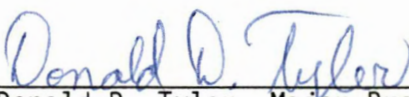


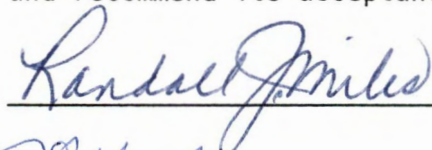
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I am submitting herewith a thesis written by Constance L. Neely entitled "Cover Crop, Nitrogen and Tillage Effects on Cotton as Indicated by Petiole Analysis." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

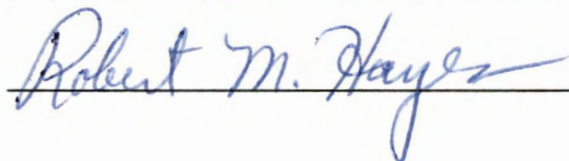


Donald D. Tyler, Major Professor

We have read this thesis
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Accepted for the Council:



Vice Chancellor
Graduate Studies and Research

COVER CROP, NITROGEN, AND TILLAGE EFFECTS ON COTTON
AS INDICATED BY PETIOLE ANALYSIS

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Constance L. Neely

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ABSTRACT

Soil erosion is a major problem in the Southeast. This, coupled with the increasing cost of nitrogen fertilizer, has made no-tillage and the use of leguminous cover crops more attractive. Many problems have been solved in no-till grain crop production, whereas very little research has been done in no-till cotton production, especially involving legume covers.

Field experiments were conducted at Jackson and at Milan, Tennessee, during 1981 and 1982. Objectives of these experiments were to determine the effect of different cover crops, tillage systems, and nitrogen rates on cotton height and lint yield. The tillage systems were conventional (CT) and no-tillage (NT). The covers were no winter cover (NC), rye (R), vetch (V), or a rye-vetch (RV) mixture. The four nitrogen rates were 0, 34, 67, or 101 kg/ha.

Petiole analysis was used as a possible indicator of the plant N status. Ammonium nitrate or foliar urea (F) was applied based on this analysis. Petioles of cotton grown in vetch had high $\text{NO}_3\text{-N}$ content, while those of cotton following rye were low. No cover and rye-vetch produced cotton petioles with intermediate $\text{NO}_3\text{-N}$ content. In 1981 cover affected petiole $\text{NO}_3\text{-N}$ content at Jackson, and cover by tillage interactions and N rate affected petiole $\text{NO}_3\text{-N}$ content at Milan. In 1982 cover, tillage, and nitrogen interacted to affect petiole $\text{NO}_3\text{-N}$ at both locations. Petiole $\text{NO}_3\text{-N}$ content increased with increasing N rate; however, even at higher N rates, petioles of cotton grown in rye were deficient in $\text{NO}_3\text{-N}$.

Cotton grown in NC produced the highest yields followed by R and RV. Where cover was present, CT cotton outyielded NT. Cotton grown in V grew more vegetatively, matured later, and had lower lint yields as compared to other treatments. Cotton grown in NC and R matured earliest, with that grown in RV being intermediate in maturity. Foliar fertilization had no consistent effect on lint yield. Changes in lint yield were minimal and were of no practical significance. Yields were not significantly different in the NT-NC cotton and CT-NC cotton. Yields were reduced when cotton was no-tilled into a heavy mulch. Tillage in the absence of a heavy mulch was not necessary for maximum yields.

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CHAPTER I

INTRODUCTION

Cotton production is widespread in the southwestern part of Tennessee. In 1982, 110,000 hectares were grown with an average lint yield of 750 kg/ha. It is grown predominantly on highly erosive upland silt loams. The cultural practices associated with cotton production have contributed to excessive erosion in many instances. It is a clean cultivated crop and land preparation often begins in fall or early spring; and soil loss in some fields exceeds 65 T/ha/yr. This, coupled with increasing cost of fuel and fertilizer production, has prompted the introduction of no-tillage systems and the reintroduction of winter legume and nonlegume cover crops.

The cotton plant can respond dramatically to deficient or excessive nitrogen. Nitrogen rates are difficult to predict because of soil N losses, differences in soil N mineralization, and the interaction of the plant with other environmental factors such as temperature and water. Excess N often results in excess vegetative growth, delayed maturity, and reduced harvest efficiency. Current N recommendations are 67-90 kg/ha on upland soils, but many data show no significant yield increases to more than 34 kg/ha. Petiole analysis is being widely researched in an attempt to evaluate the N status of cotton and to avoid the addition of excessive amounts of N to the plant. This has been used extensively in Arkansas (Maples et al., 1977) where petiole analysis is available to producers. Samples are

taken at random from fields and sent in to the University of Arkansas for analysis. Recommendations for additional N, either soil applied or in the form of foliar urea, are made as indicated by the petiole analysis. Research has not been done to determine the validity of this practice in Tennessee.

Cover crops have been evaluated in cotton cropping systems as well as other row crop systems (Long and Overton, 1963; Bailey et al., 1930). Advantages of nitrogen fixing legumes and nonlegumes as covers are well known. A cover crop could be seeded before cotton matures and it would provide protection of soil during months with high rainfall. Chemically killing cover crops in the spring and no-tilling cotton can cut soil loss to less than 1 T/ha/yr. Much research has been conducted on green manure crops for cotton but none where no-tillage cotton followed winter cover crops. Petiole analysis as an indicator of plant $\text{NO}_3\text{-N}$ has not been evaluated with no-tillage cotton or the use of cover crops.

Experiments were conducted to compare cotton conventionally or no-till planted into four cover crops at four N rates. The primary objectives of these experiments were to:

- a. determine the effect of tillage, N rate, and cover crops on cotton petiole $\text{NO}_3\text{-N}$, cotton lint yield, maturity, and quality;
- b. determine the effect of foliar applied urea on petiole $\text{NO}_3\text{-N}$ and lint yield.
- c. determine the effect of tillage, N rate, and cover crops on soil N, soil temperature, soil water, and plant height.

CHAPTER II

LITERATURE REVIEW

Erosion and Tillage

It has long been recognized that certain cultural practices in cotton production cause an increase in erosion on uplands. Erosion has been found to be a selective process in that greater amounts of soil nutrients are present in eroded material. This leads to decreased organic matter, soil fertility, and causes textural changes on cropland. (Stoltenburg and White, 1953). Johnson et al. (1979) found that conservation tillage systems reduced erosion by 40% and also reduced soil loss by 60 to 90%. Soil loss directly affected the loss of N and P. Reduced runoff is an important benefit to a farming system where residue use and no-tillage are practiced.

Cotton Production and Tillage

There has been little research comparing conventionally or no-till planted cotton in the southeastern United States. Mullins et al. (1977) compared cotton planted on three soil types with treatments of conventional seedbed preparation, bedded seedbeds, and no seedbed preparation where a previous cotton crop was followed. Four levels of traffic--no, low, medium, and high--were studied. No-tillage cotton under any traffic frequency had the least depth to traffic pan and had the shortest tap root length. Yields were not significantly different within soil type. However, the third year of the

experiment the no-till plots were abandoned due to poor seedling emergence due mostly to inadequate no-tillage planting equipment.

Dumas (1979) compared rotary till, strip rotary till, and no-tillage cotton planted after crimson clover. Inadequate cotton plant stands were prevalent the first year due to the mulch preventing adequate soil-seed contact. A change in equipment allowed this to be corrected. Average yields over the four years were not significantly different.

Porterfield and Davidson (1974) conducted a five-year non-irrigated study on two soil types in Oklahoma and found that yields were enhanced by tillage performed prior to, at, and after emergence. Subsoiling, precision tillage, and bedding in the same operation have been shown to successfully increase cotton yields on sandy and sandy loam soils (Carter, 1965). In Mississippi, subsoiling in fragipan soils increased yields 100%; however, no response was found in heavy clay soil. Edwards (1964) saw no yield reduction on heavy clay soil where cotton was planted in a previous crop bed with no primary tillage. Cook (1971) found yields as high or higher with fall subsoiled beds than conventional tillage treatments in a three-year test.

Carter and Colwick (1971) reported that the zone concept or optimum tillage reduced the number of operations in cotton production and reduced the total energy input and cost of production with no significant differences in yield. Sistler and Smith (1981) compared conventional and reduced-tillage cotton production systems in an

energy model and found that reduced-tillage would promote energy savings and reduce soil loss.

Cover Crops for Cotton Production

Winter cover crops have been successfully utilized in the production of cotton. When incorporated into the soil, green manure crops can add or maintain organic matter. (Rogers and Giddens, 1957). Leguminous covers have been popular for cotton and other row crops. In 1938, over one million dollars was spent for winter legume seed and inoculation (Coleman, 1939). About 13 million acres of green manure crops were grown in the Southeast in 1940. (Rogers and Giddens, 1957). In the south, leguminous crops most commonly used for winter cover and green manure were Austrian winter peas and vetch. Crimson clover has been used in the northern part of the cotton belt, but establishment was a problem. Other legume covers include alfalfa, Bur clover, button clover, red clover, cow peas, lespedeza, yellow melilotus, and blue lupine (Rogers and Giddens, 1957).

At the Mississippi Holly Springs Branch station on a Grenada silt loam, cotton planted following a previous crop, Austrian winter peas, or with commercial fertilizer produced 670, 916, and 1,018 pounds of seed cotton per acre in a 5-year average. A nine-year study on Lintonia silt loam revealed that cotton following hairy vetch yielded 1,319 pounds of seed cotton and cotton following an application of 40 kg/ha N yielded 1,503 pounds seed cotton per acre (Coleman, 1939).

In a comparison of five soils, very little differences in cotton yield were found following hairy vetch, Austrian winter peas, crimson clover, or 27 kg/ha N. Bur clover was also a treatment but establishment was a problem. Button clover as a green manure crop for cotton was studied and found to be as effective as 56 to 67 kg of N in increasing yields of cotton over five- and seven-year experiments (Long and Overton, 1963).

Bailey et al. (1930) performed a comprehensive study on the effect of cover crops on corn and cotton yields. Cotton yields following vetch were about the same as where 56 kg/ha N were applied. Residue from vetch and annual yellow melilotus turned under from 1925 to 1927 resulted in an average increase of 251 kg/ha of seed cotton in 1928 and similarly increased corn 82 kg/ha. Grissom (1950) found also that hairy vetch as a cover crop was equivalent to applications of 45 to 67 kg N/ha; however, he found that cotton stands were poor 50% of the time due to insect damage. He concluded that vetch should be turned under two to three weeks prior to planting to obtain an adequate stand of cotton. It was found that the higher cotton yields were obtained when hairy vetch was turned under on March 25 rather than April 5 or 15. This indicates that early planting of cotton or early decomposition of vetch is more important than the increased growth of the vetch (Alabama, 1929).

Buie (1920) found that rye has apparently harmful effects on cotton after it is turned under. At the time of year the rye is turned under, soil N is being slowly mineralized. The micro-organisms responsible for decomposition of rye straw in the soil

require nitrogen for their activity and may utilize the soil supply, resulting in N deficiency. The N composition of several winter crops was reported as follows: Austrian peas (1.69%), crimson clover (2.35%), hairy vetch (3.21%), vetch plus rye (1.15%), and rye (1.06%). Delayed turning of winter legumes until about the time they flower will result in the addition of more total N/ha, but significant N is added when turned under at even earlier stages. The use of non-legumes gave no beneficial results on the succeeding cotton crop (Grissom, 1950). Grissom found that after 12 years of rye as a cover crop, organic matter (O.M.) content was not increased, with N fertilizer increasing O.M. 0.2% and vetch increasing O.M. content 0.3%. Buie (1929) found that rye resulted in depletion of soil N during decomposition, but provided an excellent crop to conserve available plant food as well as prevent erosion and maintain or increase organic matter.

Kamprath et al. (1958) found that the heavier the soil texture, the greater the dry matter production of vetch. The benefit of the cover is related to the dry matter. He found that seed cotton yields were higher after Austrian winter peas than hairy vetch. This related to excessive cotton growth after hairy vetch due to larger amounts of N in the soil. After nine years in a cotton-corn rotation, total N content of the surface soil was significantly higher where legumes had been grown compared to non-legumes or no-cover situations. Yields of winter cover crops were not increased by N application.

Nitrogen and Tillage Practices

Bandel et al. (1975) compared corn yields from different rates of applied N under no-till and conventional culture. At suboptimal levels of N, more severe deficiency symptoms were evident under no-till culture. With optimal N levels there was no difference in the yield of no-till and conventional corn. Distribution of N in the root zone at a given rate of applied N was similar in no-till and tilled plots. MacMahon and Thomas (1976) found greater anion leaching rates in soils under no-tillage systems. They attributed the excessive loss of $\text{NO}_3\text{-N}$ under killed sod to greater $\text{NO}_3\text{-N}$ leaching through the larger pores. No-till corn yielded higher in killed sod in dry years and equivalent to conventional till in wetter years. They further reported that higher N rates may be required when corn is grown in killed sod compared to conventionally tilled corn.

Bennett et al. (1975) found striking differences in the amount of soil N and mineralizable N developed between conventionally plowed plots and no-tilled plots in the first year. This was attributed to the net accumulation of N with no-tillage and net loss of N with plowing.

Growth Habit of Cotton

Cotton is recognized as a striking example of plant adaptation through breeding and selection. In its wild state it is basically a perennial woody shrub which has a semidesert habitat and requires a very long, hot growing season. To be produced successfully in the Southeast and many other areas of the United States, it is planted

long before the arrival of favorable weather conditions for its growth (Tharpe, 1965). The optimum soil temperature for germination and seedling development is 34°C, but in Tennessee planting begins when soil temperatures reach about 20°C. Small deviations from optimum can cause slower germination and slower shoot and primary root elongation.

The cotton plant has an indeterminant growth habit and possesses dimorphic branches. Depending on the environmental conditions, branches produced are either vegetative or fruiting. Upland cottons of the south produce variable proportions of the two (Tucker and Tucker, 1968).

Effect of N on Cotton

Nitrogen influences growth and fruiting behavior and can be of great importance in the increased yield of cotton. Nitrogen additions have been used since before the Civil War. Tucker and Tucker (1968) note that it is no coincidence that yields of cotton have increased concurrently with increased uses of N fertilizers. In 1959, 63% of the cotton was fertilized with an average of 77 kg/ha. Maples and Keogh (1973) report that N is the first limiting element for cotton on delta soils and note that the N applied annually to cotton is greater than all other fertilizer elements combined. Nitrogen fertilizer increases total yield by prolonging the fruiting period. A lack of N causes the cotton plant to become more determinant by reducing the late summer top growth and reducing late boll load. Moderate amounts of N cause longer internodes, early square

shedding, and the occurrence of flowers higher on the main stalk and further out on the fruiting branches.(Tucker and Tucker, 1968).

Nitrogen hastens maturity, delays maturity, or shows no effect at all. Nitrogen affects boll size, lint fiber quality and length. A constant supply should be available throughout the life cycle. The length of the growing season, soil moisture conditions, early- to mid-season insect damage, level of nutrients, rate of N application, and initial N content of the soil all affect the N effect on earliness.(Tharpe, 1965). In cotton producing states much research has been done to establish the proper N rates to obtain the highest yield and quality.

Soil Temperature and Soil Moisture Effects on Cotton

Temperature of the soil in the seed zone is the most important variable during the planting season and perhaps results either directly or indirectly in more failures than all factors combined (Elliot, 1968). The minimum soil temperature for both germination and early seedling growth of upland varieties averages about 16°C, and the maximum about 39°C. The optimum soil temperature at which germination takes place earliest and at which most rapid seedling growth can be expected is 34°C (Tharpe, 1965). Any deviation from optimum can slow germination rate, shoot elongation, and primary root elongation rates.

Hudspeth et al. (1960) of Texas found that maximum emergence of the plants occurred when soil temperature was 18°C or above for ten days prior to planting. Seed germination is dependent not only

on the right temperature at planting, but also on the occurrence of previous and following day temperatures in the soil.

Optimum soil temperature for cotton seed germination is between 29°C and 34°C . In west Tennessee cotton planting cannot wait for this soil temperature range because when planted late, cotton becomes more vulnerable to insects, early summer droughts, early fall rains, and early winter freezes. In this respect, the planting date must be balanced between lower soil temperature and late season planting. In general, planting takes place thirty days after the last killing frost. In Tennessee, cotton is usually planted when the soil temperature at a two-inch depth is 20°C , which is usually attained between April 20 and May 10.

Soil temperature plays a role in other stages of development, but it is most important at germination and during seedling development. Low soil temperatures may reduce the rate of root penetration into moist soil, the rate of water flow to the root, and root membrane permeability (Tew, 1963). Under favorable conditions, the plant will soon develop roots deep enough into the soil such that soil temperature fluctuations are minimal. Quality of planted seed is a major factor in the way soil temperature affects seedling development (Riley et al., 1964).

The soil moisture content at planting is also extremely significant. According to some research, during the germination and emergence phase of cotton plant development, there is little variation in growth responses to graduations between a soil moisture content just above the wilting point and one equaling field capacity of

the soil (Tharpe, 1965). The cotton plant uses relatively little moisture early in the season. At this time leaf area is small and the root system is shallow, particularly if soil temperatures are low (Rugh, 1973). However, other research states that preservation of moisture during emergence is the major problem in planting (Elliot et al., 1968). Inadequate moisture can extend time to emergence. For optimum growth conditions, soil should have 60% of its pore space filled with water and 40% with air (Collings, 1926).

As the seedling grows, soil moisture has a significant effect on the root system. If the soil is too wet, a shallow root system is developed. Excess water also lowers temperature and causes poor aeration (Brown, 1938). If the temperatures are cool and there is excess moisture when plants first emerge, processes of growth as well as root development will be delayed. If the soil water is inadequate this also impedes plant development. Drying winds draw water from tissues and cause cells to collapse. This leads to disorganization and permanent injury in the form of stunting. Soil mulches can be beneficial at this stage as they increase temperature, preserve moisture, and prevent crusting (Elliot, 1968).

If cotton is stressed for moisture early in the season and later given adequate moisture, it becomes rangy, fruiting is delayed, and yield is reduced. If roots are deep they can utilize soil moisture in a greater volume of soil. Root growth rate is controlled by temperature provided soil has sufficient moisture and O_2 (Balls, 1915).

Plant Analysis for Nitrogen

Armstrong and Albert analyzed cotton plants for total N in 1926 and 1927. They found that the percentage of N in all plant parts was greater under low N rates regardless of favorable or unfavorable conditions during the test period. They showed that 80% of the plant N was in the leaves when the first few squares were present and this was reduced to 30 to 55% when a full load of fruit had been produced. The bolls and particularly the seed contained 40 to 60% of the plants' nitrogen--a considerable proportion of the N in the latter part of the season. Roots contained little N. Cotton grown under low (0 kg) and high (101 kg) N followed this same trend as just indicated. At the end of the season there was a greater difference than was found in 1926 as compared to the 1927 data which showed very little difference in the percentage of N in the leaves and bolls.

Reports of the change in N content of the plant parts with stage of development led to research to determine the $\text{NO}_3\text{-N}$ level in the plant as $\text{NO}_3\text{-N}$ represents a reserve of the unassimilated N in the plant and this storage form doesn't usually accumulate unless the other N compounds and proteins are high.

Howard Joham (1951) determined which portion of the plant would be most suitable and sensitive as an index for N plant status. He determined this by looking at (a) the ease of handling of the particular part of the plant to be sampled, (b) the concentration of the various nutrients within the tissue, and (c) the response of these concentrations to variations in the substrate. Petioles of the

main stem were consistently higher in $\text{NO}_3\text{-N}$ and K. The $\text{NO}_3\text{-N}$ of the main stem increased with concentration as the stem apex was approached. Leaf blades were noticeably higher in P although petioles maintained a concentration of P which was favorable for the analysis being employed. He found that petioles from the main stem taken from the third and fourth nodes from the apex most nearly satisfied their requirements for sampling. The levels of five nutrients which were determined in the petioles by colorimetric and turbidimetric methods reflected the availability of the individual ions in the substrate. In 90-day-old plants positive correlations were obtained when petiole N, P, K, Ca, and Mg were compared with their respective concentrations in the growth substrate. From these tests it was evident that tissue tests could play an important part in determining the nutritional status in the cotton plant. Indications of deficiency may be obtained in advance of the typical deficiency symptoms. The chief interest of the agronomist in $\text{NO}_3\text{-N}$ lies in its use as an indicator of N nutritional status. A single critical value of $\text{NO}_3\text{-N}$ is desired. Unfortunately, a single value cannot be given because the level changes with advancing stages of development.

At this point the subject was approached from the standpoint of utilizing chemical analysis as the diagnostic tool rather than total nutrient uptake. MacKenzie et al. (1963), working from 1953 to 1960, studied the seasonal $\text{NO}_3\text{-N}$ content of petioles especially as affected by N application and its relationship to yield. Ammonium nitrate ($\text{NH}_4\text{-NO}_3$) was used as the N source for soil application. They found the $\text{NO}_3\text{-N}$ content of the petiole reflected the N

application. During subsequent sampling dates, petiole $\text{NO}_3\text{-N}$ content increased for a time following N application and then gradually decreased as the season progressed. As N status increased, response declined. There was a close relationship between petiole $\text{NO}_3\text{-N}$ levels at three bloom periods and lint yield. High yields were obtained from treatments which had 16,000; 8,000; and 2,000 ppm $\text{NO}_3\text{-N}$ in the petioles at the early, mid, and late bloom stages. This indicated an adequate supply according to their present recommendations for cotton production. This study established seasonal levels that would be necessary to ensure optimum growth and production. They concluded that $\text{NO}_3\text{-N}$ concentration during growing season was directly related to applied N and that a relationship exists between yield and $\text{NO}_3\text{-N}$ levels during certain stages of bloom. In Arizona, Gardner and Tucker (1967) from 1959 to 1961 applied different N rates to cotton and sampled petioles every two weeks. One treatment received 112 kg N/ha at planting while another was 28 kg N/ha at planting and the remaining 84 kg N/ha on June 22, which should have been prior to first bloom. Another treatment was an application of 28 kg N/ha on June 8 and July 22 and 56 kg N/ha on August 24. The sidedress applications caused an increase in petiole $\text{NO}_3\text{-N}$ whereas in the treatment in which the total applied N was at planting, the petiole concentration decreased. Yields where N was applied prior to bloom were the highest. There was a marked decrease in yield when N was applied considerably after bloom. When N was applied as late as August 24 there was no influence on the petiole concentration.

In Oklahoma, Baker et al. (1970) studied the effects of N application and date on petiole $\text{NO}_3\text{-N}$. They reported that since it does not appear that it would be possible to diagnose a deficiency early enough according to their curve, this diagnostic tool would probably be most suitable for correcting deficiencies on subsequent crops.

In Texas, Sunderman et al. (1979) researched the effect of N application on the $\text{NO}_3\text{-N}$ concentration of cotton petioles to assess the application of plant analysis for determining N status of cotton using lint yield as a criterion. Again, increasing N rate resulted in increased $\text{NO}_3\text{-N}$ in the petiole. However, only a few significant relationships were found between lint yield and concentration even though N fertilizer affected yields at both locations both years. They felt that since petiole analysis levels were different in years--one year of two--the difference in growing season would likely be a major problem in interpreting petiole analysis on a routine basis. It was found that the rate of change in petiole $\text{NO}_3\text{-N}$ with change in N application rate was consistently as great or greater from the peak bloom sample date as any other date, so if only one day were picked to sample, this is the most sensitive time to evaluate $\text{NO}_3\text{-N}$ status. However, this would relegate plant tissue analysis to adjusting N application rates in succeeding seasons as it would be too late to effect much change. It was felt that with longer growing seasons, $\text{NO}_3\text{-N}$ could be determined early enough to effect a change.

At the Cotton Branch Station in Arkansas, Maples et al. (1977) using petiole analysis developed diagnostic criteria for tailoring N fertilizer application to the needs of cotton and checked against yield responses to several rates of applied N. Petiole samples were taken eight times each year at weekly intervals. They were analyzed for $\text{NO}_3\text{-N}$ reflecting the influence of available N and water on the N status of cotton plants. $\text{NO}_3\text{-N}$ analyses were correlated positively with $\text{NO}_3\text{-N}$ analysis of soil and with seed cotton yields. An estimated sufficiency range for petiole $\text{NO}_3\text{-N}$ was then established. When this work was done on the $\text{NO}_3\text{-N}$ levels, P content was checked as well in order to try to evaluate the influence of soil moisture. They reported that a relationship exists between N and P such that if both N and P were low, this would indicate an inadequate moisture condition causing low uptake of N. However, if N was low and P was sufficient, then there was probably an adequate moisture regime, and this implied a N deficiency.

Touchoon et al. (1981) in an experiment that studied petiole N in Alabama showed that $\text{NO}_3\text{-N}$ content was very erratic. It varies greatly with changes in soil moisture more so than it does with applied N rates. Their data could not distinguish between low petiole $\text{NO}_3\text{-N}$ due to low N supply and low petiole N due to other environmental stress such as moisture stress.

Thom and Spurgeon (1982) reported that petiole $\text{NO}_3\text{-N}$ concentration could not be related directly to the observed cotton yields. However, a concentration range was derived from the three years of data from 67, 90, and 112 kg N/ha rates that they felt could be

understandable under similar environmental conditions to identify cotton that has too much N during the fruiting period. This may be helpful in adjusting the recommended N rates when petiole $\text{NO}_3\text{-N}$ deviates widely. This recommendation of urea leads to a very interesting point. No literature has been able to show an increase in petiole $\text{NO}_3\text{-N}$ due to an application of urea. The literature states that most plant leaves contain urea. Urea has been used successfully on fruit and vegetable crops. Neumann in 1978 studied the fertilizer-induced damage of several fertilizer compounds on maize and reported that from the standpoint of avoiding membrane damage urea is a very efficient supplier of N. Yamada et al. (1965) studied cuticular membrane penetration using labeled urea and found that the urea moves as the intact molecules through the cuticular membrane. Based on this reasearch, urea could possibly be used as a foliar fertilizer.

Many questions concerning N fertilization of cotton, whether with foliar urea or other soil applied N sources, remain unanswered. Cotton N relationships planted in legume cover crops under no-tillage management are poorly understood. This thesis attempts to answer some of these remaining questions.

CHAPTER III

METHODS AND MATERIALS

Experiments were conducted at two locations, one at West Tennessee Experiment Station in Jackson, Tennessee, on a Lexington silt loam (fine-silty, mixed, thermic, typic Paleudalf) and the other at the Milan Experiment Station near Milan, Tennessee, on a Loring silt loam (fine-silty, mixed, thermic, typic Fragiudalf).

