCNB treatments, it is felt that this is of little importance. The severity of R. solani greatly exceeds the temporary stunting of the cotton seedling by PCNB.

The lack of reports by various workers on PCNB injury to cotton seedlings might question the reduced seedling weight and stunting obtained in this study. One possibility in the differences arises from the methods of treatment. Most workers apply the fungicide to the seed line and that zone of soil immediately above the seed. Since PCNB does not move in the soil solution, it would appear that the roots would not be growing in soil treated in the above manner. However, the treatment method used in this test (fungicide mixed throughout the soil) forced cotton roots to grow in the treated zone.

The relative importance of *R. solani* concentrations can be influenced by soil temperature. Working with four levels of inoculum at 73°F resulted in severe *R. solani* infection at all levels. However, these same concentrations did not cause a similar degree of infection on cotton seedlings grown at temperatures of 80° to 84°F. Thus low levels of *R. solani* are not indicative of the potential hazards, since optimum pathogen temperatures will accentuate the severity of this disease.

The completion of this study has raised several questions; among them is the pathogenicity range of mixed-isolate cultures of several pathogens as compared to a single pathogen. This is especially important when one considers that seedling diseases are caused by several soil fungi. Another area that relates to this is the effects of non-sterilized soil with a natural infection as compared to sterilized soil with inoculated pathogens.

The possibility of these being additional experimental variations, suggest that further studies with herbicide-disease relations should include complexed pathogen populations in both sterilized soil and naturally infected soils.

The use of trifluralin as a soil-incorporated herbicide would tend to restrict the compound in the upper soil surface. Normal planting procedures would place the seed in the treated zone. Germination and root development under normal conditions would extend above and below this zone in the early days of seedling growth. Subsequently, the effects of trifluralin on the cotton seedling in the field should be less than on those grown in confined containers in the greenhouse where the roots were restricted to the trifluralin-treated soil. If sub-optimal soil temperatures prevailed in the field restricting the roots to the trifluralin-treated zone, it appears that results would be similar to those obtained in the greenhouse.

When conditions were adverse to cotton plant growth or favored the pathogen the presence of _R. solani_ might result in loss of stand if not controlled.

The control of _R. solani_ is essential to insure cotton stand establishment under adverse conditions. Regardless of where these conditions exist, fungicide treatment should be used where seedling diseases are anticipated to insure maximum benefits from preemergence herbicides.

SUMMARY

This study was undertaken to determine the effects of a herbicide and a soil-borne fungus on cotton seedlings under greenhouse conditions.

This investigation was conducted to study several phases of activity with the herbicide, pathogen, and fungicide involved. Experiments were designed to study the pathogenicity of *R. solani* on cotton seedlings under varied environmental conditions. Cotton seedlings were grown in soil treated with 0 to 8 lb/A of trifluralin. Data were collected to determine the effects of the herbicide on plant growth. The effectiveness of PCNB on the pathogen and its effects on cotton seedlings were studied in several experiments.

The herbicide, pathogen, and fungicide were studied in combined treatments and at temperature averages of 73° and 82°F.

The relative effects of four concentrations of *R. solani* were studied in combination with three rates of trifluralin on cotton seedlings at temperature means of 74°, 80° and 85°F.

The results of these studies may be summarized as follows:

1. Fresh weight of cotton seedlings grown in soil treated with 1/2 to 8 lb/A rates of trifluralin were significantly reduced from those of the check.

2. Trifluralin caused more inhibition of roots than of top growth.
3. PCNB was effective in controlling _R. solani_ at rates of 15 to 60 lb/A. There was a significant reduction in weight of cotton seedlings at all rates tested.
4. There was no significant interaction in percent emergence or hypocotyl infection of cotton seedlings, when _R. solani_ was inoculated in soil treated with 0, 1/2, and 1 lb/A trifluralin.
5. The addition of PCNB to _R. solani_ and trifluralin-treated soil significantly increased cotton emergence and fresh weight and significantly decreased hypocotyl infection at 73°F.
6. Hypocotyl infection on cotton grown in soil treated with _R. solani_ and trifluralin did not indicate an enhancement of the pathogenicity of the fungus by the herbicide.
7. The influence of temperature on the pathogenicity of _R. solani_ was evident when compared in tests conducted at 73° and 85°F. A significantly higher hypocotyl infection on cotton seedlings was obtained in the tests conducted at the lower temperature range.

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