Experimental design was a randomized complete block with split plot design using four replications. Nitrogen rates were the main plots, covers the sub-plot, tillage the sub-sub plot, and additional nitrogen based on petiole analysis as the sub-sub-sub plot. At Jackson the four N rates were 0, 34, 67, and 101 kg/ha. At Milan the three N rates were 0, 34, and 67 kg/ha. Nitrogen was surface broadcast as ammonium nitrate. The sub-plots four cover situations were vetch (Vicia villosa L., variety not stated), rye (Secale cereale L., variety "Balbo"), a combination of vetch and rye, and no winter cover. The sub-sub plots were conventional or no-tillage treatments. The sub-sub-sub plots were additional N in the form of soil applied ammonium nitrate or foliar applied urea as needed as indicated by petiole analysis according to the University of Arkansas (Maples, 1977).

Individual plots were four rows spaced 1 m apart and 12 m long at Jackson and two rows spaced 1 m apart and 19 m long at Milan. The two center rows were harvested at Jackson and both rows were harvested at Milan.

Cover crops were seeded by hand or from a clearance sprayer on October 17, 1980, and October 16, 1981, at Jackson and on October 31, 1980, and October 16, 1981, at Milan. Vetch was seeded at a rate of 34 kg/ha and rye at 100 kg/ha.

Conventionally tilled plots were disked 3 to 4 times to a depth of 10 cm and rolled. Disking, moldboard plowing, followed by 1 or 2 diskings and rollings was utilized on plots with heavy residue.

Petiole analysis was used to indicate plant N needs and this was the basis for the sub-sub-sub plot treatment. When plants indicated a deficiency before reaching the first bloom, ammonium nitrate (NH_4NO_3) was surface applied by hand at a rate of 7 kg N/ha. After first bloom, plots indicating deficiency upon sampling received foliar applied urea at a rate of 10 kg N/ha.

Lime, P, K, and B were added according to University of Tennessee recommendations. Terraclor Super X was placed in furrow at 11.2 kg/ha at planting. Acid delinted "Stoneville 825" was planted at a rate of 19.3 kg/ha with a John Deere 7100 planter with cast iron press wheels. Seeds were treated with a two-way treatment of carboxin and captan. The experiments were planted on May 13, 1981, at both Jackson and Milan. In 1982 the experiment at Jackson was planted on May 13 and at Milan on May 15. Replanting where necessary was done on June 2, 1982, at Jackson and on June 4, 1982, at Milan.

Cover crops were killed one week prior to planting by using paraquat at 0.56 kg ai/ha. In addition, glyphosate at 2.3 kg ai/ha was used to kill vetch plots in 1982. Fluometron and pendimethalin

at 1.7 and 1.1 kg ai/ha were used as preemergence herbicides. Weed control was maintained by supplemental hand weeding and cultivation where possible. As needed, MSMA was used postemergence overtop for johnsongrass control. MSMA plus cyanazine were post-directed for spotted spurge control at Milan in 1981. MSMA plus dinoseb was post-directed for spotted spurge control at Milan in 1982. Metachlor at 1.7 kg ai/ha was used where nutsedge was a problem.

Acephate, profenofos, sulprofos, and permethrin were used to control plant bugs and/or bollworm larvae. In addition chlordimeform and methomyl were used as bollworm ovicides. All herbicides, fungicides, and insecticides were used at University of Tennessee recommended rates.

Soil temperature at a depth of 5 cm was monitored throughout the growing season using a Weathertronics remote continuously recording thermograph.

Cotton plant vigor ratings were accomplished by visual observation. Vigor ratings were based on a scale of 1 to 10 with higher numbers being more vigorous.

Cotton was harvested using a spindle picker at Jackson on October 28 and 29, with a second harvest on November 10, 1981. At Milan cotton was harvested once on November 11, 1981. In 1982 cotton was harvested at Milan on October 18 with a second harvest on November 19. At Jackson a single harvest was conducted on November 8, 1982. Seed cotton yields from each plot were recorded. Subsamples of approximately 1 kg were taken from each plot, weighed, composited,

and ginned. Percent gin turnout was determined and used to calculate kg lint/ha.

Petiole samples from all plots were collected four times at each location each year. Sample dates in 1981 were July 14, July 31, August 19, and September 10. In 1982 sample dates were July 13, July 27, August 9, and August 25 at Jackson. Samples were taken at Milan in 1981 on July 15, August 3, August 20, and September 3. In 1982 sample dates were July 7, July 23, August 6, and August 23 at Milan. Petioles were dried and ground to pass through a 4 mm sieve and analyzed for $\text{NO}_3\text{-N}$ with an Orion "Nitrate specific" ion electrode, model 92-07 (Orion Research Inc., Cambridge, Mass.). This electrode was paired with an Orion double junction reference electrode, model 90-20 (Orion Research Inc., Cambridge, Mass.). The sample preparation procedure given in the Orion 98 series electrodes method manual (Orion Research Inc., Cambridge, Mass.) was followed. Residue samples were taken at random from sample areas 8 square meters in area to determine amount of dry matter/ha and total N content of the plant samples. Soil samples were taken on each plot of one replication to a depth of 45 cm with increments of 0 - 7.5, 7.5 - 15, 15 - 30, and 30 - 45 cm. These were analyzed for $\text{NO}_3\text{-N}$. At Jackson sample dates were May 26, 1981; July 13, 1981; June 7, 1982; and August 18, 1982; and at Milan dates were June 18, 1981; July 16, 1981, and June 2, 1982. The percentage soil water on a dry weight basis in each soil sample was determined gravimetrically with oven drying (Gardner, 1965). The percentage of water on a volumetric basis was calculated by multiplying the percentage of water on a dry

weight basis by bulk density of soil layer from which it was collected. The soil bulk density was determined by the core method (Blake). Soil samples were ground to pass a 2 mm sieve and analyzed for $\text{NO}_3\text{-N}$ with an Orion "Nitrogen specific" electrode as described above. Bulk densities were used to convert ppm N values to kg N/ha on a soil volume basis.

CHAPTER IV

RESULTS AND DISCUSSION

Cover Crop Residue

Residue weights of rye, vetch, and rye-vetch samples were determined as seen in Table 1. In 1981, the amounts of V residue were similar at both Milan and Jackson. The R growth and residue amount at Jackson was twice that at Milan. The residue amount of RV was comparable to that of R alone at Jackson but was considerably more than R alone at Milan. It is felt that the excessive rye growth at Jackson was possibly due to N carryover from high fertilization of corn in 1980 which was followed by drought and low yield.

In 1982 residue samples were taken only at Jackson. Samples were not taken at Milan due to accidental seeding overlap in plots. At Jackson the amount of V was similar to that in 1981; however, there was a greater percent moisture. Rye residue wet weight was considerably less than either V or RV in 1982. Rye residue weights were less than half of the R weights obtained at Jackson in 1981. The RV cover weights were the highest of the covers but not as high as the 1981 cover weights.

Soil Temperature

Soil temperature was monitored at a depth of 5 cm under no-tillage treatments in all cover situations as well as in the alley and in the conventional no-cover treatment. Figure 1 compares the

Table 1. Mean weight of cover crop residues just prior to planting in spring 1981 and 1982.

Cover	Wet Weight T/ha	Water %	Dry Weight T/ha
1981			
<u>Jackson</u>			
V	12.5	86	1.7
R	17.9	74	4.6
RV	20.7	77	4.7
<u>Milan</u>			
V	15.5	87	1.9
R	9.2	76	2.2
RV	20.0	81	3.7
1982			
<u>Jackson</u>			
V	11.9	82	2.0
R	5.5	53	2.5
RV	17.6	79	3.5

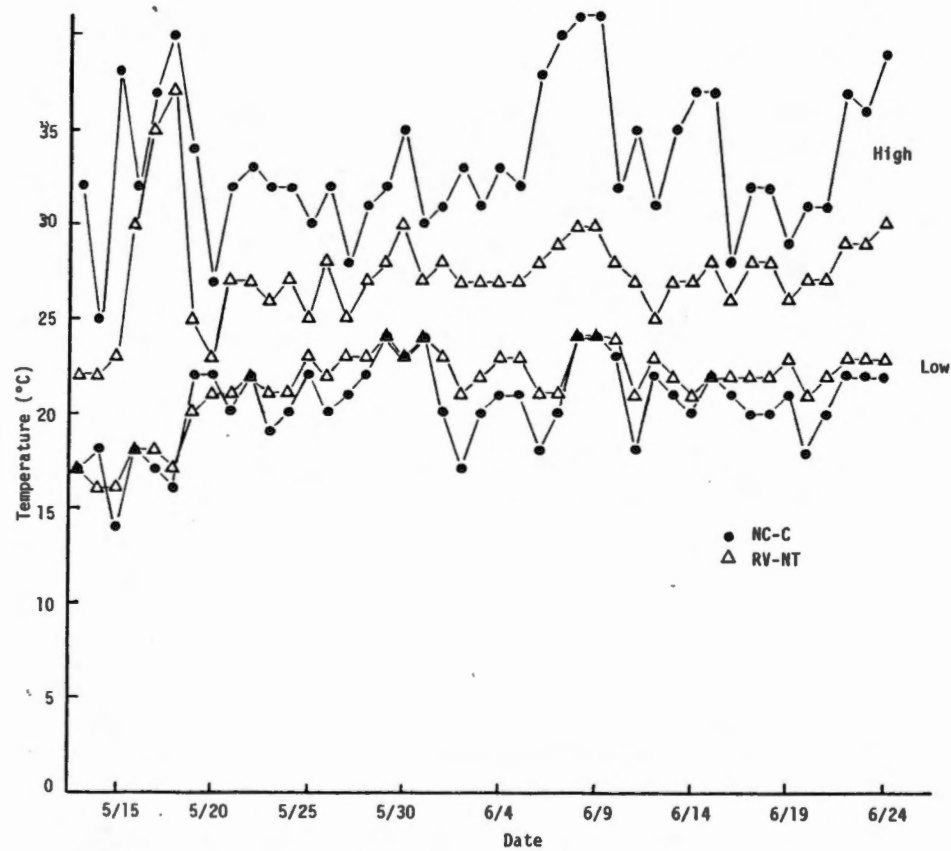


Figure 1. Soil temperature daily high and low under conventional no cover and no-tillage rye-vetch during 1982 at Jackson, Tennessee.

daily high and low soil temperatures for 1982 under NT-RV and CT-NC treatments at Jackson for the first 42 days after planting.

Daily low temperatures under RV were as much as 2°C warmer. There was a great difference in daily high under the two treatments. Soil under the RV-NT was cooler than that under the NC-CT. In some cases it was by as much as 11°C cooler. This trend continued throughout the season with the range and difference in daily high and low temperatures becoming less as the season progressed. Low temperatures were very close under all covers planted no-till.

The amount of residue had an effect on the soil temperature and soil water amounts. Soil which was not exposed directly to heating, cooling, and drying of the soil surface tended to stay cooler during the warmest period of the day. Greater amounts of surface water under covers caused soil temperature ranges to be narrower than under no winter cover.

Seedling Vigor

Cotton seedling vigor was evaluated with this system in 1981. In 1982 the stand of cotton in V and RV was not adequate and some cotton was replanted. Vigor ratings were not made due to this inconsistency in planting date. In 1981 seedling vigor was affected by cover at Jackson (Table 2). Cotton seedlings in R and RV were more vigorous than those planted in NC situations. Cotton seedlings in vetch cover were the least vigorous. In some cases seedling emergence was also a problem under vetch cover.

Table 2. The influence of cover and tillage on cotton seedling vigor in 1981.

	Seedling Vigor ^a	
	Jackson ^b	Milan ^c
<u>Cover</u>		
R	5.5	5.9
RV	5.2	5.8
NC	4.2	4.8
V	3.5	5.6
<u>Tillage</u>		
NT	4.8	5.0
CT	4.4	5.2

^aRating based on a scale of 1 to 10 with the higher value being more vigorous.

^bRated on June 16, 1981.

^cRated on June 28, 1981.

At Milan in 1981, the most vigorous seedlings were again in R and RV covers, but these were not more vigorous than those in the vetch covers. The least vigorous were those in the no-cover treatments.

At Jackson seedling vigor was affected by tillage. No-till cotton was more vigorous. At Milan there was no difference due to tillage. At Jackson there was no effect of N rate on vigor; however, at Milan, those treatments receiving 67 kg/ha were more vigorous.

In summary, in 1981 at Jackson the vetch cover resulted in initially lower cotton seedling vigor ratings. Cotton planted both NT and CT into R or RV covers was more vigorous than no cover. Cotton planted NT was slightly more vigorous than that planted CT at Jackson. Tillage differences were not present at Milan and the effect of cover did not follow the same pattern as at Jackson. N rate did affect cotton vigor at Jackson but did affect vigor at Milan.

Soil Water Content

Precipitation at Jackson and Milan during growing seasons of 1981 and 1982 are shown in Figures 2 and 3. At Jackson the rainfall patterns were similar in both 1981 and 1982 with the total seasonal rainfall being the same for both years. Milan was drier throughout the season with the exception of a 35 cm rain in September.

Volumetric soil water content was determined at selected dates where no-till and conventional cotton was planted in no cover or rye-vetch cover. Results are shown in Figures 4 through 9. At Jackson

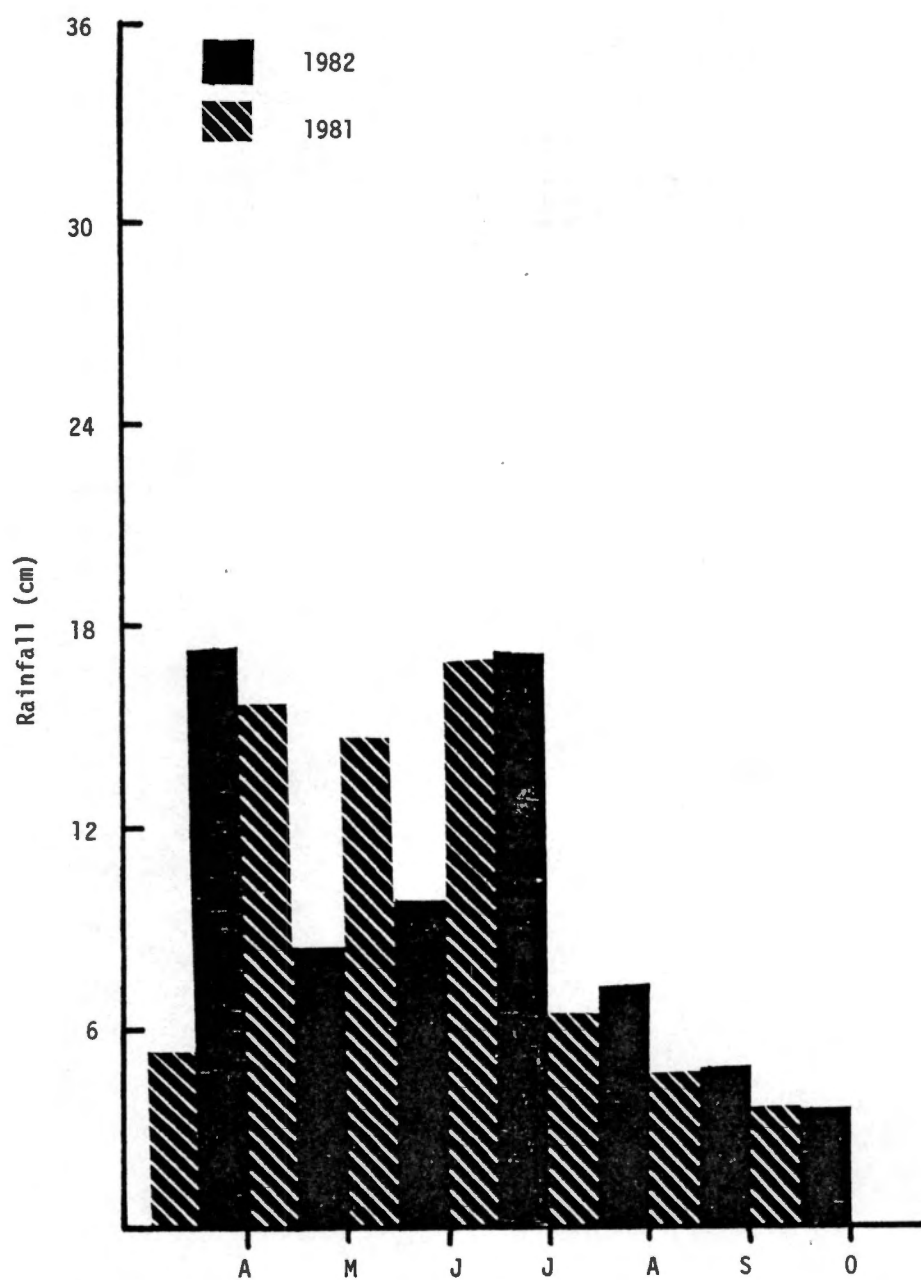


Figure 2. Monthly rainfall totals at Jackson in 1981 and 1982.

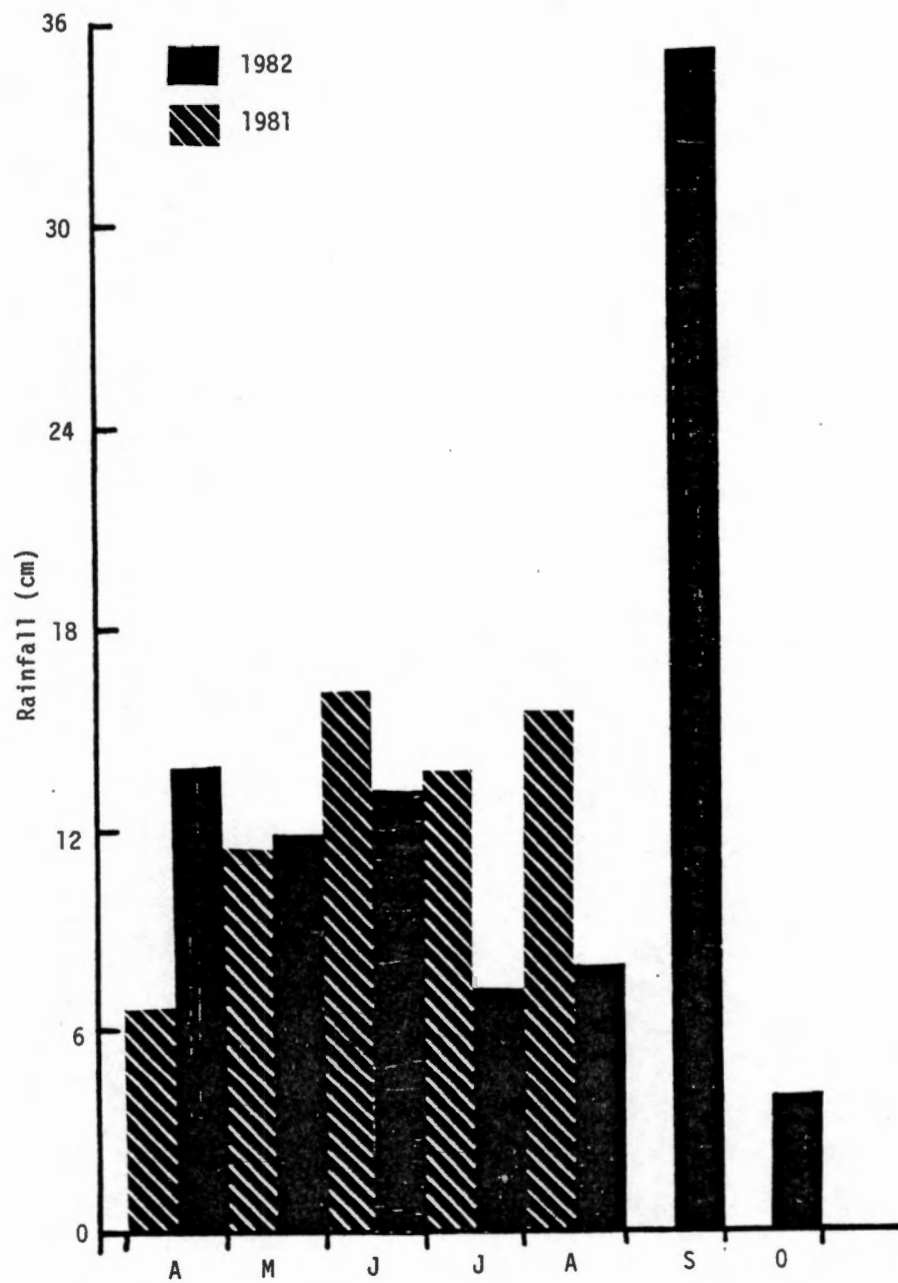


Figure 3. Monthly rainfall totals at Milan in 1981 and 1982.

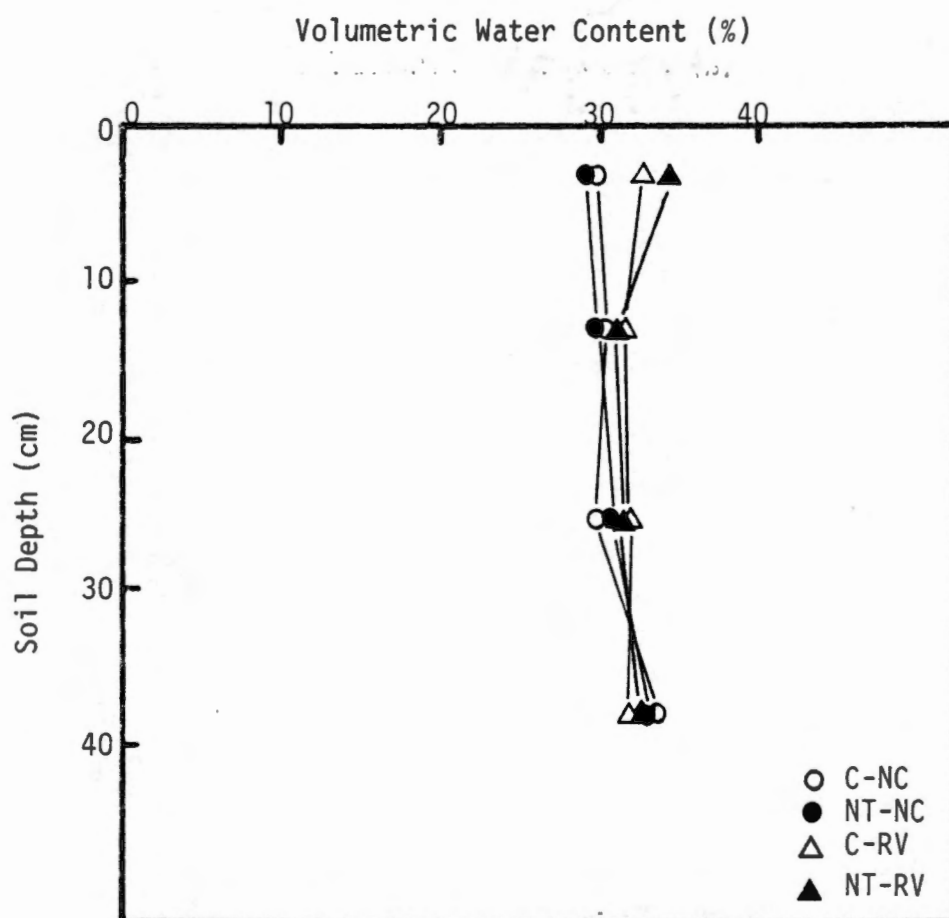


Figure 4. Soil water content at Jackson on May 28, 1981, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

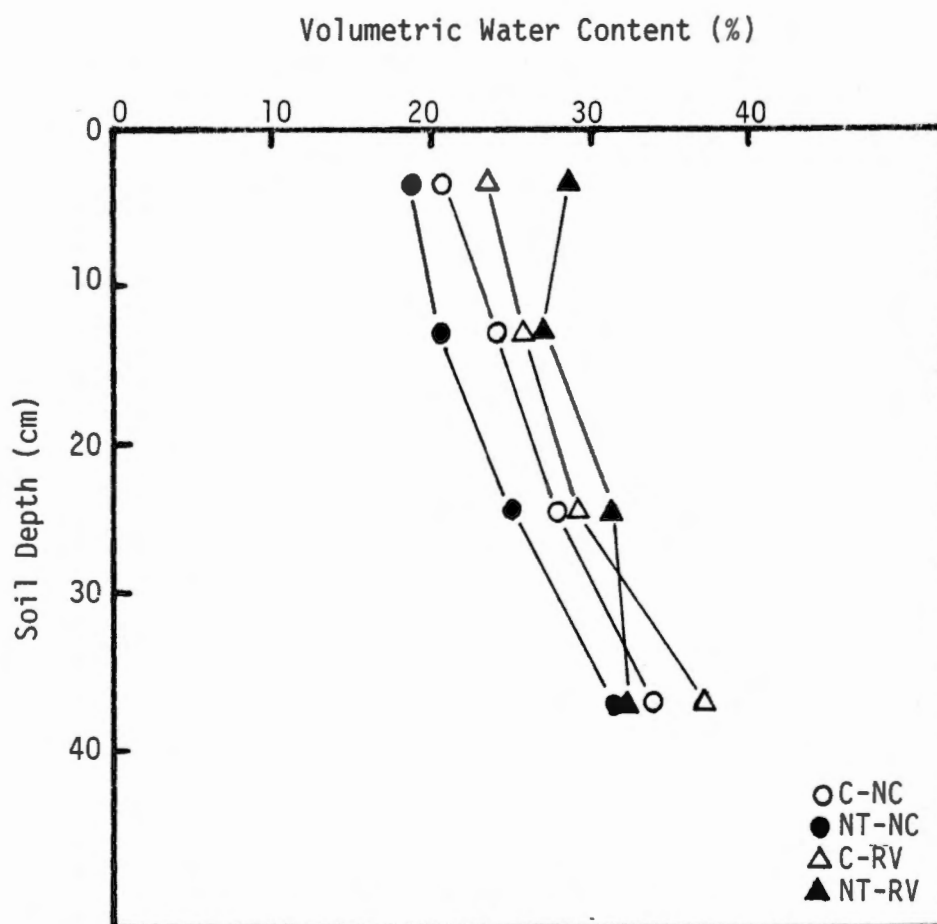


Figure 5. Soil water content at Jackson on July 13, 1981, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

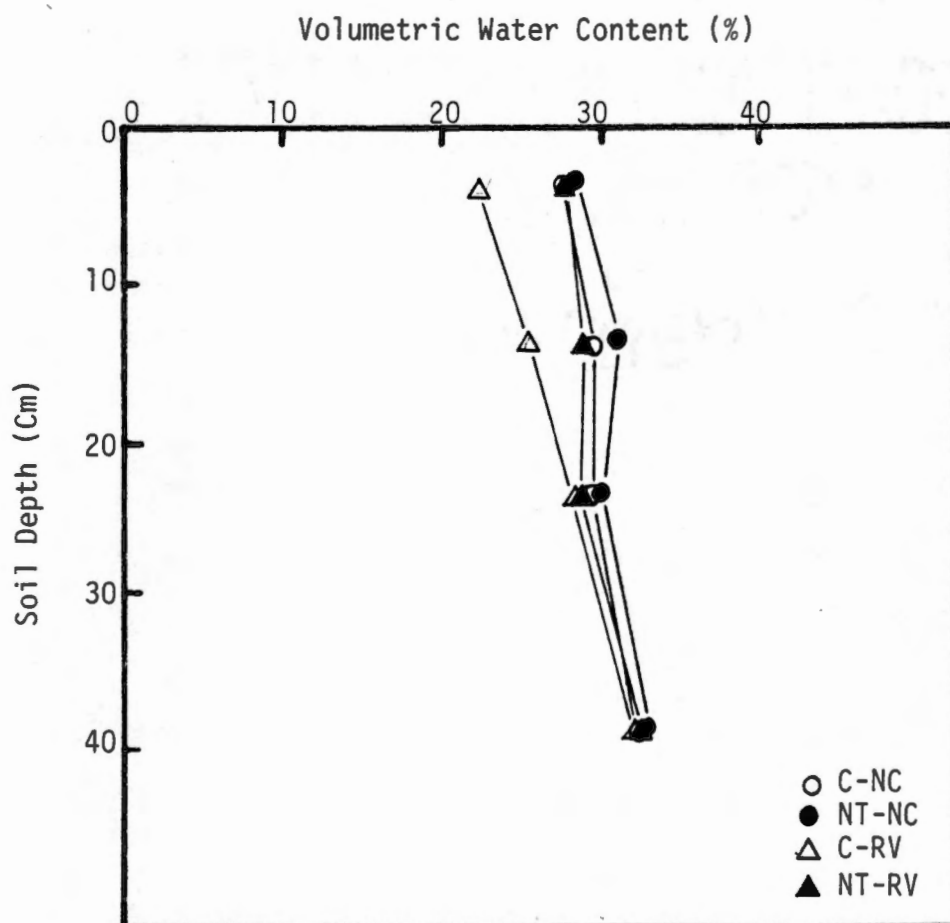


Figure 6. Soil water content at Jackson on July 7, 1982, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

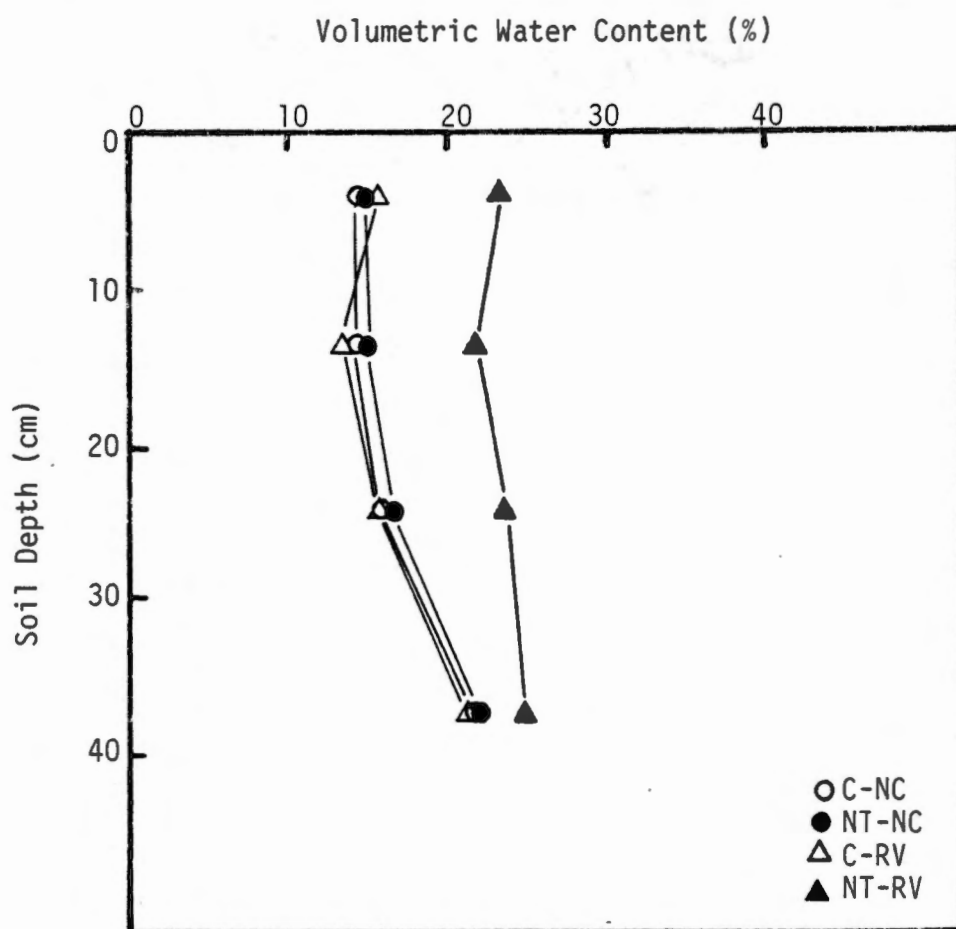


Figure 7. Soil water content at Jackson on August 18, 1982, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

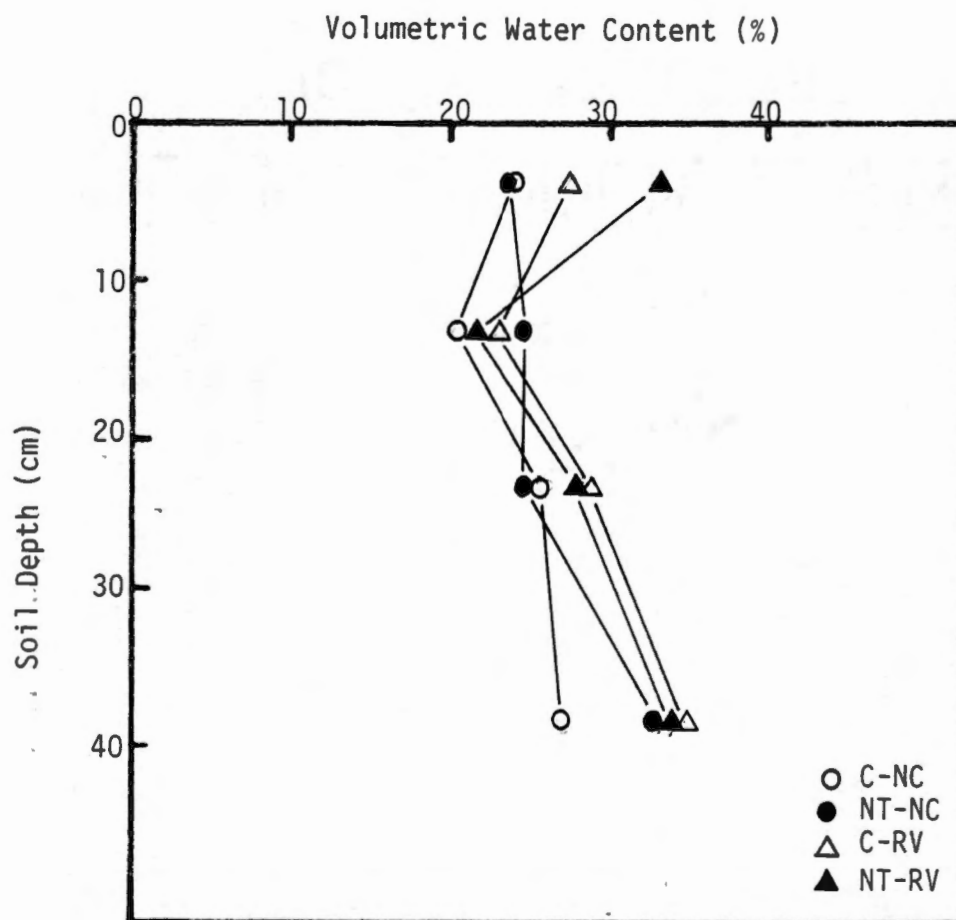


Figure 8. Soil water content at Milan on July 16, 1981, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

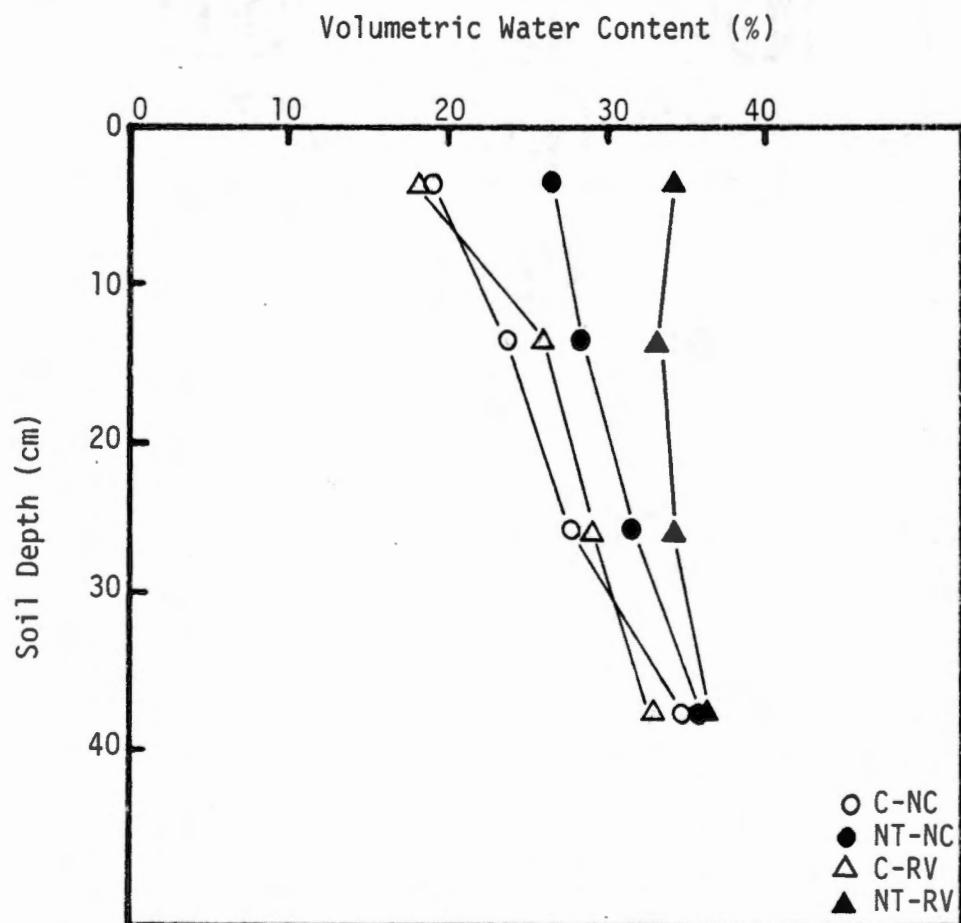


Figure 9. Soil water content at Milan on June 21, 1982, under conventional and no-till planted cotton following no cover crop and rye-vetch cover crop.

on May 28, 1981, (Figure 4) soil water contents were similar under all treatments. However, in the upper 10 cm soil water was somewhat greater under NT-RV. On July 13, 1981, (Figure 5) soil water content was highest under NT-RV followed by CT-RV. CT-NC was higher than NT-NC at all depths, possibly because of differences in plant growth. At this time soil water was affected by plant uptake, but the data indicate moisture was being conserved where a cover was present. On June 7, 1982, the NT-NC had a higher soil water content at all depths followed closely by C-NC and NT-RV (Figure 6). In the upper 10 cm of the soil no-tillage treatments had a higher water content except under CT-NC. This was possibly due to less evaporation from the surface, but plant uptake makes this difficult to determine. By August 18, 1982, the water content under NT-RV was much greater than the other treatments (Figure 7).

At Milan on July 16, 1981, the NT-RV had the highest water content in the upper 10 cm (Figure 8). On June 21, 1982, soil water content under NT was much greater at all depths (Figure 9). The NT-RV was much higher than the NT-NC, but this difference diminished with depth. Soil water differences under CT and NT were present throughout the season. Those differences were narrow early in the season and wider as the season progressed. NT treatments where a cover was present had the highest soil water content as the soil was not exposed to drying as much as in CT. Where a cover was incorporated, more water was held as compared to the NC treatments.

Soil Nitrate-Nitrogen Content

Soil $\text{NO}_3\text{-N}$ content at the first sampling date for various depths is presented in Figures 10 through 23.

At Jackson on May 28, 1981, there was a tendency for $\text{NO}_3\text{-N}$ under R and RV to be lower than V or NC at 0 and 34 kg N/ha in both CT and NT. At the 67 and 101 kg N/ha rates all treatments had higher $\text{NO}_3\text{-N}$ amounts at all depths, but samples from the 0 to 7.5 cm depth were highest. NC treatments were higher at the 101 kg N/ha rate. Soil under CT was higher in $\text{NO}_3\text{-N}$ than NT treatments at the 67 and 101 kg N/ha rates. This could be due to less immobilization of N for microbial decomposition of residue as was the case under NT. Leaching of N is indicated by the presence of greater amounts of $\text{NO}_3\text{-N}$ at greater depths than under CT. Throughout the profile total $\text{NO}_3\text{-N}$ was highest under NC and V.

At Milan on June 18, 1981, soil $\text{NO}_3\text{-N}$ at the 0 kg N/ha rate was low at all depths with R and RV being the lowest (Figure 14). At 34 kg N/ha, soil $\text{NO}_3\text{-N}$ was higher and greatest amounts were from 15 cm to 45 cm. (Figure 15). At 67 kg N/ha soil $\text{NO}_3\text{-N}$ under R was lowest in the 0 to 7.5 cm depth and highest from 7.5 to 45 cm (Figure 16). Soil $\text{NO}_3\text{-N}$ under R was similar with CT and NT at 67 kg N/ha, possibly due to less immobilization under NT with larger additions of N. Data are erratic, but greater amounts of N deeper under CT is evident.

At Jackson on June 7, 1982, at the 0 kg N/ha rate, soil $\text{NO}_3\text{-N}$ was lower under R and NC than under V or RV treatments (Figure 17).

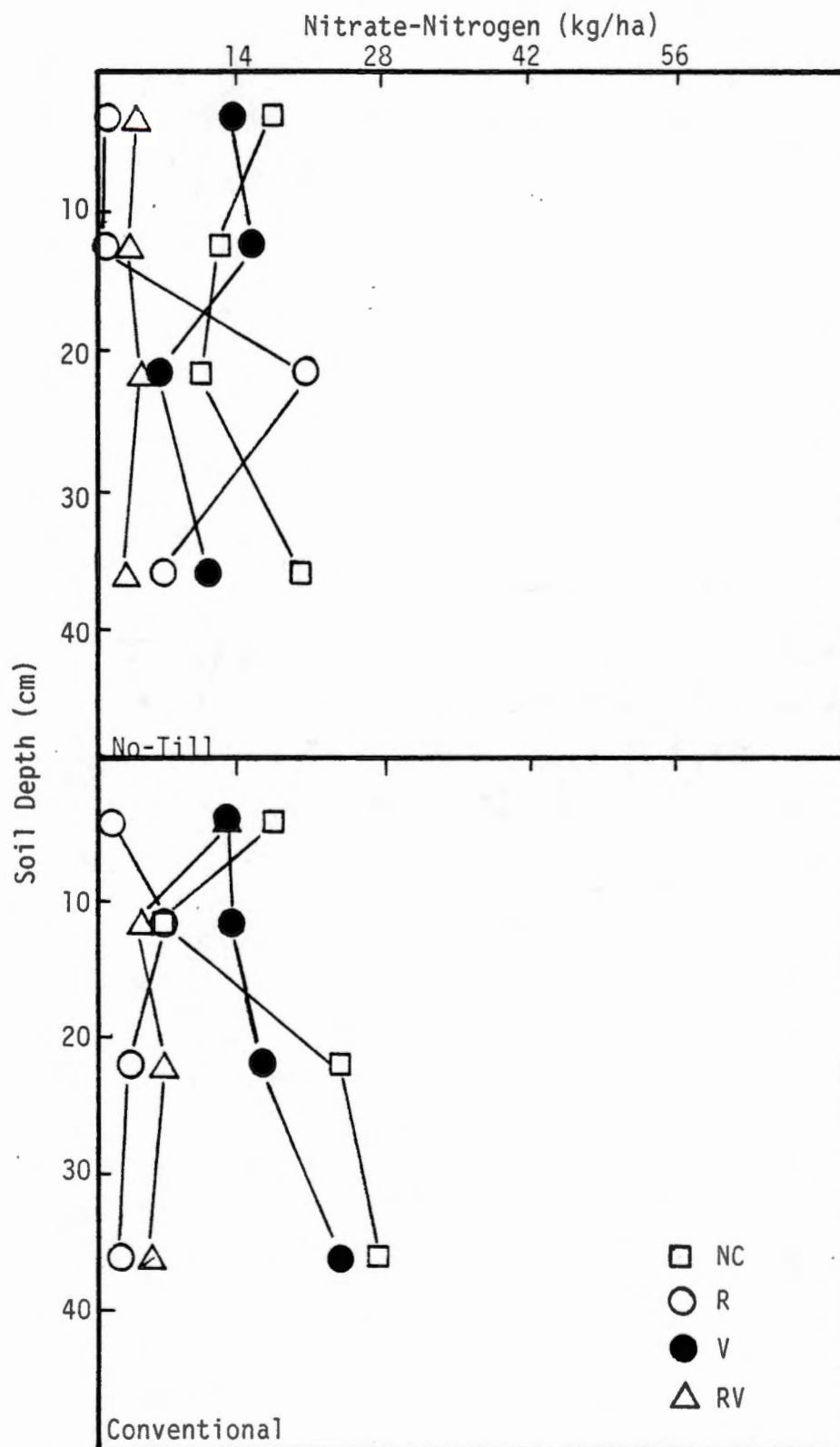


Figure 10. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 0 kg N/ha rate at Jackson on May 28, 1981.

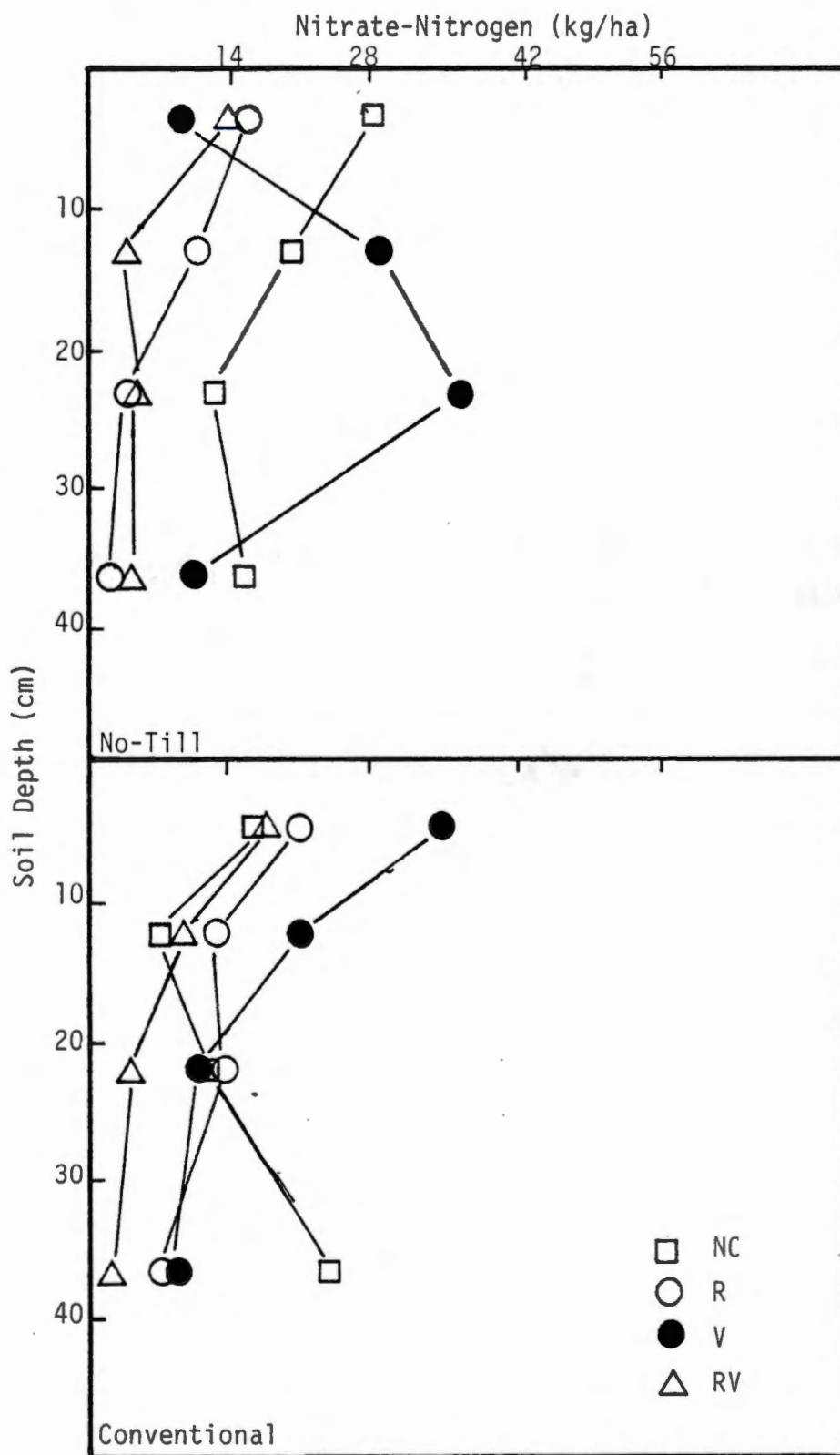


Figure 11. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 34 kg N/ha rate at Jackson on May 28, 1981.

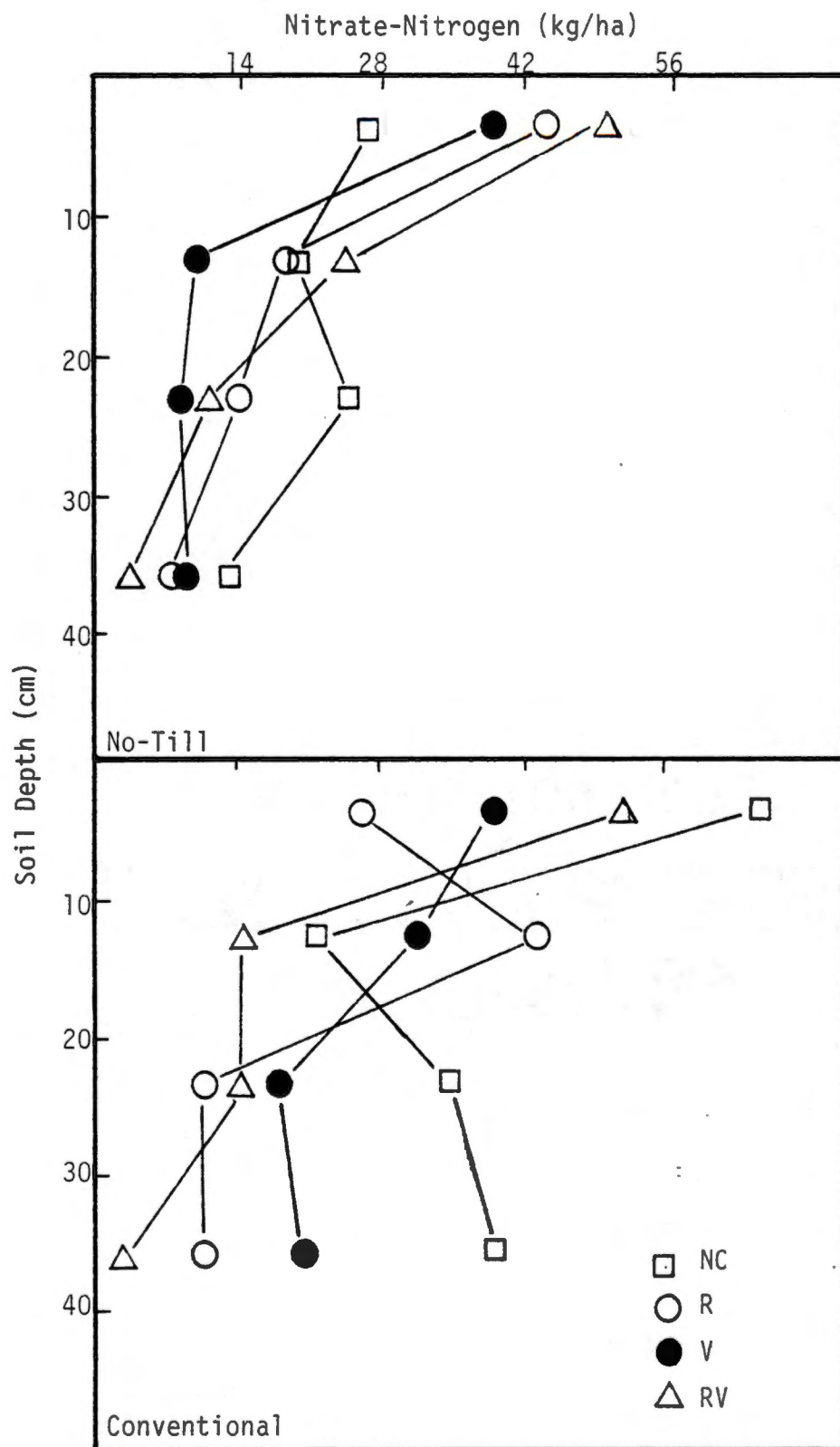


Figure 12. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 67 kg N/ha rate at Jackson on May 28, 1981.

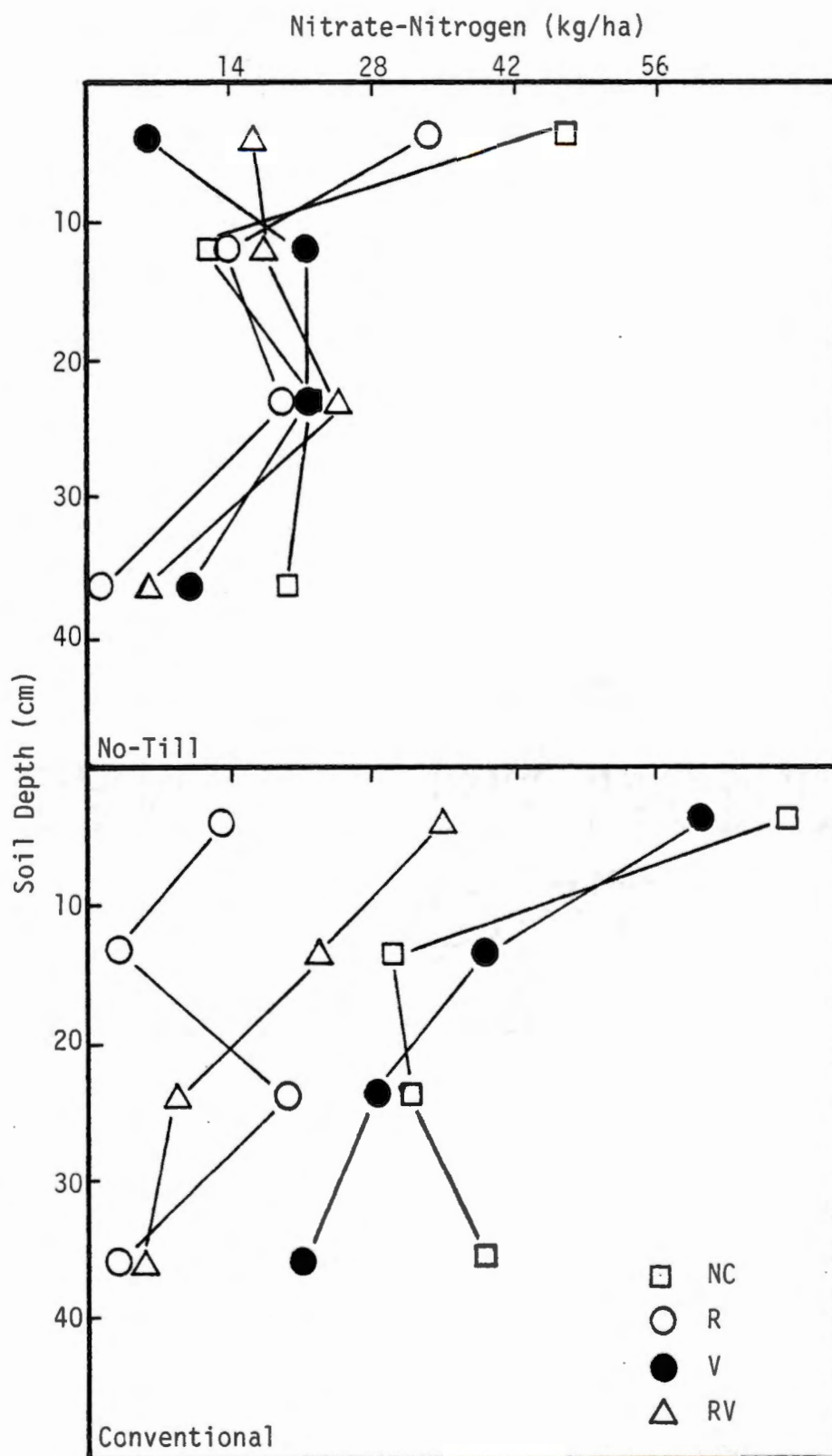


Figure 13. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 101 kg N/ha rate at Jackson on May 28, 1981.

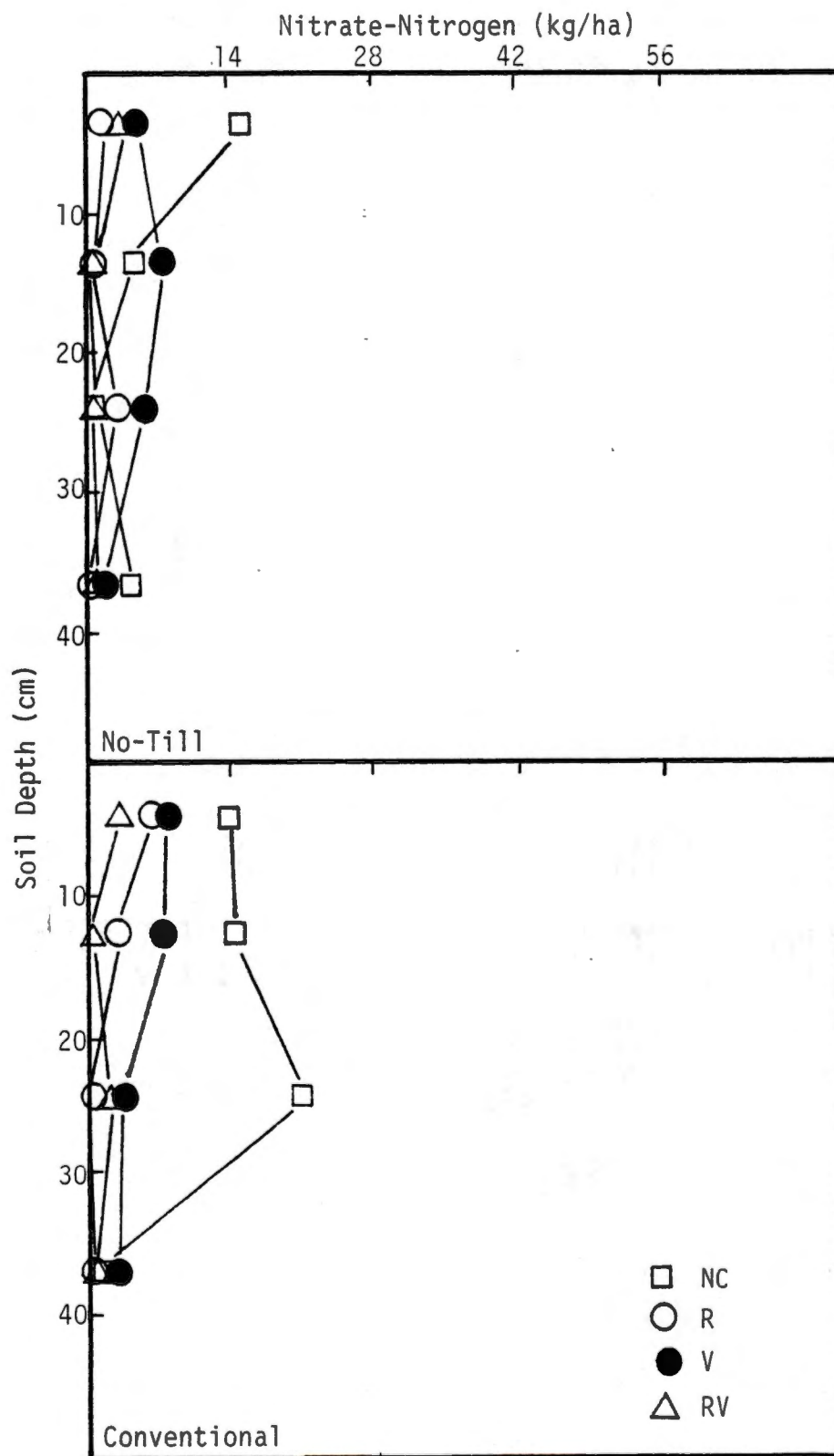


Figure 14. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 0 kg N/ha rate at Milan on June 18, 1981.

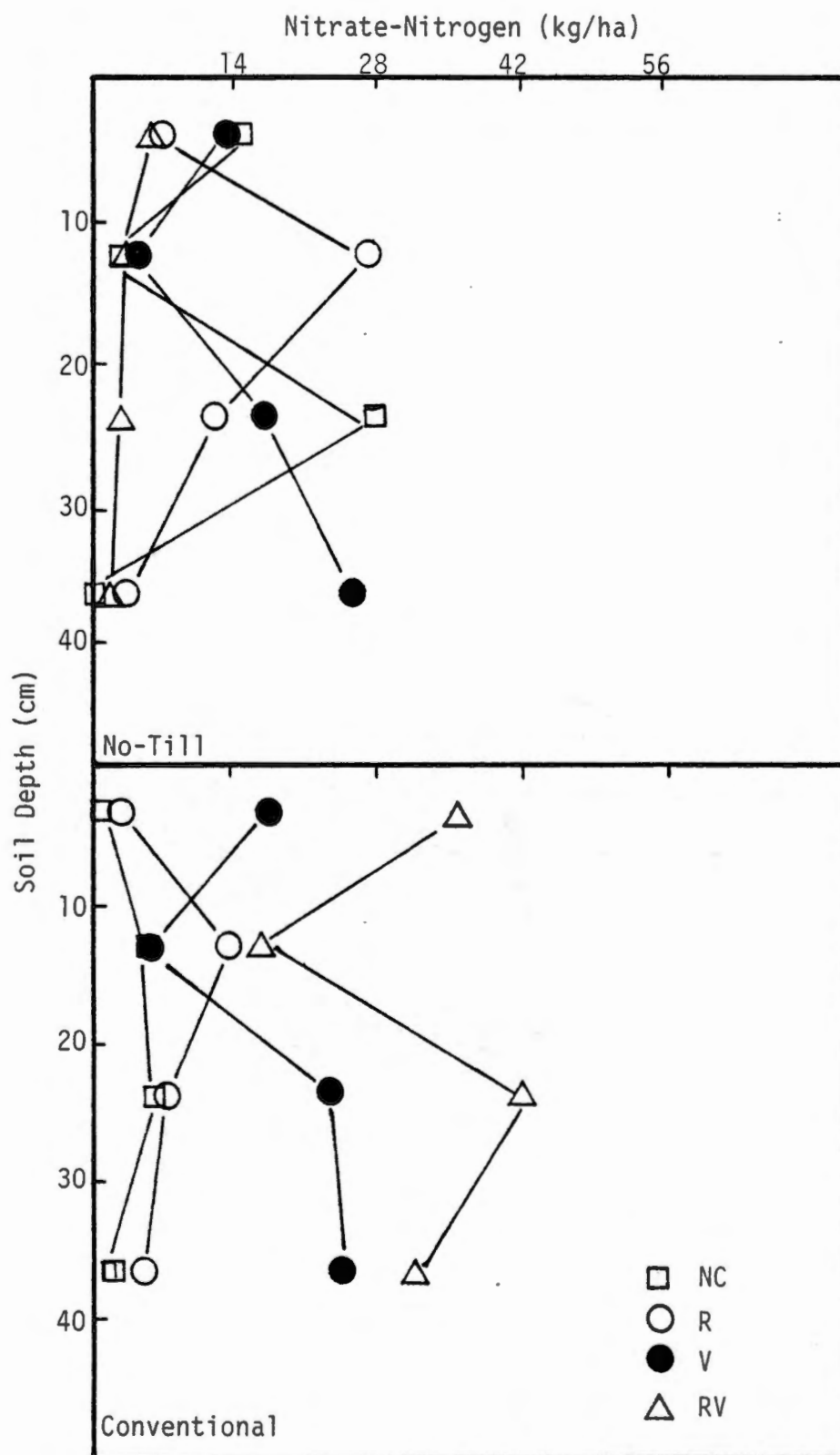


Figure 15. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 34 kg N/ha rate at Milan on June 18, 1981.

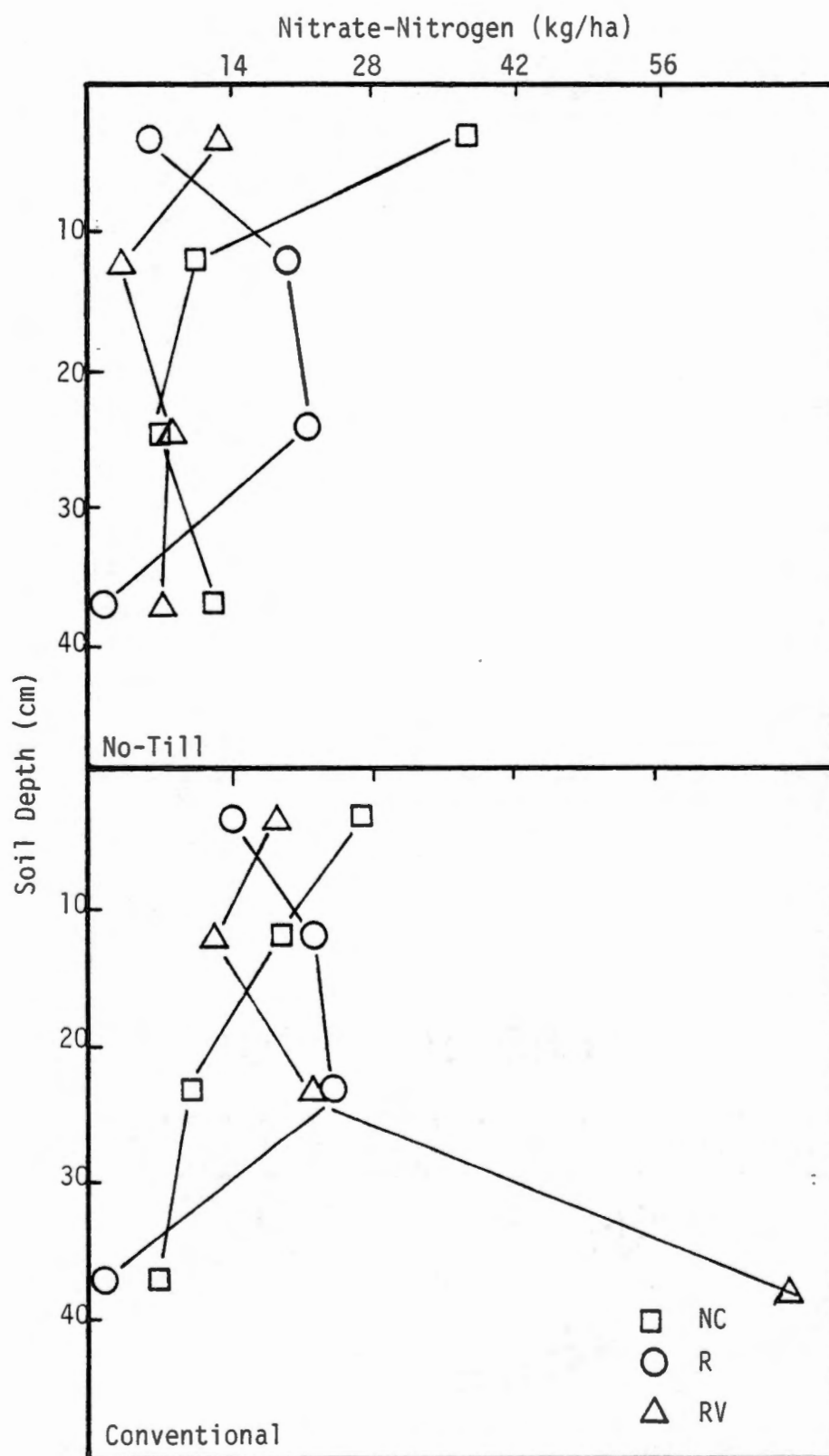


Figure 16. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 67 kg N/ha rate at Milan on June 18, 1981.

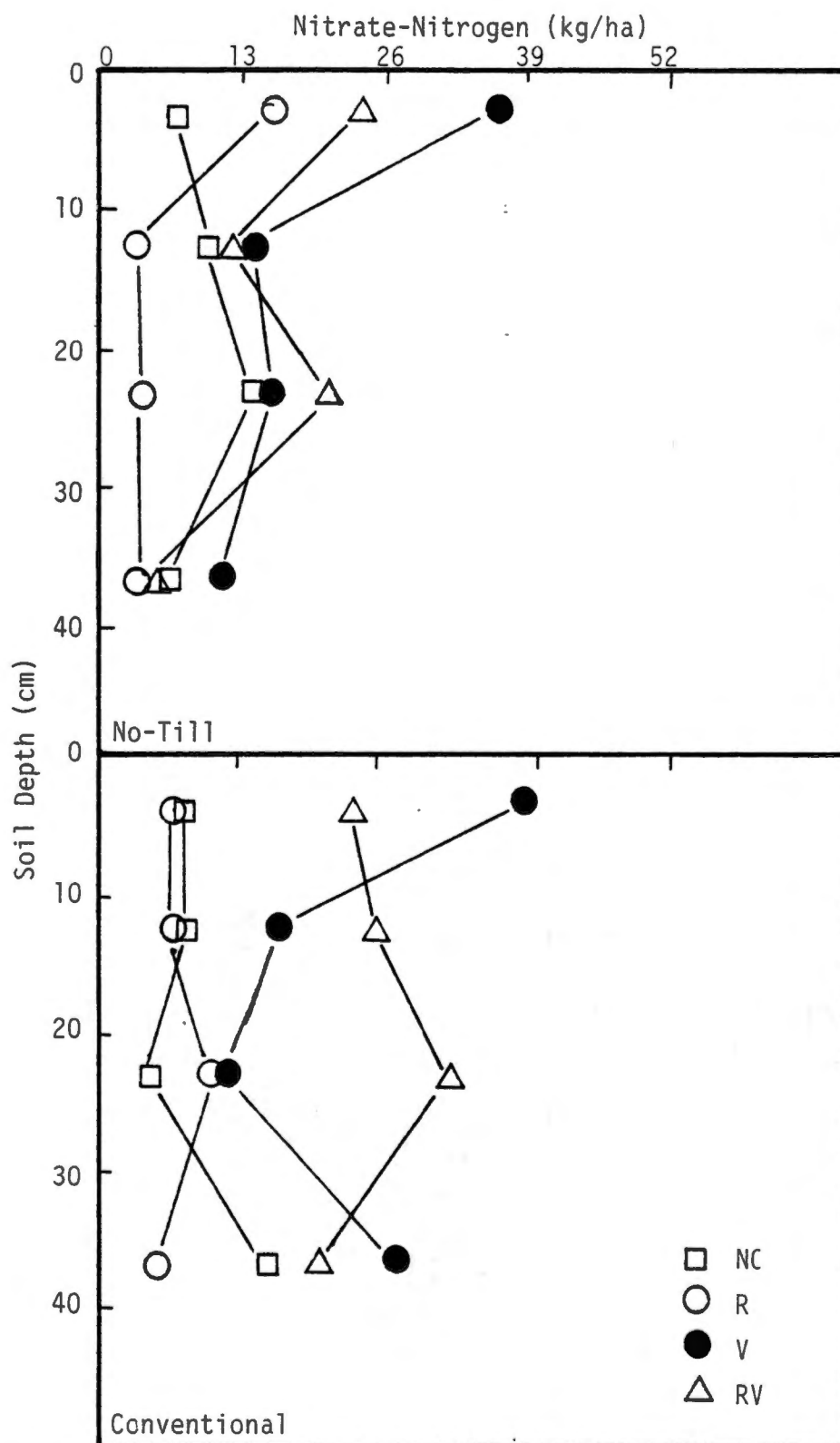


Figure 17. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 0 kg N/ha rate at Jackson on June 7, 1982.

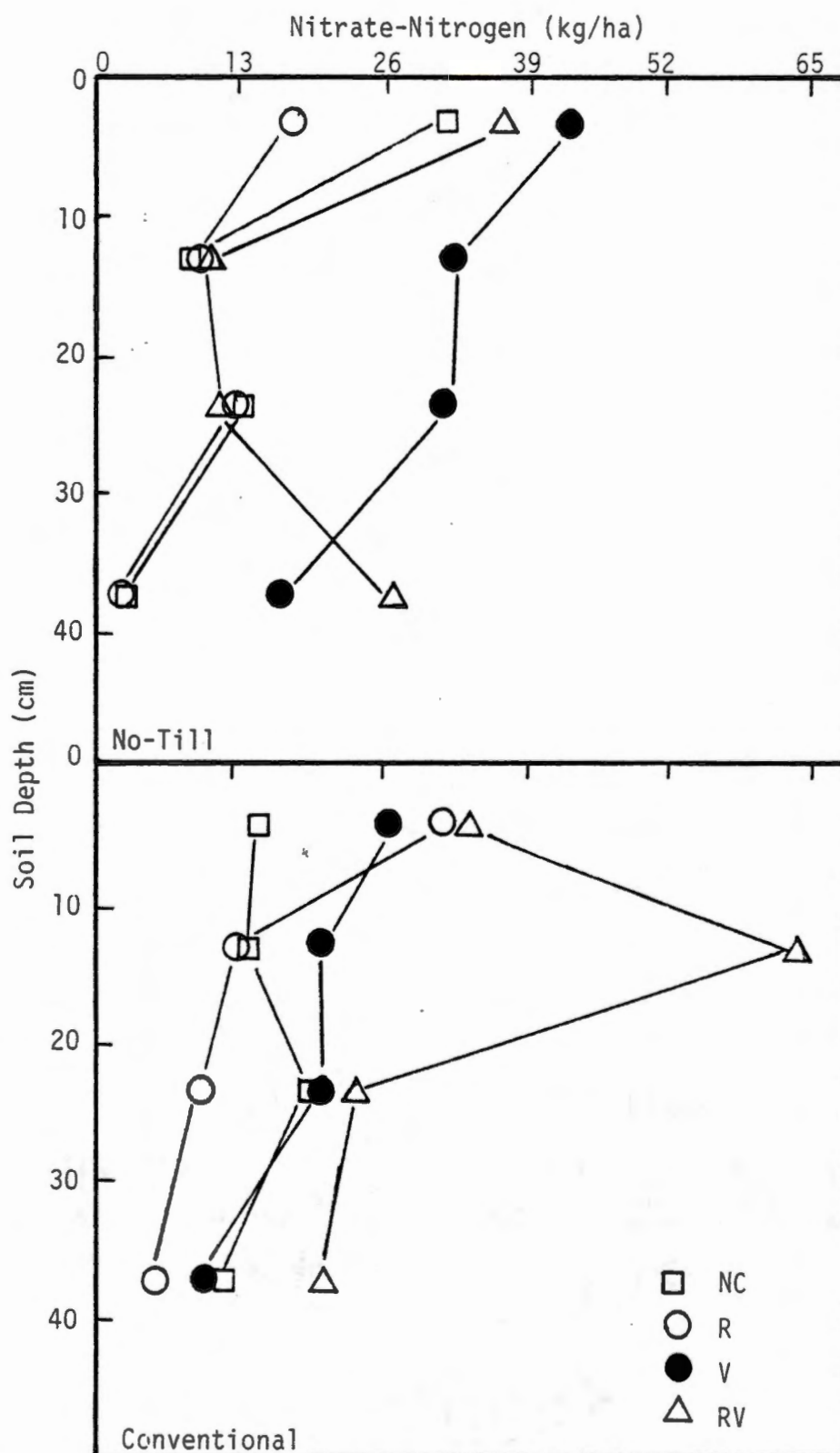


Figure 18. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 34 kg N/ha rate at Jackson on June 7, 1982.

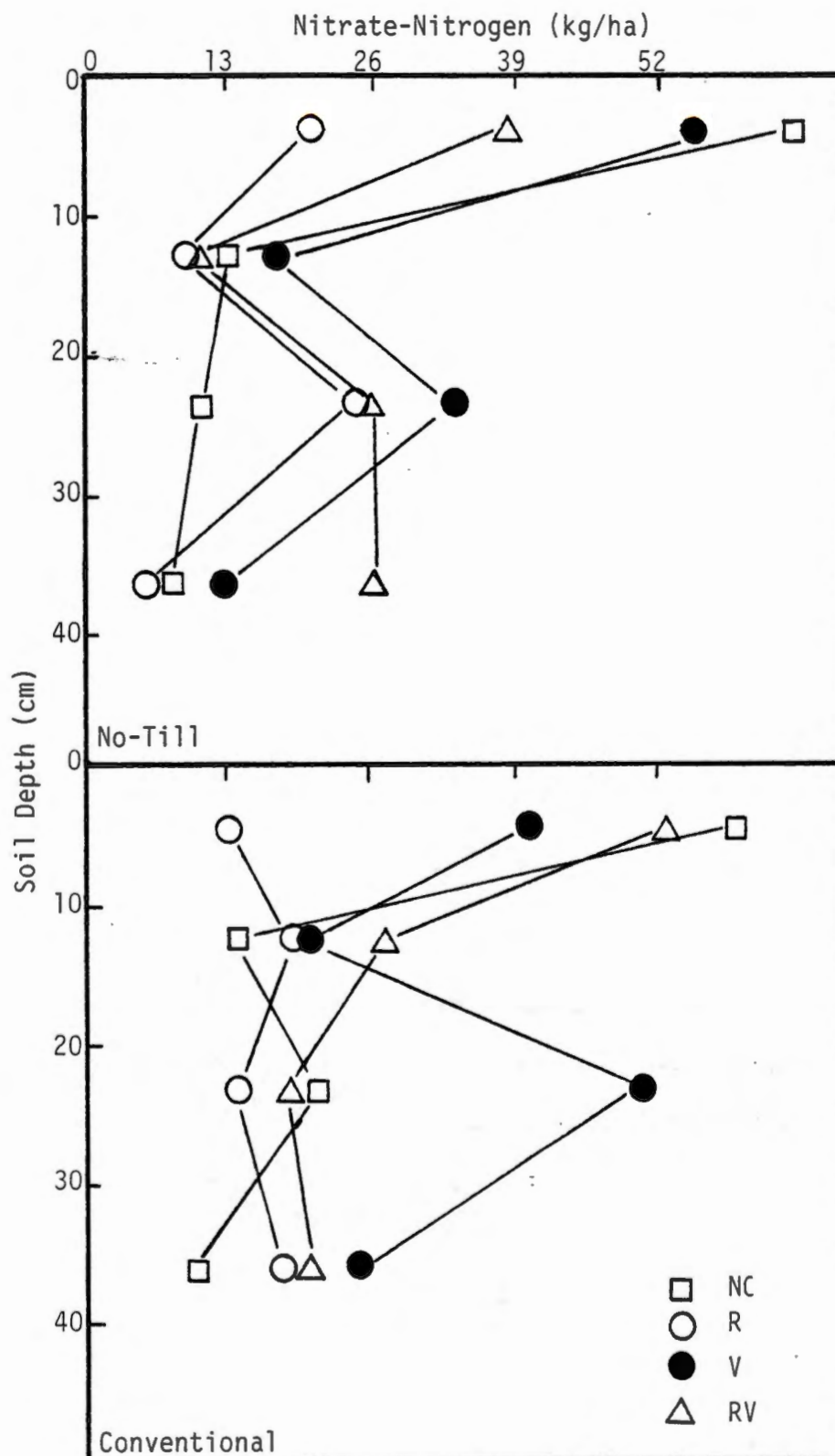


Figure 19. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 67 kg N/ha rate at Jackson on June 7, 1982.

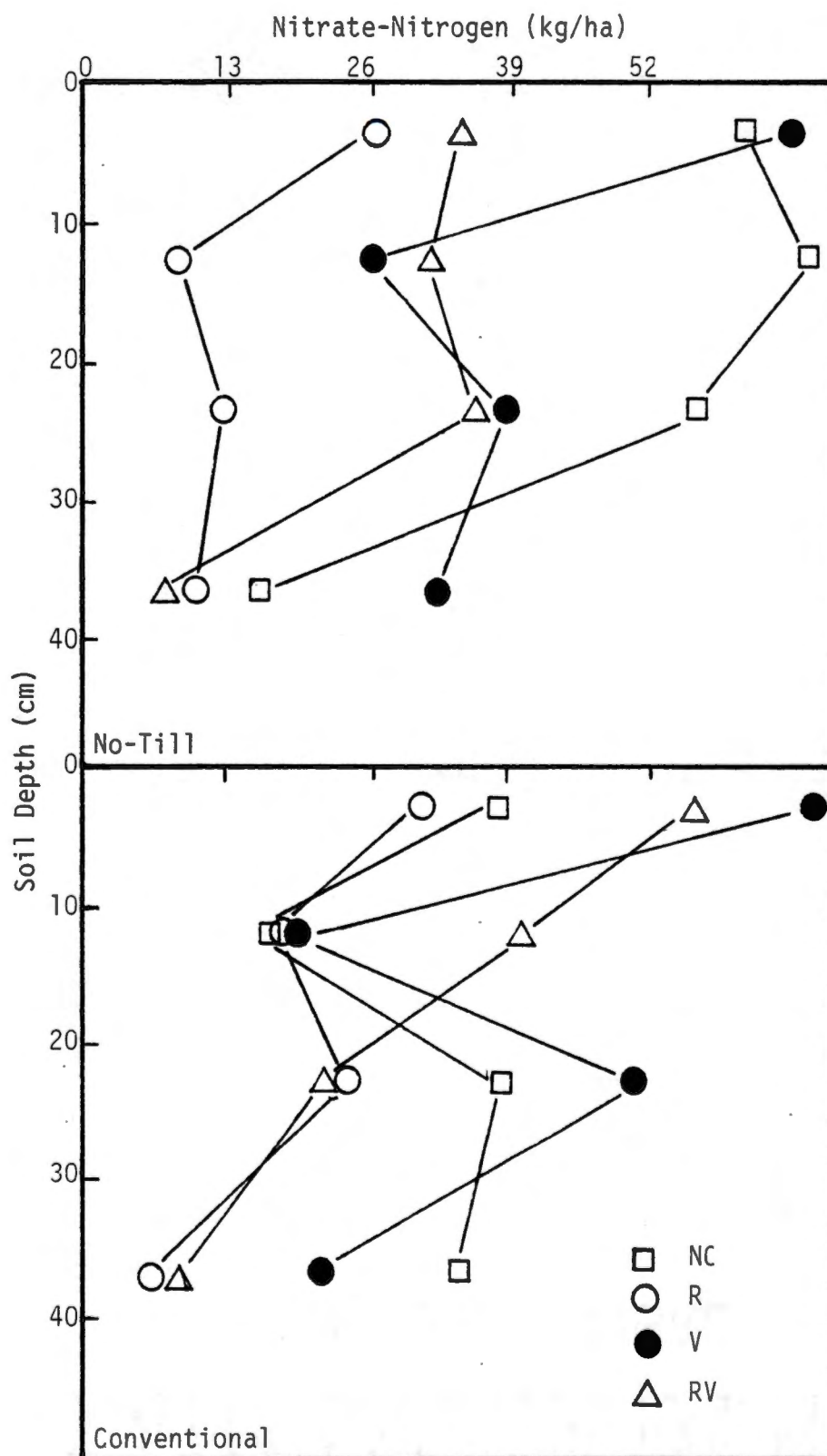


Figure 20. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 101 kg N/ha rate at Jackson on June 7, 1982.

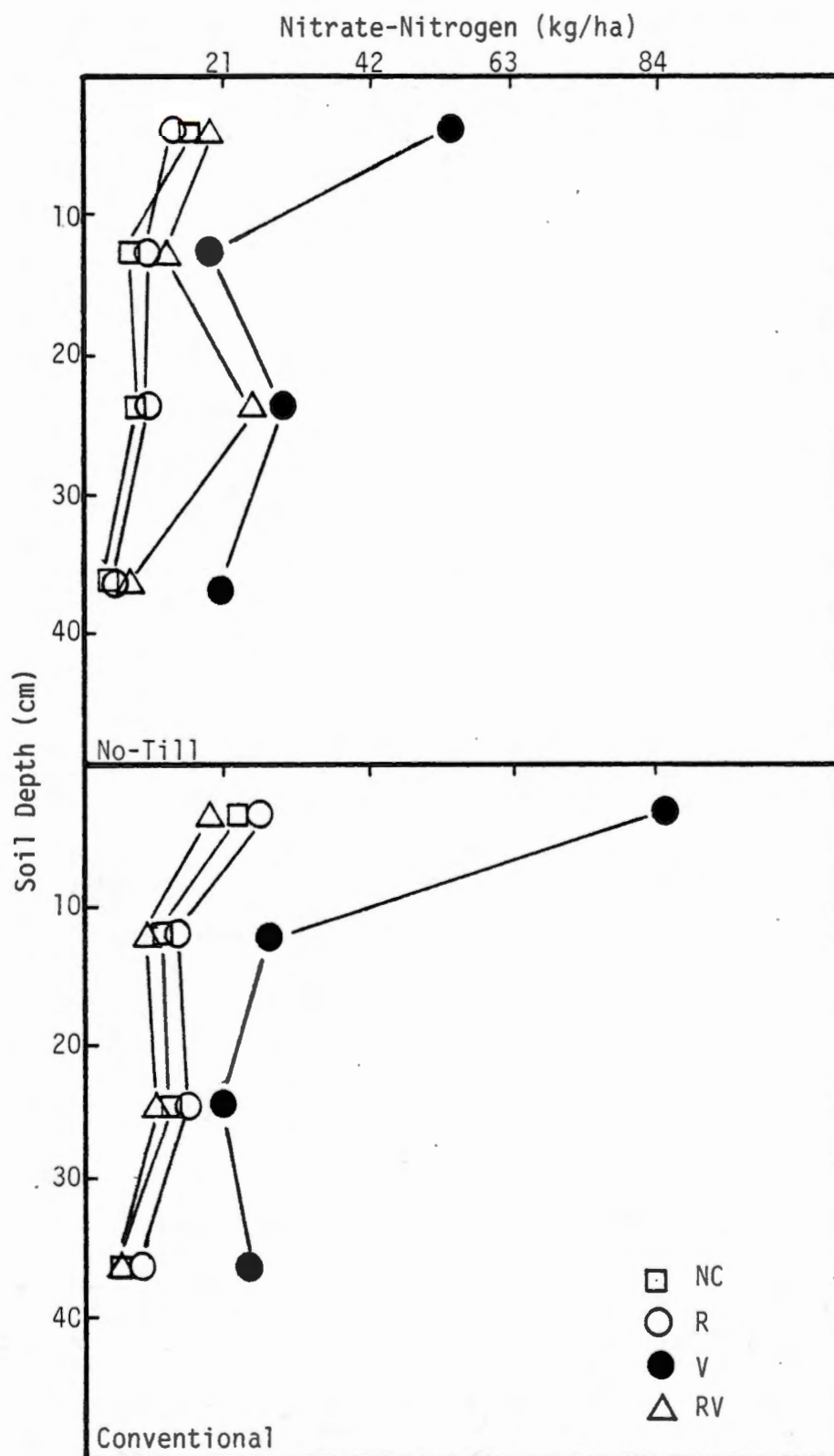


Figure 21. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 0 kg N/ha rate at Milan on June 21, 1982.

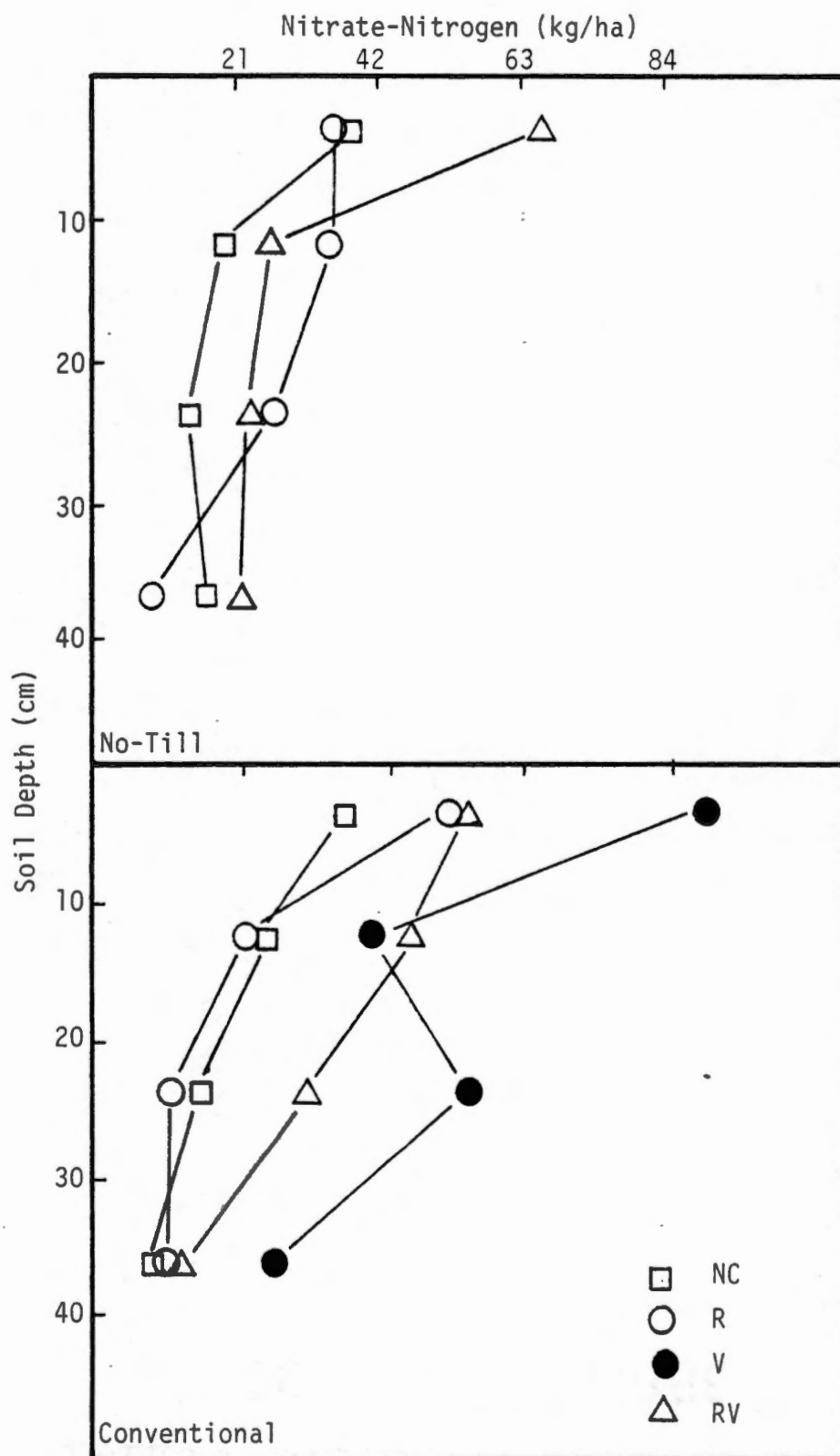


Figure 22. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 34 kg N/ha rate at Milan on June 21, 1982.

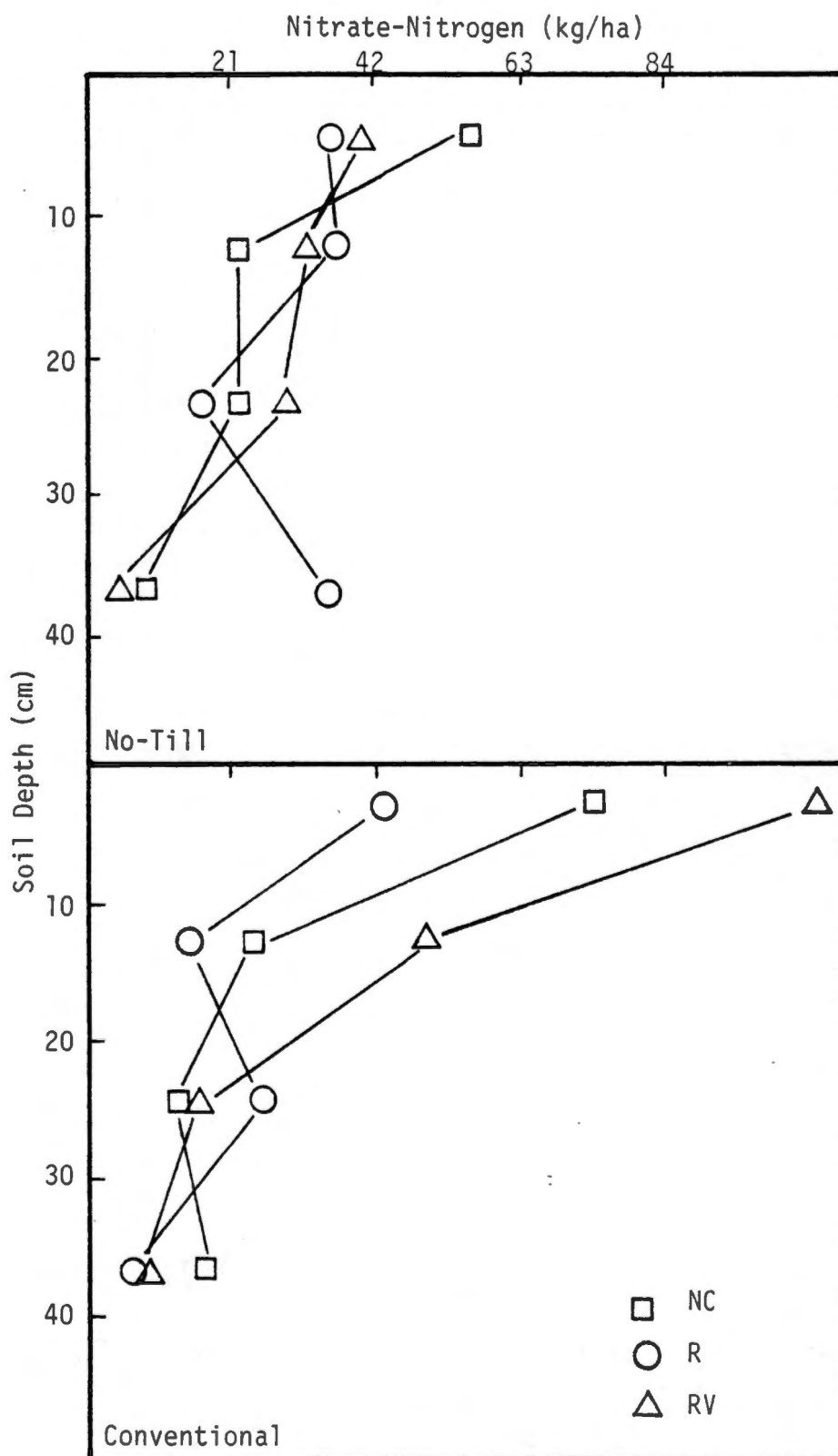


Figure 23. Soil nitrate-nitrogen distributions under no-tillage and conventional tillage at the 67 kg N/ha rate at Milan on June 21, 1982.

At 34 kg N/ha, soil $\text{NO}_3\text{-N}$ under NT was highest under V while CT was highest under RV (Figure 18). At the 67 kg N/ha rate, $\text{NO}_3\text{-N}$ content at 0 to 7.5 cm was much higher than at greater depths (Figure 19). At 101 kg N/ha, there was high $\text{NO}_3\text{-N}$ at the surface (Figure 20). Soil $\text{NO}_3\text{-N}$ below the surface was greater than at 67 kg N/ha. Soil $\text{NO}_3\text{-N}$ was lowest under NT-R and CT-R. Soil $\text{NO}_3\text{-N}$ was highest under CT-V and NT-V. At 67 and 101 kg N/ha there was some evidence of N movement to the 25 cm depth under CT and NT.

At Milan on June 21, 1982, soil $\text{NO}_3\text{-N}$ under V was higher than under other treatments at 0 and 34 kg N/ha (Figures 21 and 22). Where V was present, soil $\text{NO}_3\text{-N}$ was greater at the surface under CT than NT. Soil under other treatments was much lower at 0 kg N/ha. At 34 kg N/ha under R and NC soil $\text{NO}_3\text{-N}$ was lower than with other treatments. At 64 kg N/ha soil which was CT was higher in $\text{NO}_3\text{-N}$ than NT to a depth of 25 cm (Figure 23). NT, R, RV, and NC were similar in soil $\text{NO}_3\text{-N}$ content. Leaching was not as evident at this sample date.

At both locations there was a tendency for soil $\text{NO}_3\text{-N}$ to be highest with V cover and lowest under R cover. NC soil $\text{NO}_3\text{-N}$ was most affected by applied fertilizer N. There was increased surface soil $\text{NO}_3\text{-N}$ under all cover treatments at the higher N rates and especially under CT. This indicated that more N was immobilized under NT conditions. Microbial activity was also possibly reduced by lower soil temperature under NT. The presence of greater soil water under NT also could affect the soil $\text{NO}_3\text{-N}$ and variation with depth. There was evidence that V was supplying additional N, especially under CT.

Petiole Nitrate-Nitrogen

The estimated sufficiency/deficiency range of cotton petiole $\text{NO}_3\text{-N}$ content as reported by Maples (1977) is shown in Figure 24. This curve was utilized as a guideline for petiole $\text{NO}_3\text{-N}$ analysis and subsequent fertilizer additions. The four sample dates at Jackson and at Milan for 1981 and 1982 are shown in Figures 25 through 47.

In 1981 the first sample at Jackson was taken on July 14 which was approximately one week prior to first bloom. Samples of all treatments were in the sufficiency range (Figure 25). At Jackson, cover had a significant effect on petiole $\text{NO}_3\text{-N}$. Samples from NC and V were consistently higher than those from RV and R alone. Petioles from cotton planted NT-R with no N were close to deficiency. Excessive petiole $\text{NO}_3\text{-N}$ levels were found under CT-V and CT-NC at 34 kg N/ha.

At Milan the first sample was taken on July 15. Both N rate and cover had a significant effect on petiole $\text{NO}_3\text{-N}$ rate. Cotton petioles from all treatments indicated sufficiency (Figure 26). Petioles of cotton planted NT-R approached deficiency. Petioles of cotton planted NT-V, NT-RV, and CT-RV at 34 kg N/ha rate as well as CT-V at 67 kg N/ha indicated excessive $\text{NO}_3\text{-N}$ content.

The second sampling was done on July 31, 1981, at Jackson. Cover had a significant effect on petiole $\text{NO}_3\text{-N}$ content. Petiole $\text{NO}_3\text{-N}$ was sufficient under all NC and V treatments with levels under V being somewhat higher (Figure 27). Deficiency levels were found at both 0 and 34 kg N/ha where RV was the cover under either CT or NT, but

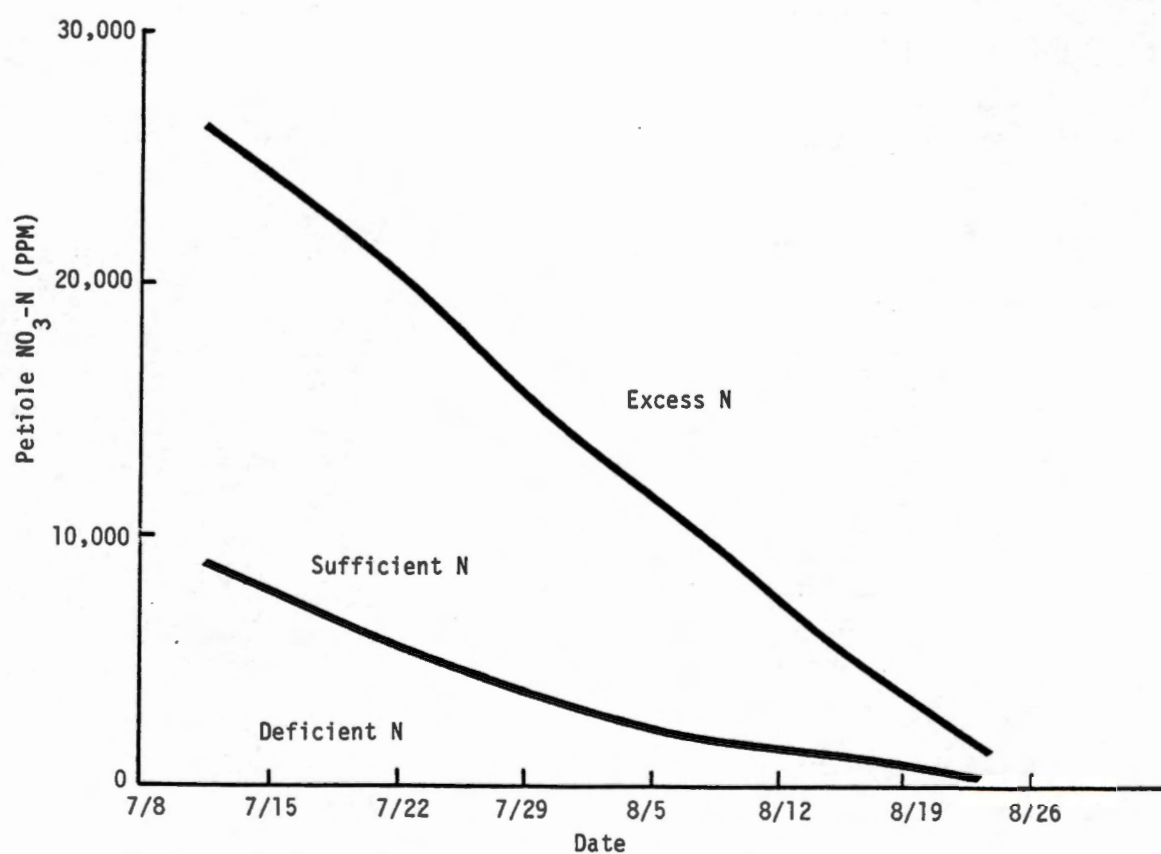


Figure 24. Estimated range of sufficient petiole nitrate-nitrogen for cotton.

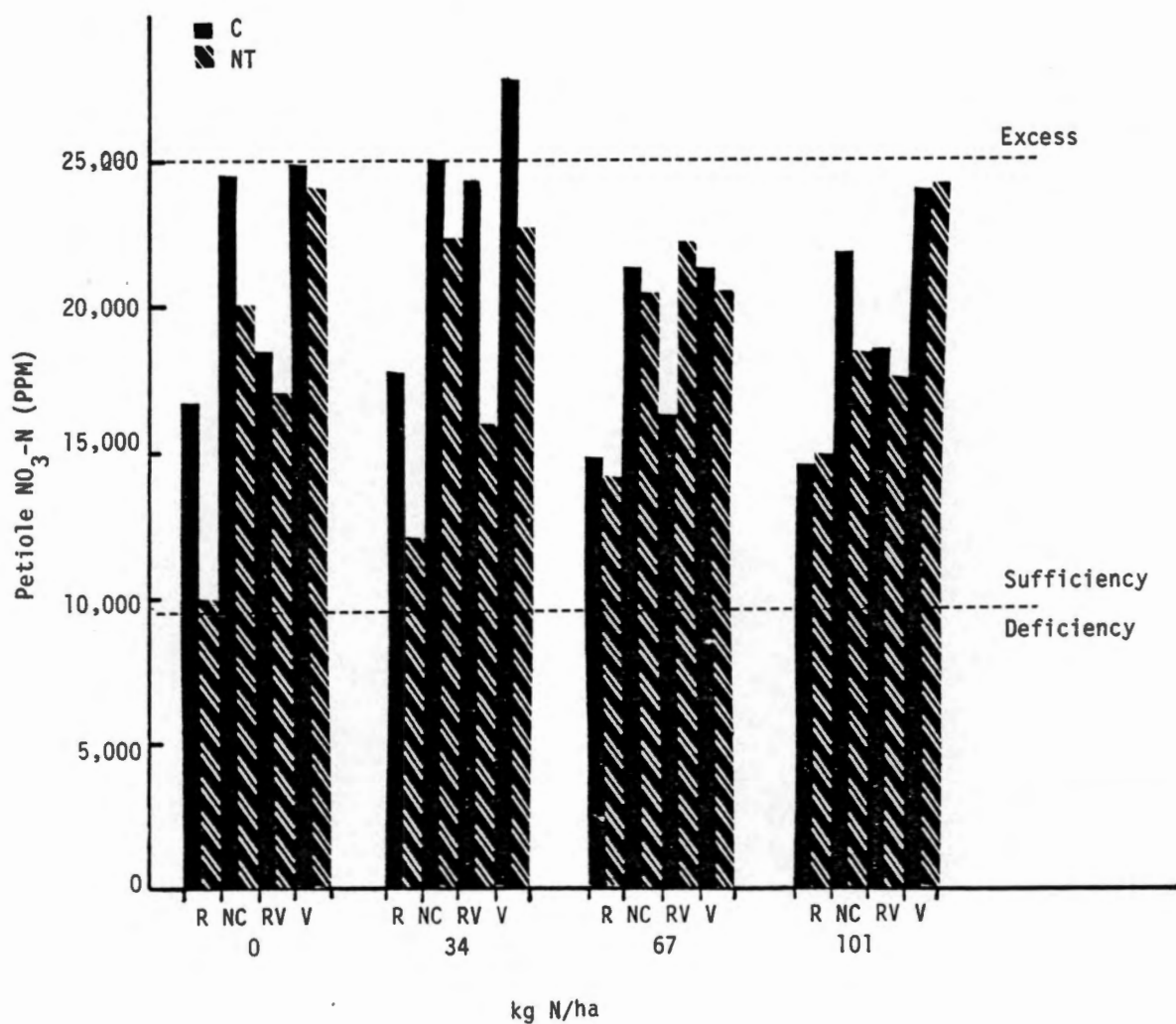


Figure 25. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on July 14, 1981.

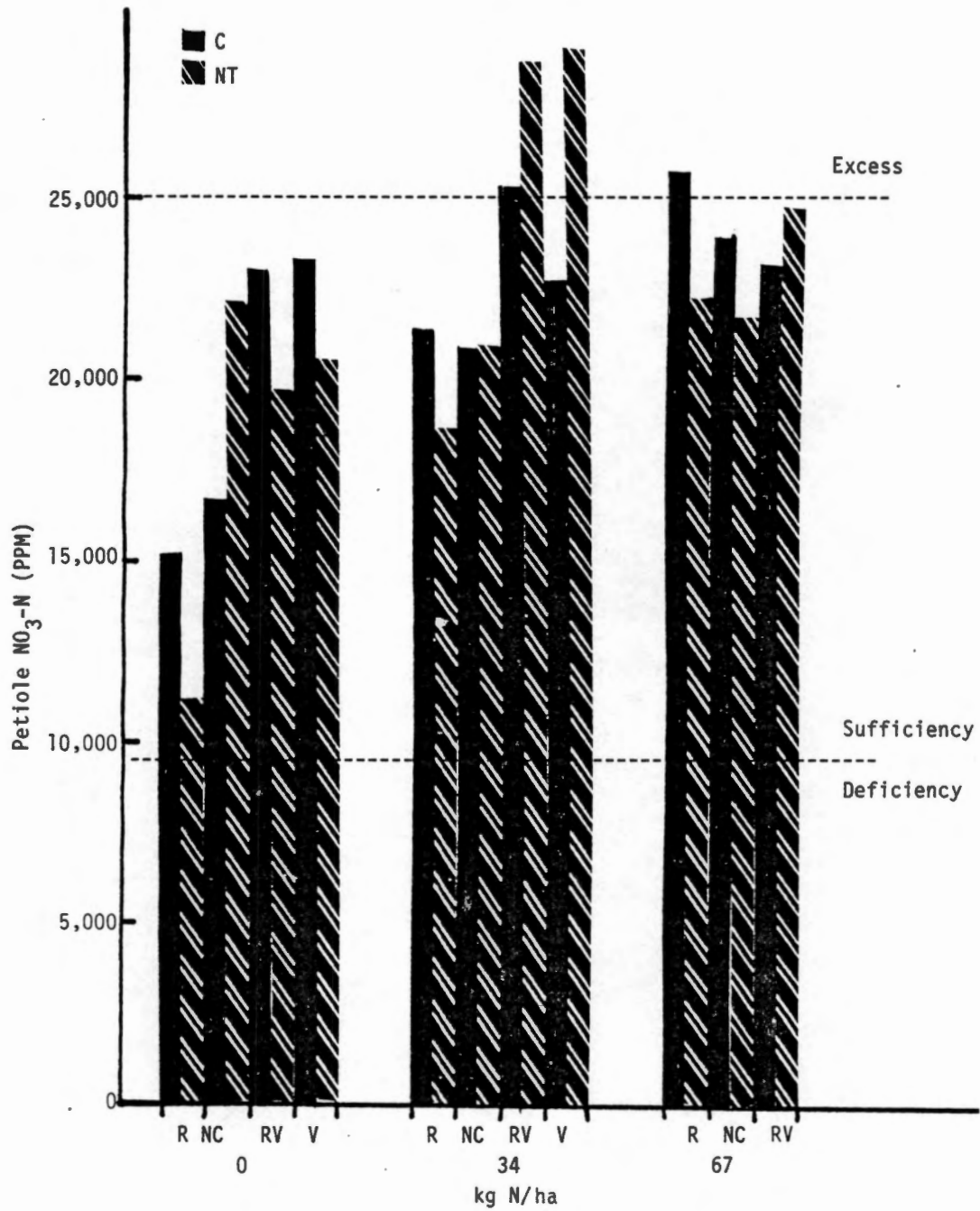


Figure 26. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on July 15, 1981.

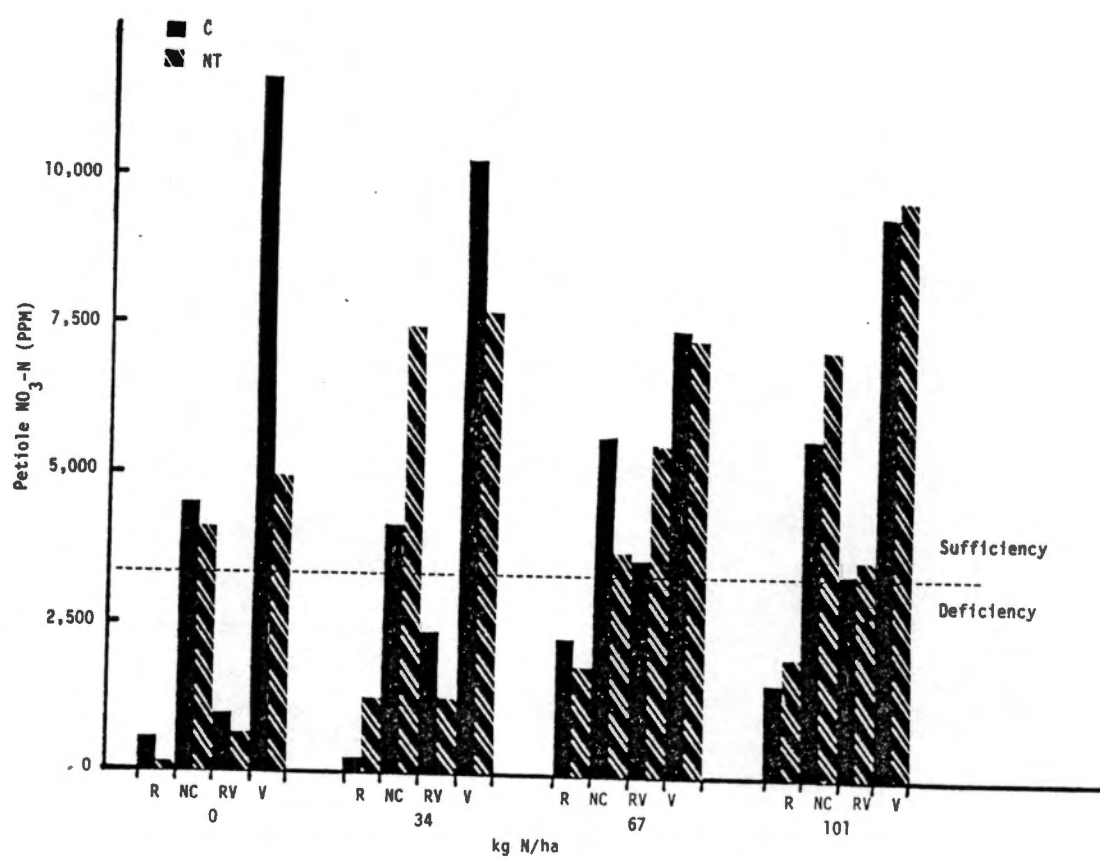


Figure 27. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on July 31, 1981.

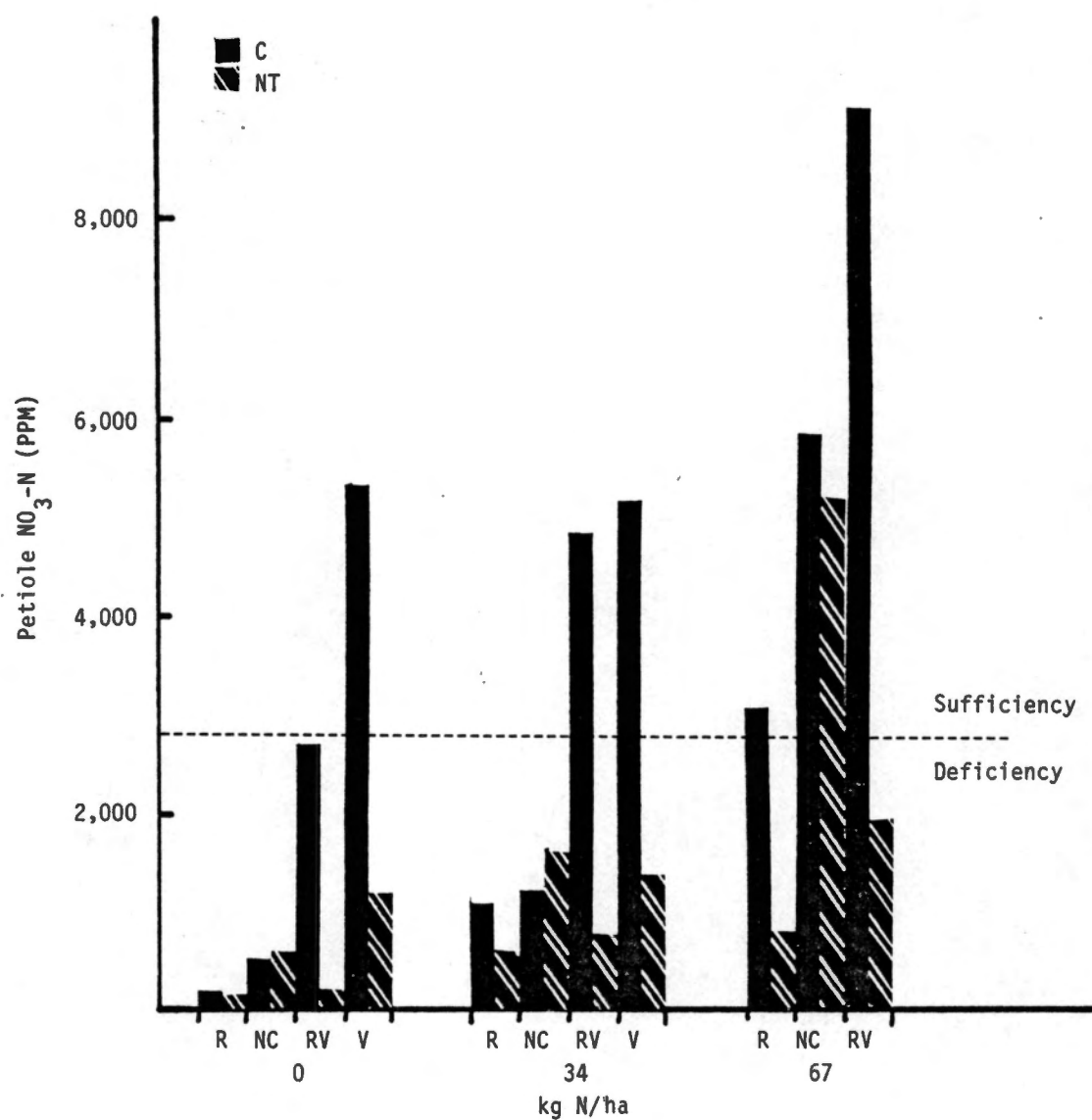


Figure 28. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on August 3, 1981.

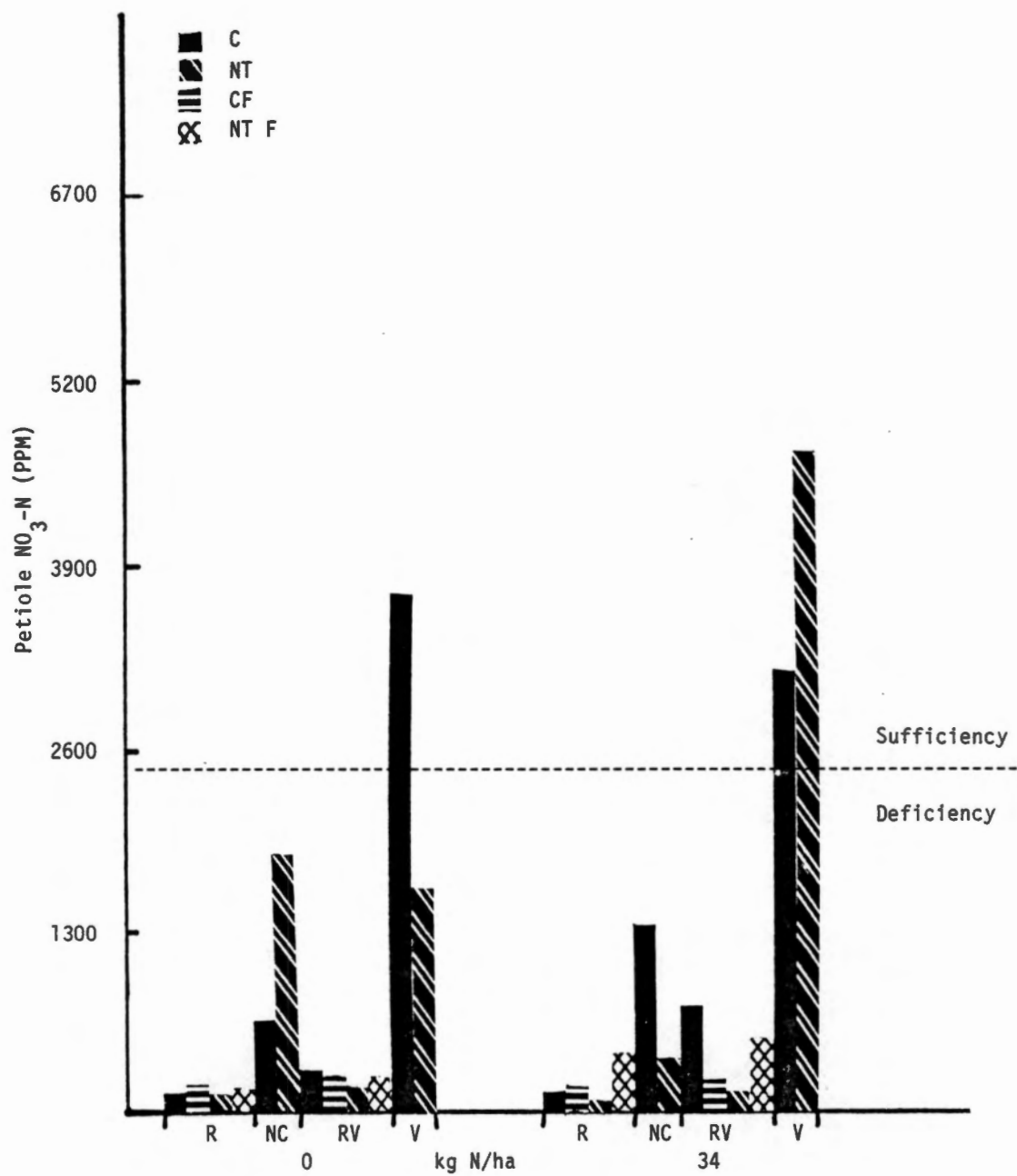


Figure 29. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 19, 1981.

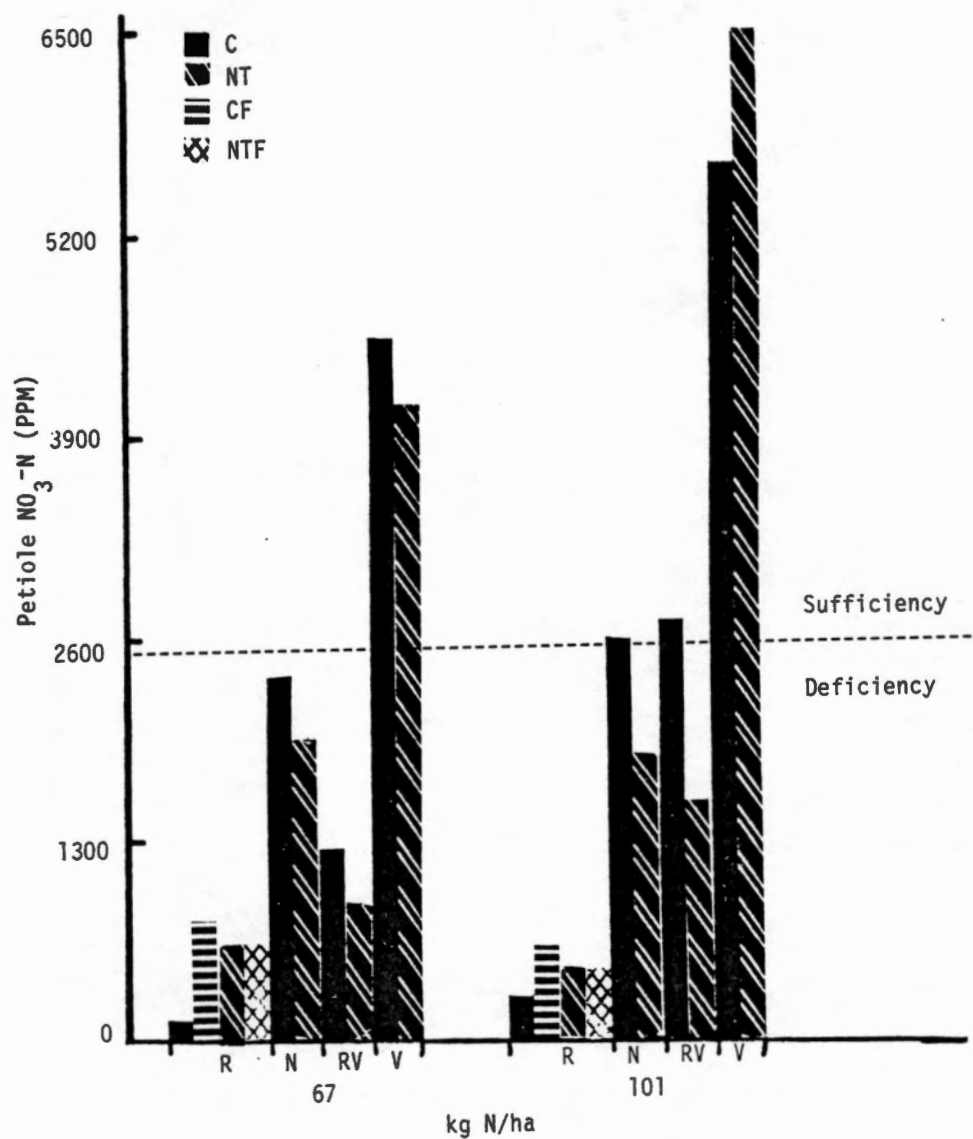


Figure 30. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 19, 1981.

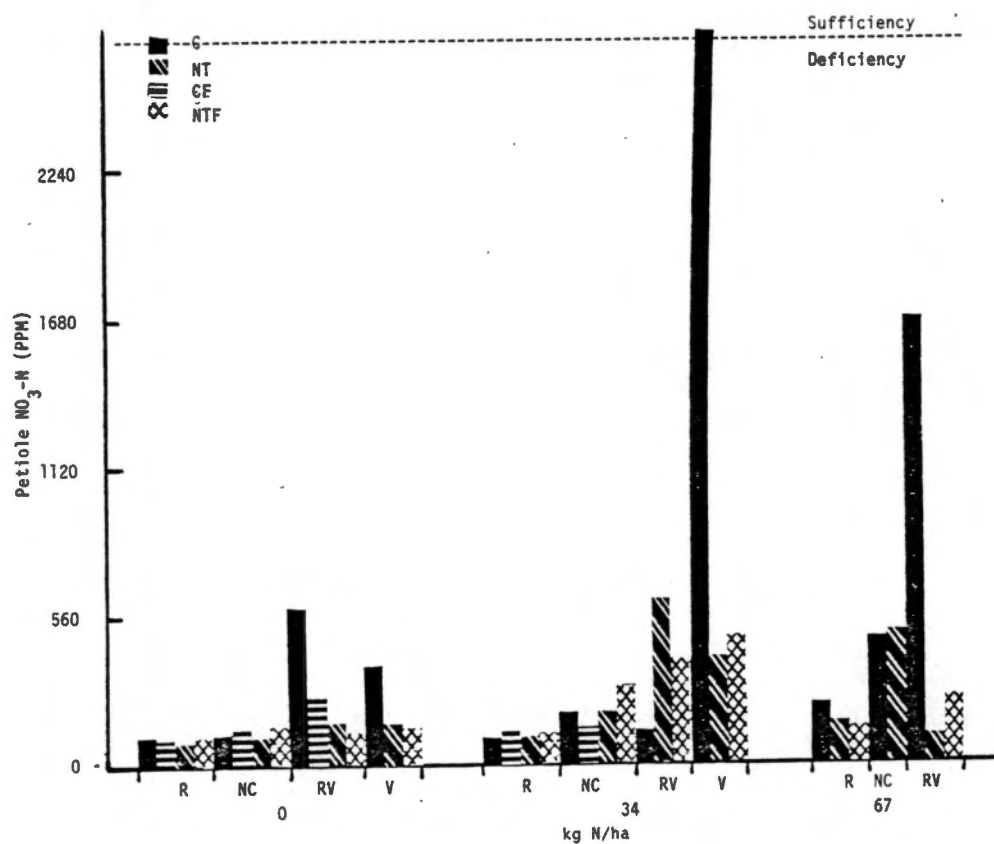


Figure 31. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on August 20, 1981.

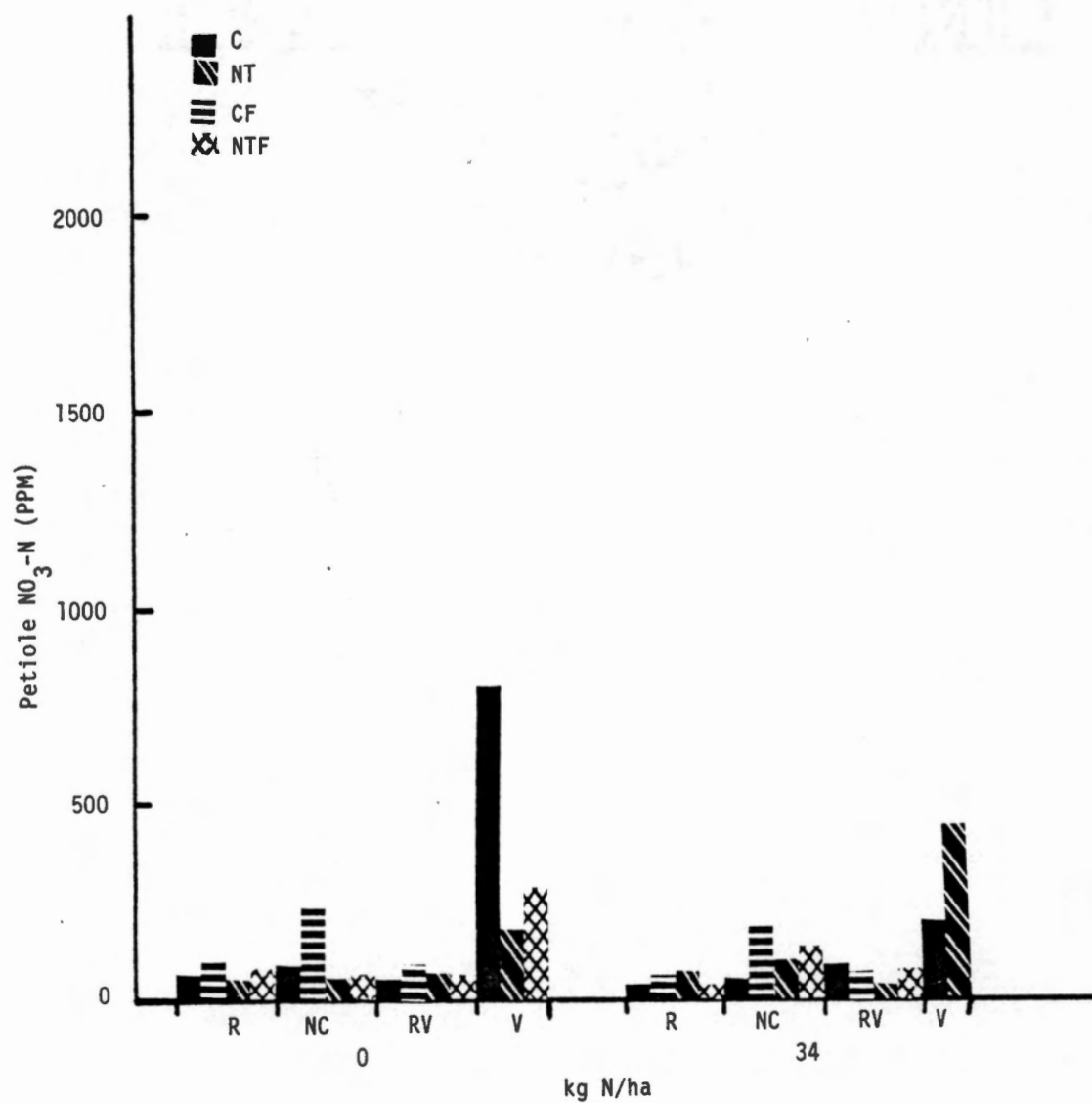


Figure 32. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on September 10, 1981.

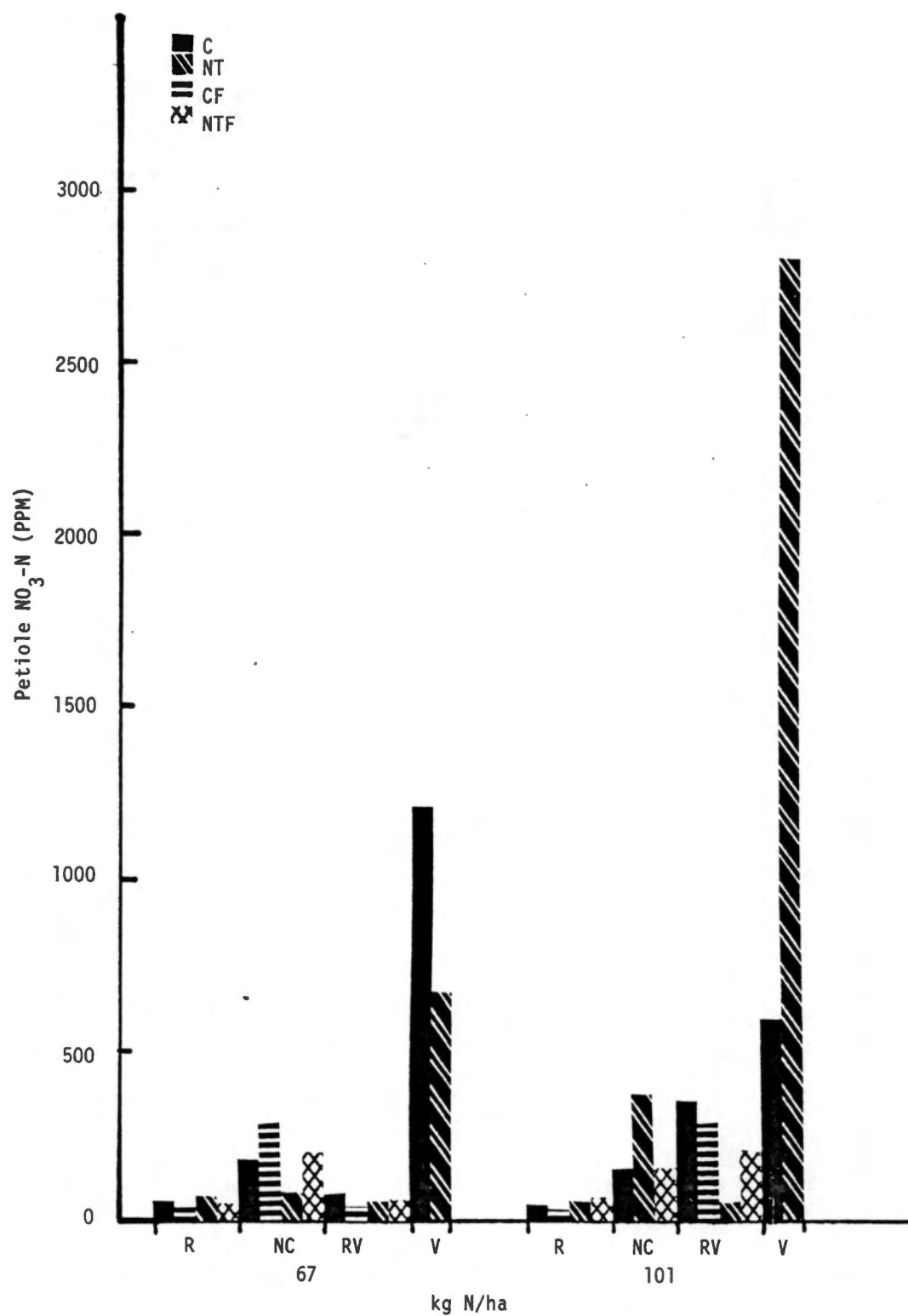


Figure 33. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on September 10, 1981.

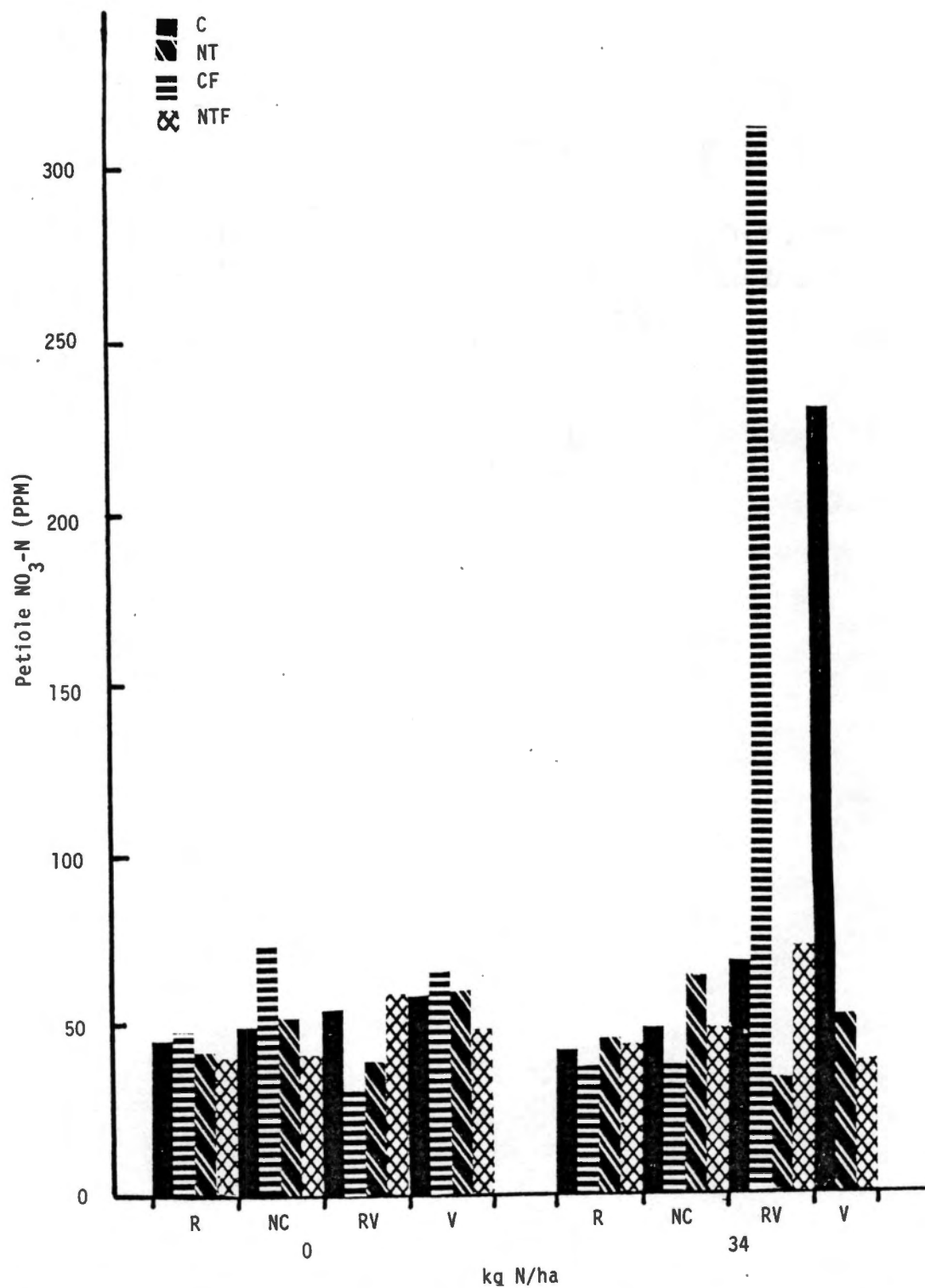


Figure 34. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on September 3, 1981.

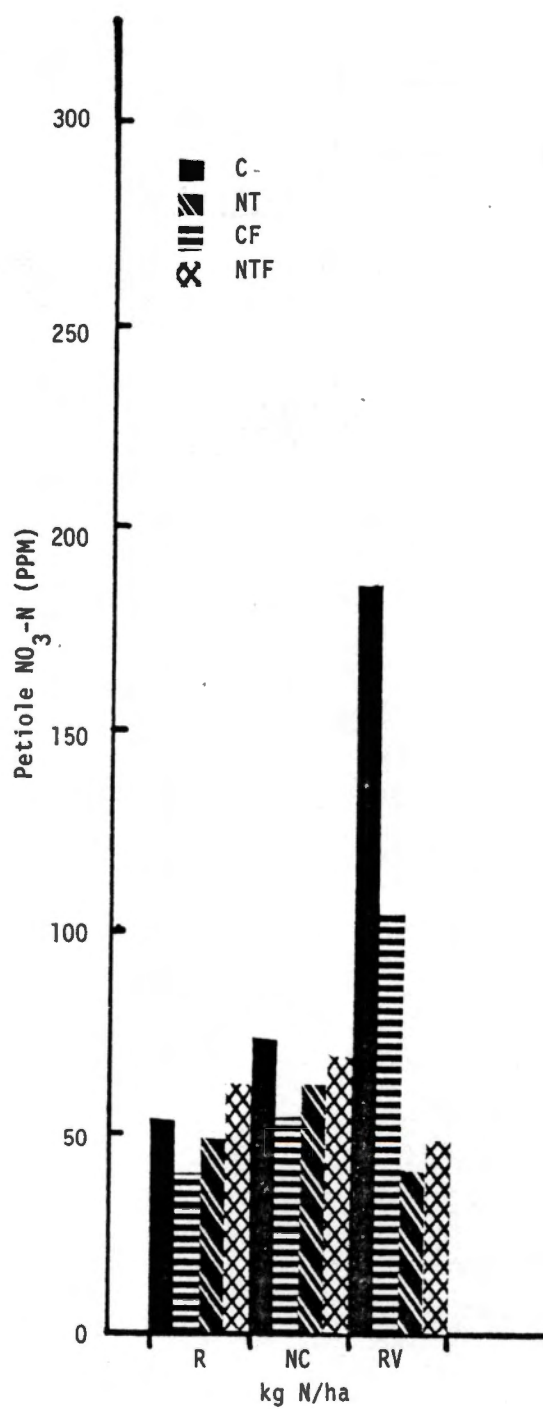


Figure 35. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on September 3, 1981.

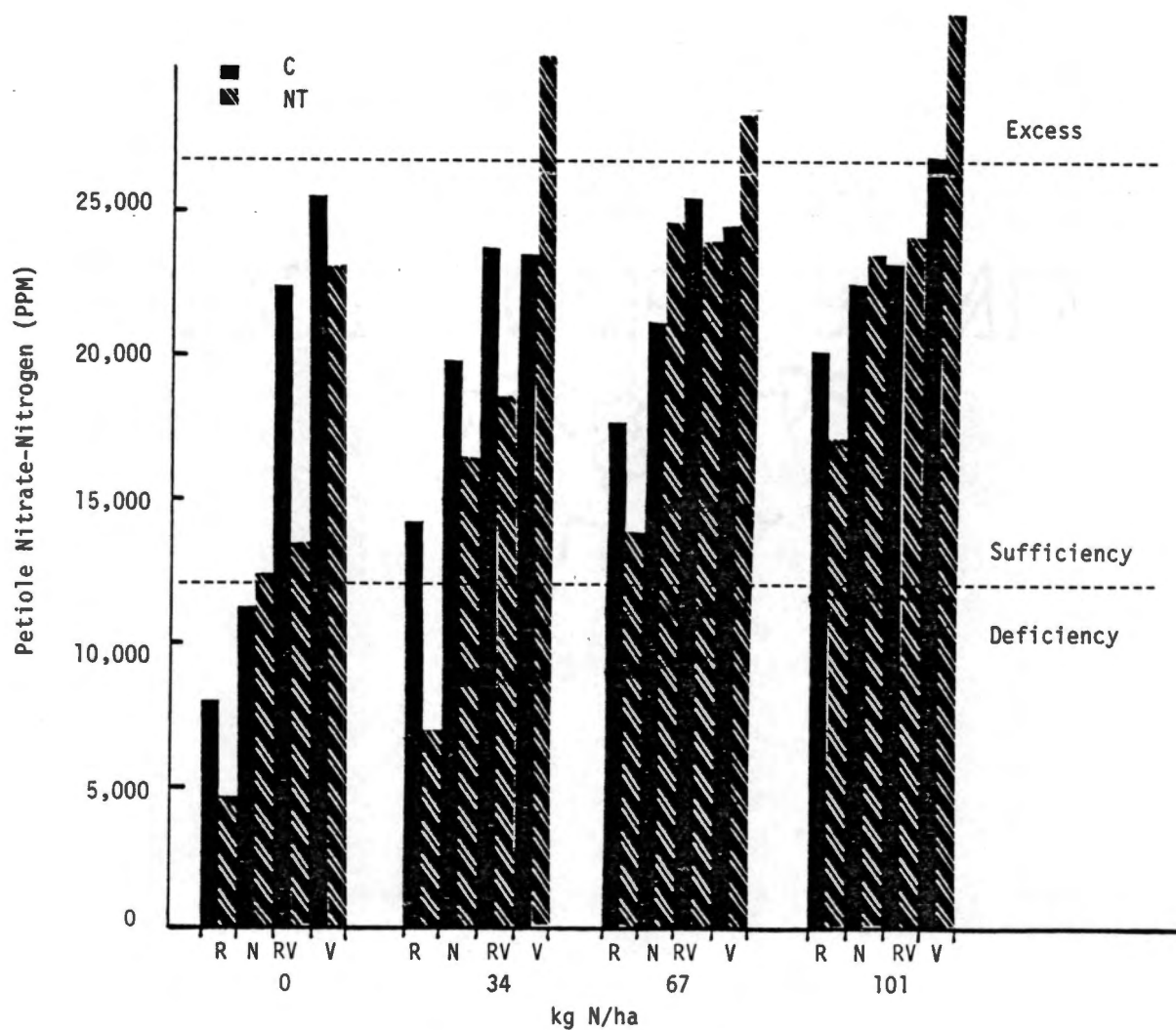


Figure 36. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on July 13, 1982.

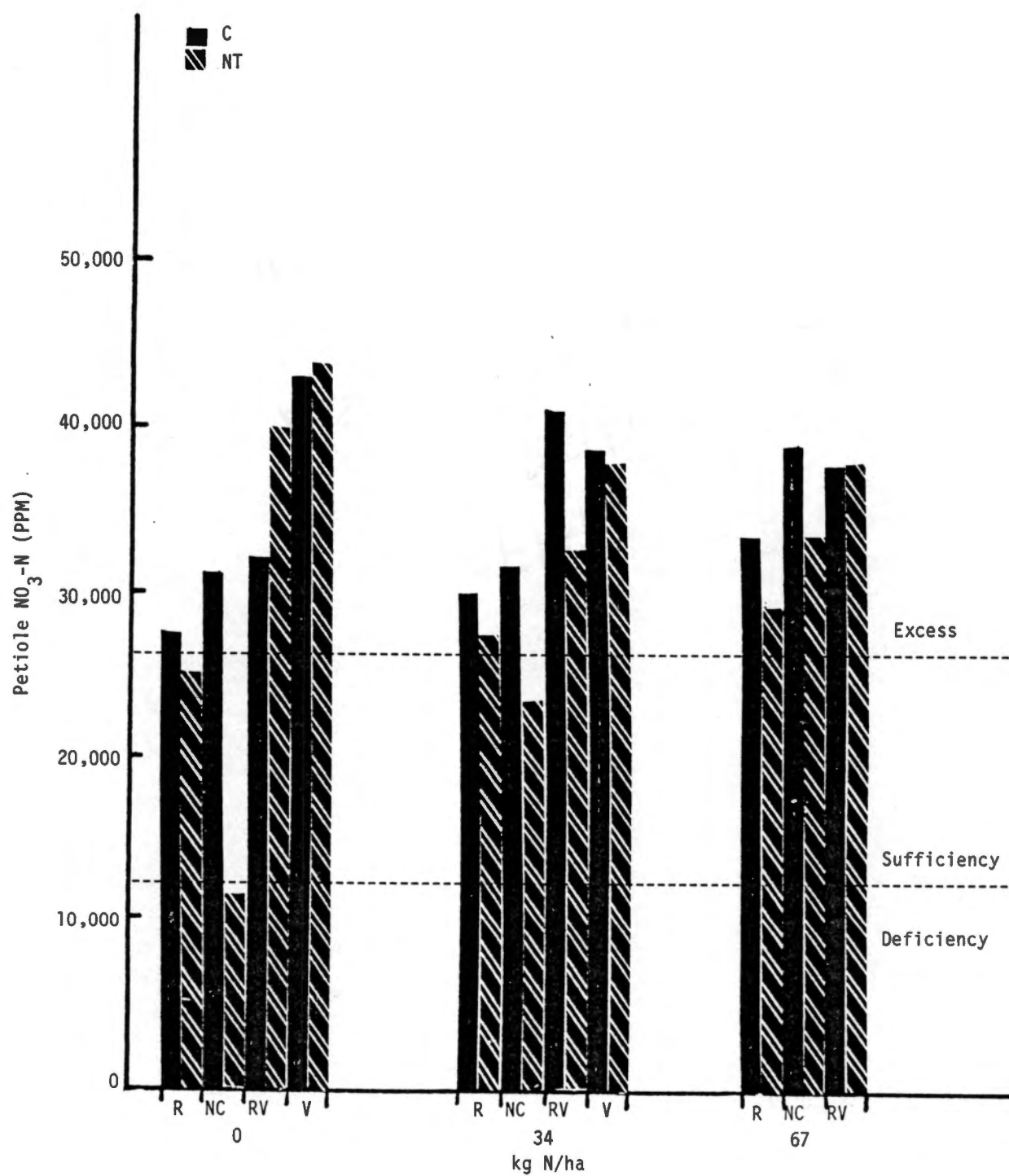


Figure 37. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on July 7, 1982.

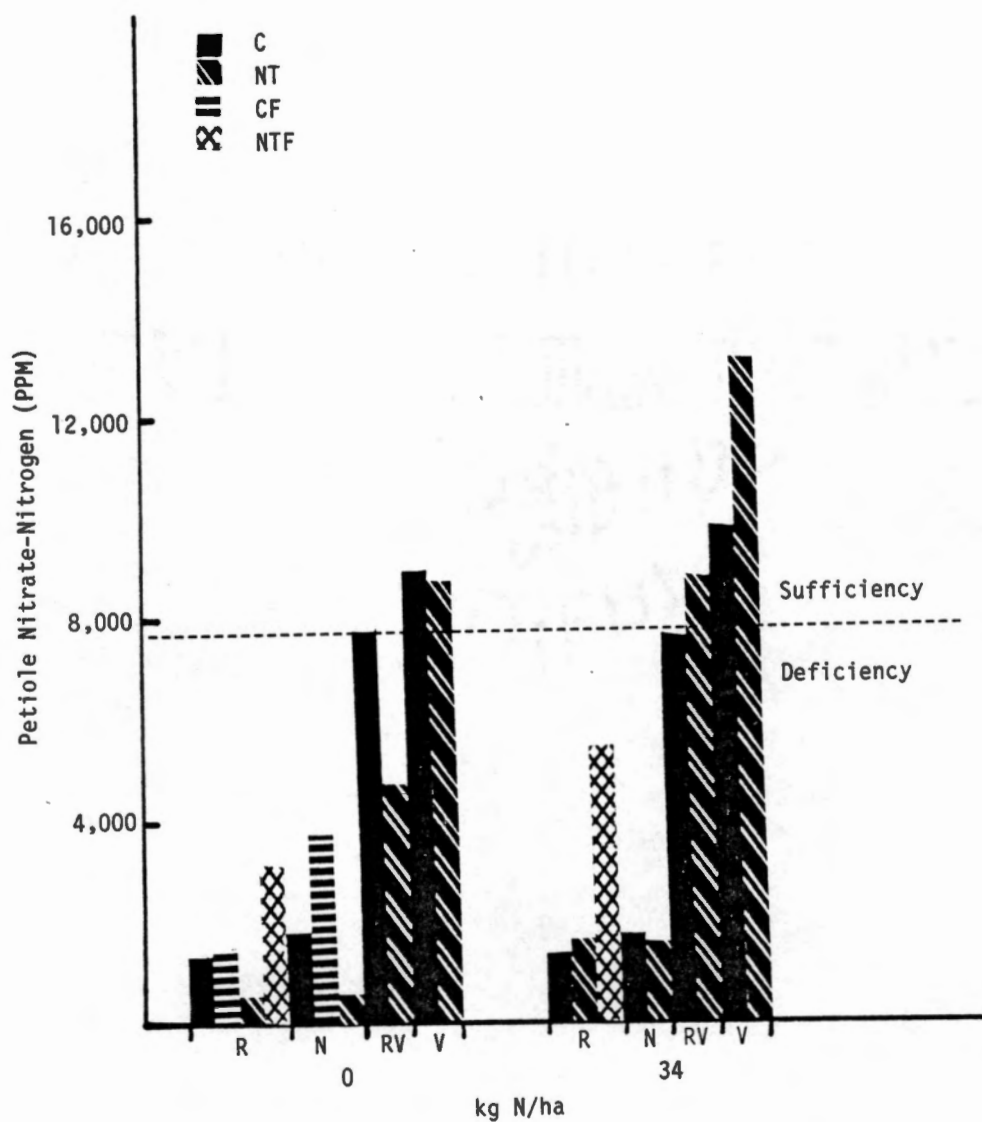


Figure 38. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on July 27, 1982.

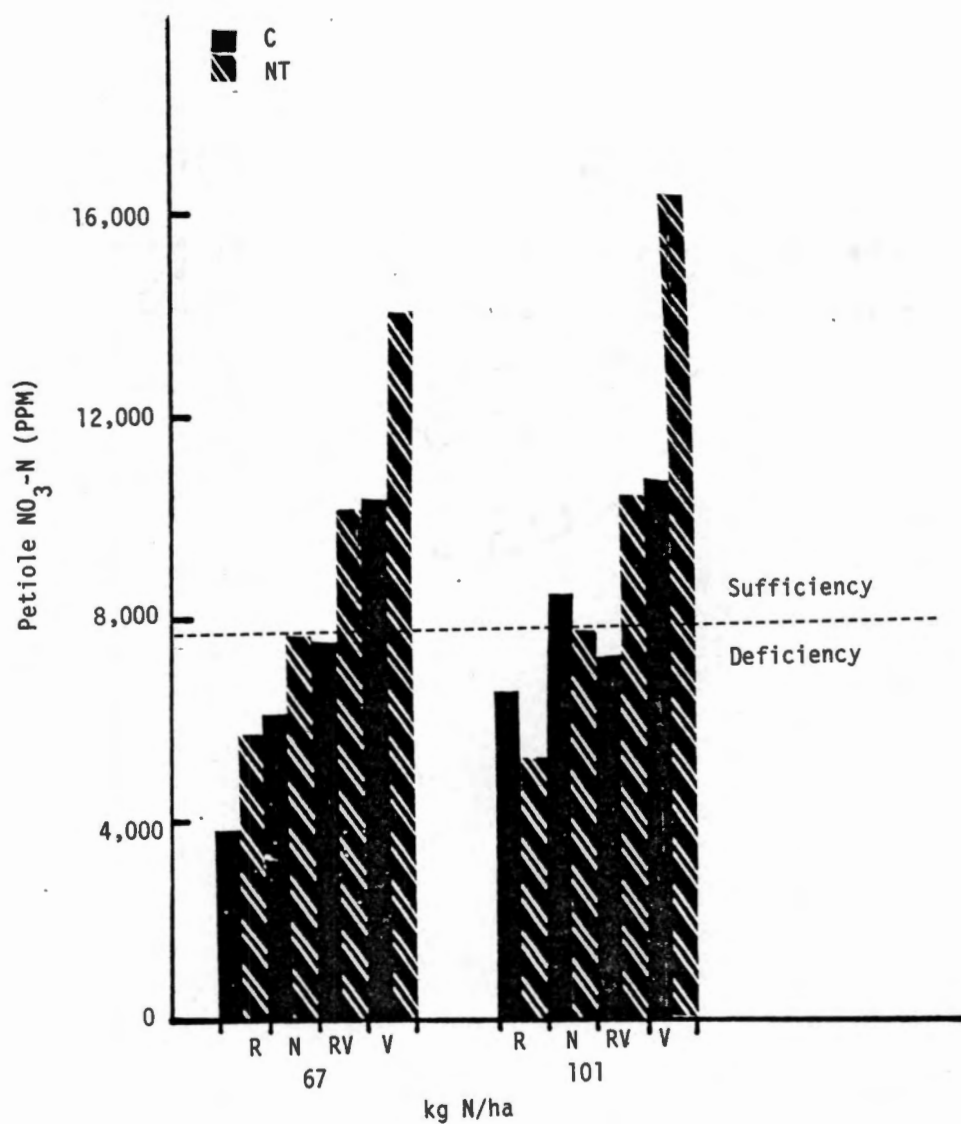


Figure 39. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on July 27, 1982.

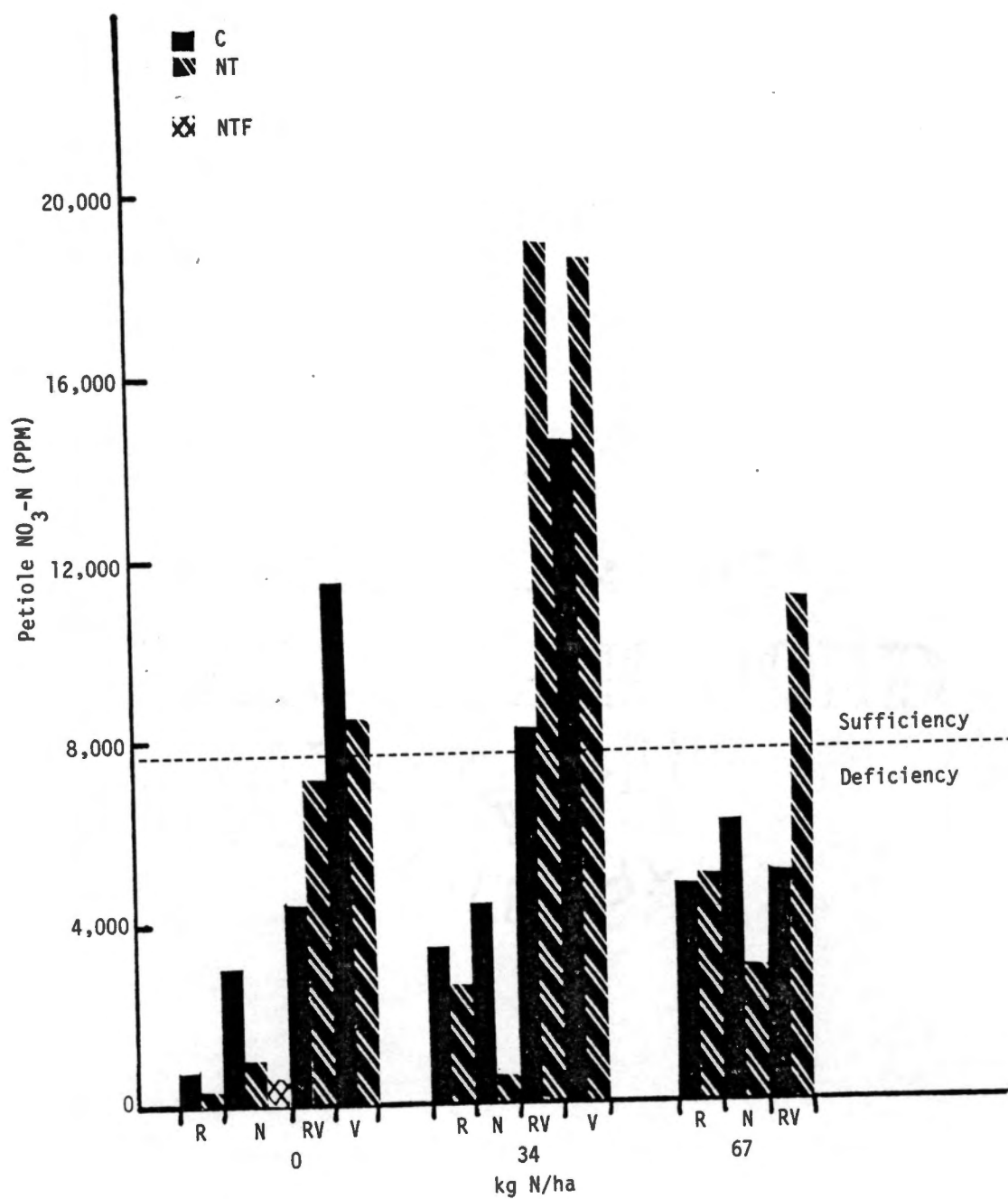


Figure 40. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on July 23, 1982.

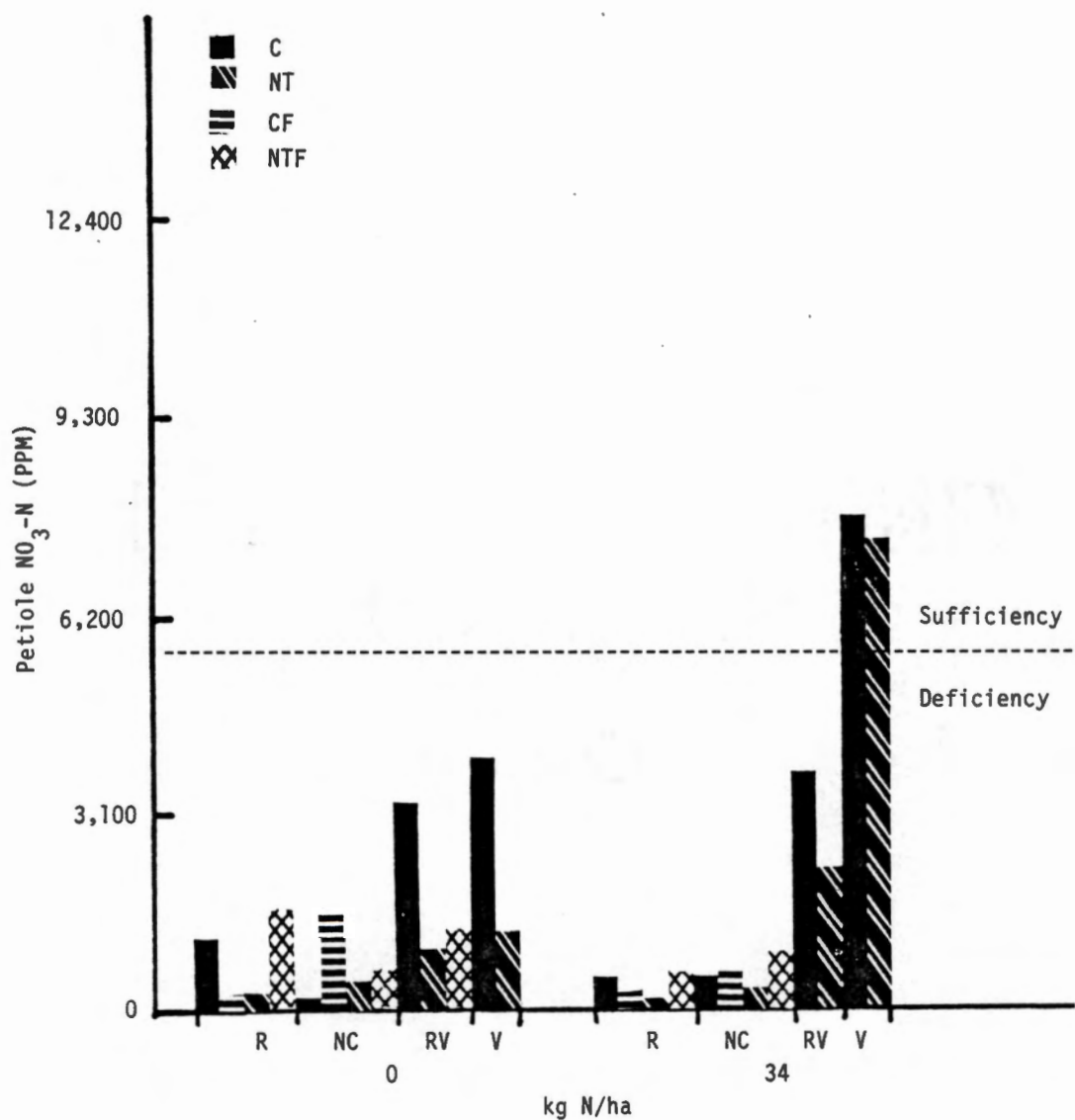


Figure 41. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 9, 1982.

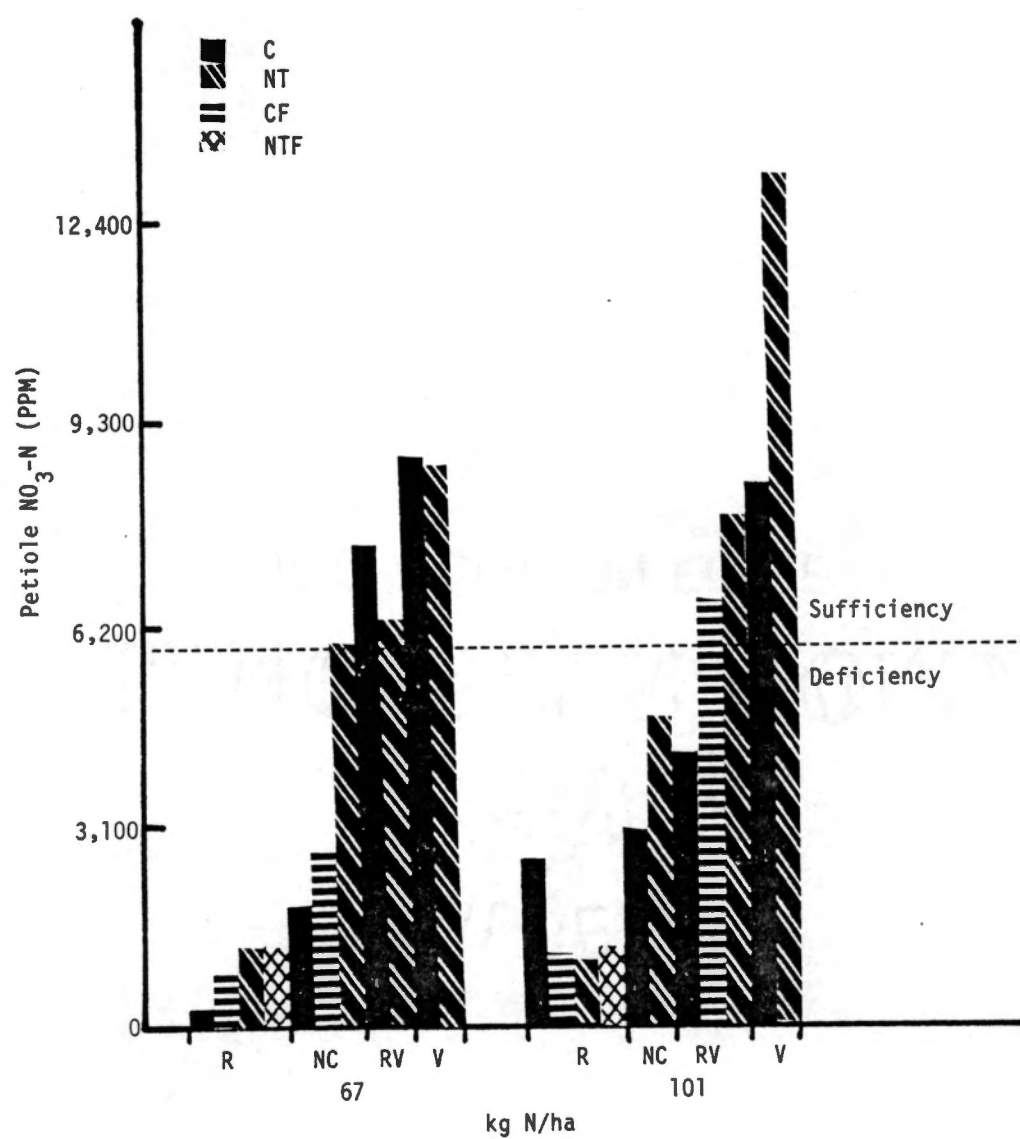


Figure 42. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 9, 1982.

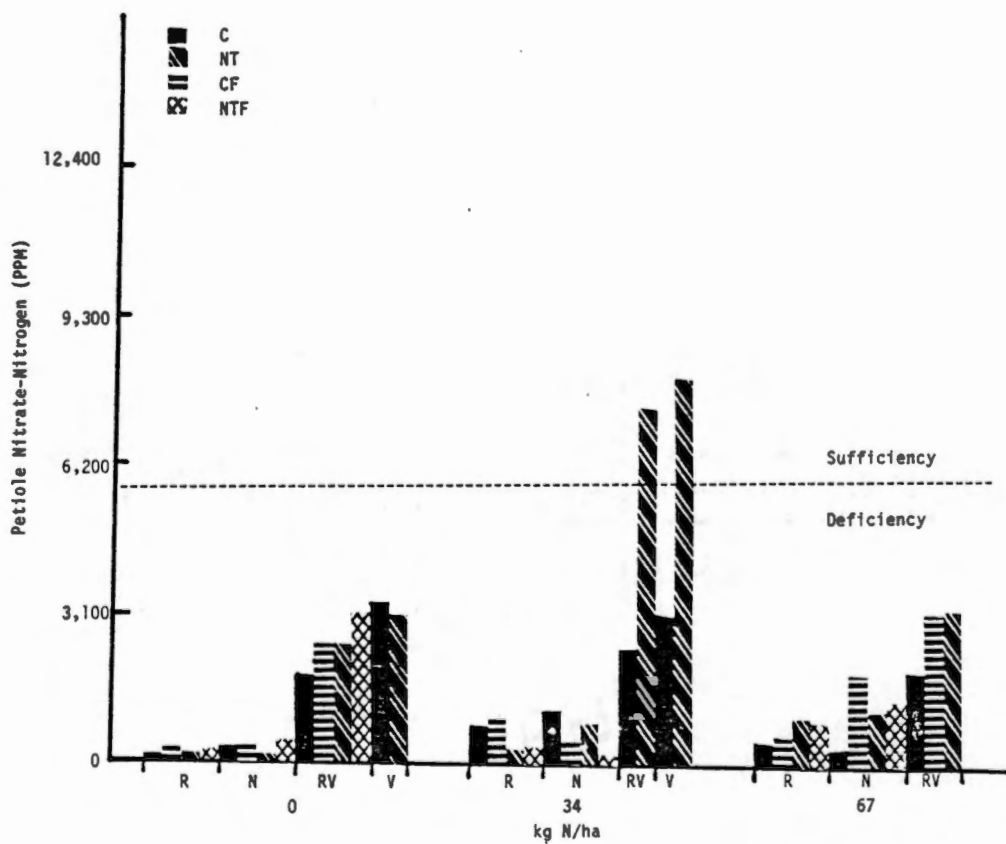


Figure 43. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on August 6, 1982.

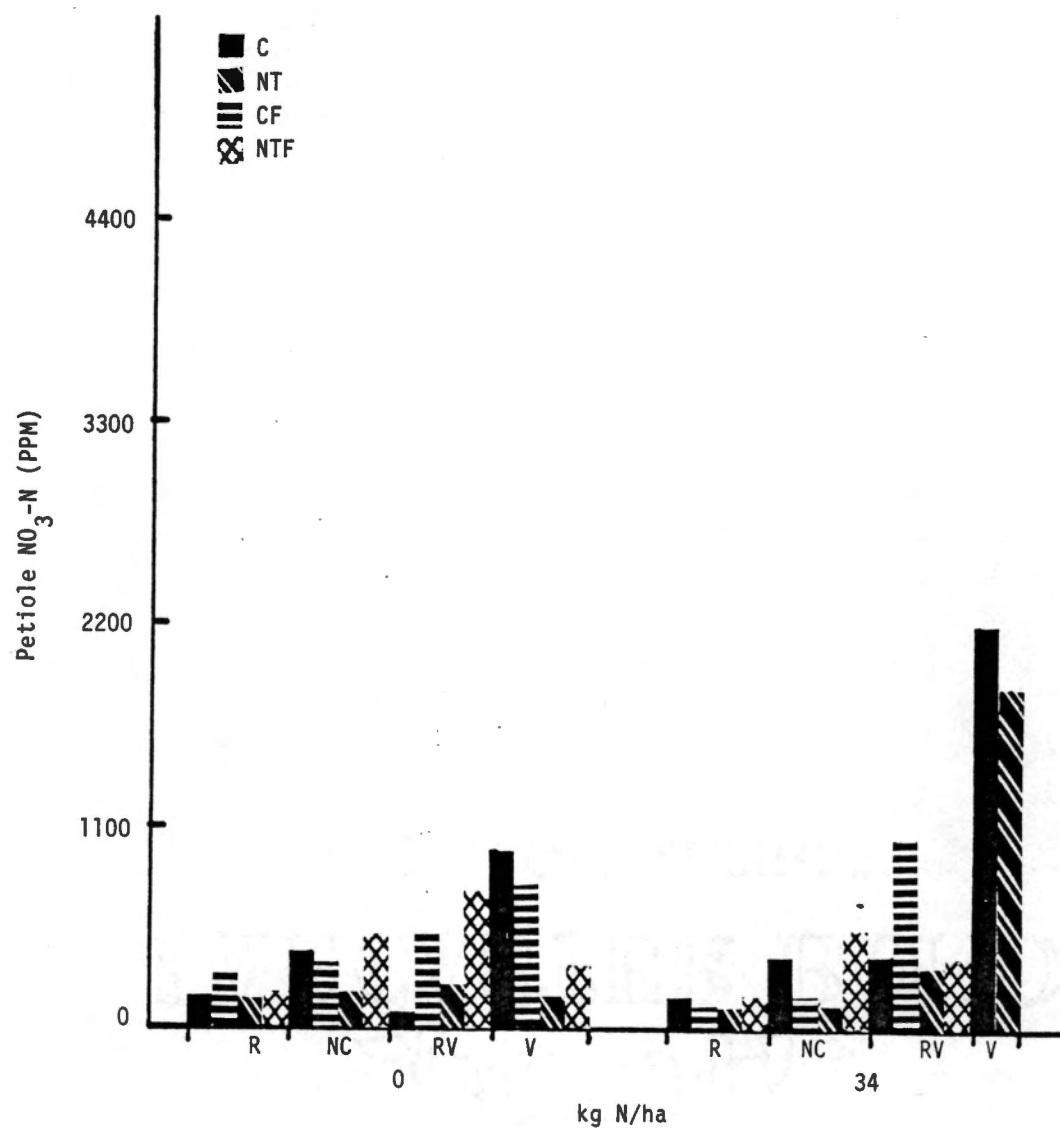


Figure 44. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 25, 1982.

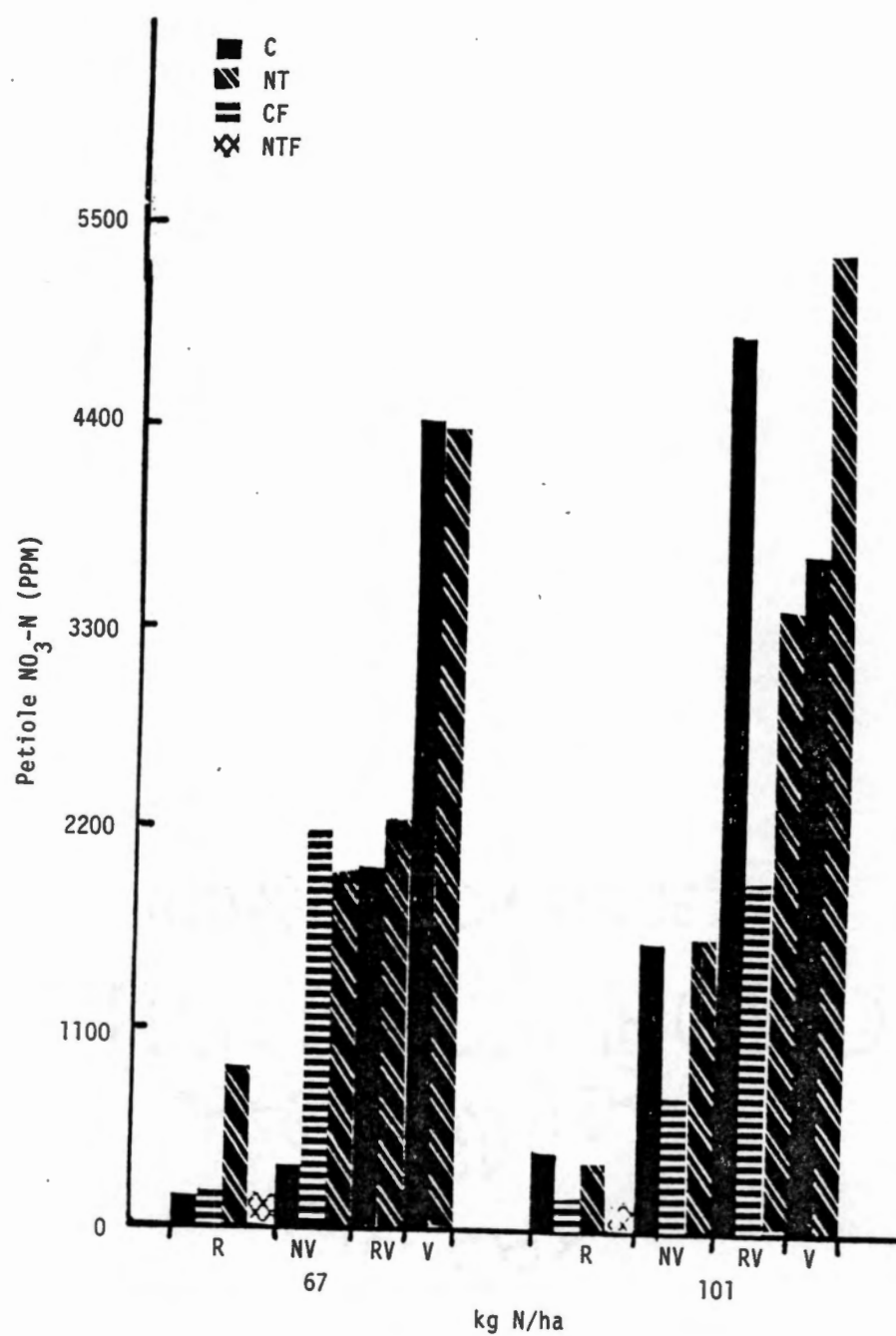


Figure 45. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Jackson on August 25, 1982.

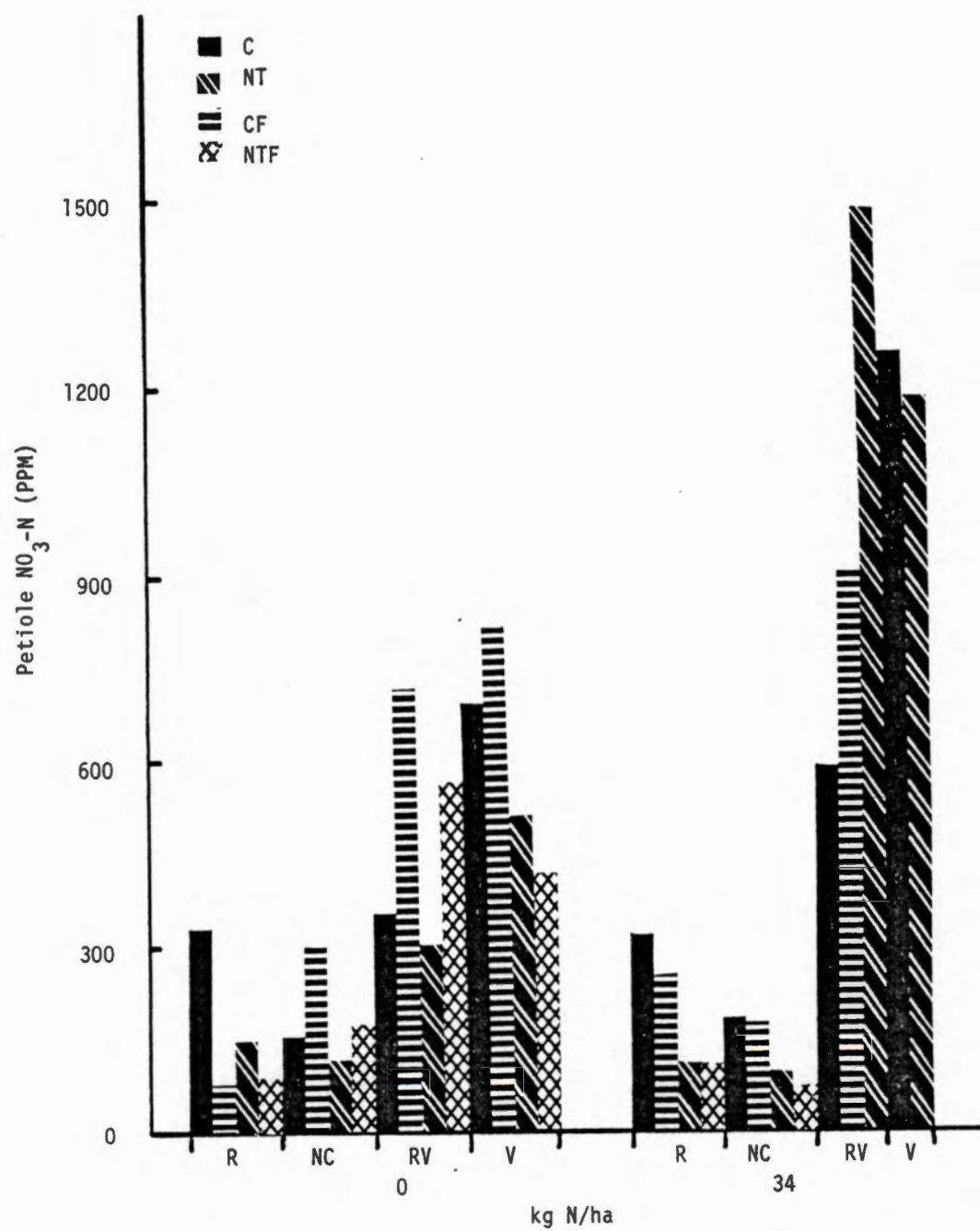


Figure 46. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on August 23, 1982.

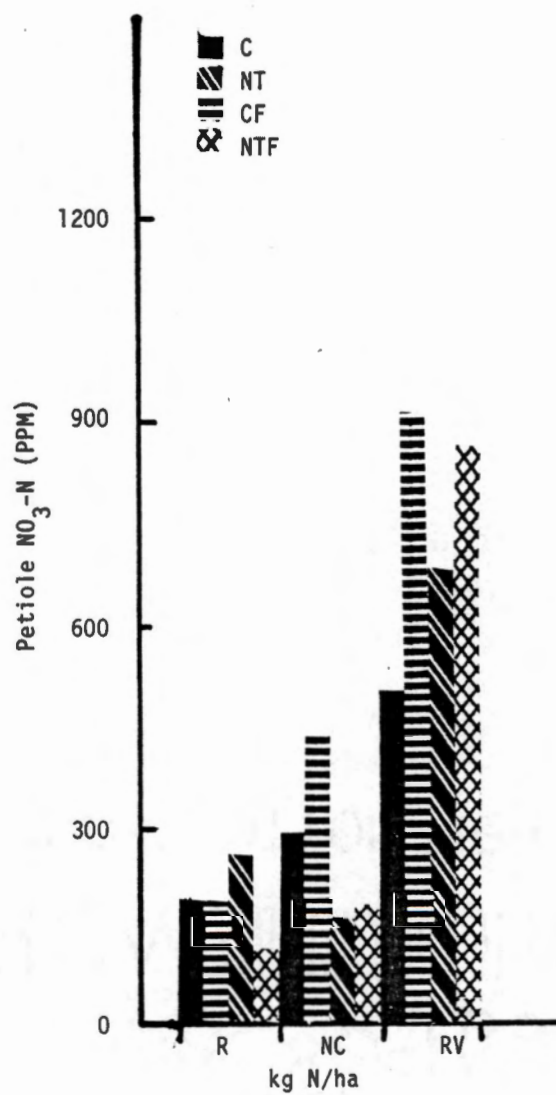


Figure 47. Effect of cover, tillage, and nitrogen fertilization on petiole nitrate-nitrogen content at Milan on August 23, 1982.

these were sufficient at 67 and 101 kg N/ha. Petiole $\text{NO}_3\text{-N}$ indicated deficiency at all N rates where R was the cover. Where RV was the cover, petiole $\text{NO}_3\text{-N}$ content was consistently higher than where rye alone was the cover. Deficiency of R and RV cover treatments could be due to immobilization of available N by decomposition of excessive dry matter.

At Milan the second sampling was taken on August 3, 1981 (Figure 28). There was a significant cover by tillage interaction as well as a significant N effect. More treatments were deficient on this date. At 0 kg N/ha rate, CT-V was the only treatment with a sufficient petiole $\text{NO}_3\text{-N}$ content. At 34 kg N/ha rate, only CT-V and CT-RV indicated sufficiency. At 67 kg N/ha rate, all treatments indicated sufficiency except NT-R and NT-RV. CT-RV at 67 kg N/ha was highest in petiole $\text{NO}_3\text{-N}$ content. Petiole $\text{NO}_3\text{-N}$ content increased as N rate increased. Petioles of cotton planted NT tended to be lower in $\text{NO}_3\text{-N}$ than those of cotton planted CT. This again was possibly due to immobilization of N by microbial decomposition of residue on the surface.

All plots indicating deficiency at the second sample date were split and a foliar application of urea was applied randomly to one subplot.

The third sampling was conducted on August 19, 1981. At Jackson a significant N rate by cover interaction was evident. Cotton petiole $\text{NO}_3\text{-N}$ under all NC, R, and RV treatments indicated deficiency with the exception of CT-NC and CT-RV at 101 kg N/ha. However, petioles of cotton planted in V remained sufficient except

NT-V at 0 kg N/ha (Figures 29 and 30). Subplots which received foliar urea tended to be slightly higher (although not significantly) or equivalent to treatments receiving no foliar urea; however, all treatments were still deficient. Petiole $\text{NO}_3\text{-N}$ content increased with N rate.

At Milan the third sampling was conducted on August 20, 1981. A cover by tillage interaction had a significant effect on the petiole $\text{NO}_3\text{-N}$ content at this sample date. Only petioles of cotton planted CT-V at 34 kg N/ha indicated sufficiency (Figure 31). Where a cover was present samples from NT plots tended to be lower in $\text{NO}_3\text{-N}$ than those from CT. Where cotton was planted in NC, petiole $\text{NO}_3\text{-N}$ was similar under both NT and CT. A release of N from V plots was evident. Again, petiole $\text{NO}_3\text{-N}$ of subplots which received foliar urea were equivalent to and not higher than those which did not.

All plots at Jackson which were deficient received foliar urea and a fourth sampling was conducted on September 10, 1981. The results are presented in Figures 32 and 33. None of the sources of variance indicated a significant effect on petiole $\text{NO}_3\text{-N}$ at this sampling date. Petiole $\text{NO}_3\text{-N}$ remained consistently higher under V, but CT was not higher than NT. Petiole $\text{NO}_3\text{-N}$ of cotton planted in NC increased with increased N rate, but content was very low. At Milan, the fourth sampling was conducted on September 3, 1981, and results are presented in Figures 34 and 35. Again, there was no significant effect on petiole $\text{NO}_3\text{-N}$. All treatments had extremely low petiole $\text{NO}_3\text{-N}$. Petioles of cotton planted CT-V at 34 kg N/ha and CT-RV at 67 kg N/ha had the highest levels of petiole $\text{NO}_3\text{-N}$. Where

foliar urea was applied to CT-RV at 34 kg N/ha, petiole $\text{NO}_3\text{-N}$ was extremely high as compared to other treatments. Subplots receiving foliar urea tended to be slightly higher in petiole $\text{NO}_3\text{-N}$ content, but none indicated sufficiency.

On the first sampling in 1981 at both locations all treatments indicated sufficiency. After the second sampling at Jackson the petioles of cotton planted in V indicated that N was being released by the V since these treatments were sufficient or higher in petiole $\text{NO}_3\text{-N}$. Petiole levels under NC were not as low as those under R or RV, but sufficiency was achieved only with 101 kg N/ha in CT plots. Petioles of cotton planted NT and CT into RV or R showed deficiency sooner both visually and based on petiole analysis, especially at lower N rates. This was partly due to immobilization of both fertilizer and native soil N by microbial decomposition of the R residue. At Milan trends were similar for petiole $\text{NO}_3\text{-N}$ levels under the four cover situations as at Jackson; however, N relationships were somewhat different. All petioles were lower in $\text{NO}_3\text{-N}$ sooner than those at Jackson. Levels under NT were generally lower which may have been due to the presence of residue which affected soil water and soil temperature. Significant tillage by cover interactions were present at Milan, but not at Jackson.

In 1982 the first sampling at Jackson was conducted on July 13. There was a significant cover by N rate interaction which affected petiole $\text{NO}_3\text{-N}$ content. All treatments indicated sufficiency except CT-R, NT-R, and CT-NC at 0 kg N/ha and NT-R at 34 kg N/ha (Figure 36). Petiole $\text{NO}_3\text{-N}$ was highest under V followed by RV and NC.

Lowest levels were under R. Petiole $\text{NO}_3\text{-N}$ tended to increase with N rate. At Milan the first sampling was conducted on July 7, 1982. Cover and tillage as well as N rate and cover interactions were evident. Treatments indicated sufficient petiole $\text{NO}_3\text{-N}$ with the exception of NT-NC at 0 kg N/ha. Petiole $\text{NO}_3\text{-N}$ levels at Milan were higher than those at Jackson. Petioles indicated excessive $\text{NO}_3\text{-N}$ under V and RV. Petioles of cotton planted NT-R and NT-NC tended to be lower in $\text{NO}_3\text{-N}$ than those of cotton planted CT. Plots indicating deficiency at the first sampling were subdivided and a ground application of ammonium nitrate (NH_4NO_3) was applied.

The second sampling was conducted on July 27 at Jackson and on July 23 at Milan. At both locations the $\text{NO}_3\text{-N}$ dropped considerably compared to the first sampling date. At Jackson both cover and N rate significantly affected petiole $\text{NO}_3\text{-N}$ content. Petiole $\text{NO}_3\text{-N}$ under NT-V and CT-V remained sufficient at all N rates (Figures 38 and 39). CT-RV at 0, 34, and 67 kg N/ha and NT-RV at 34, 67, and 101 kg N/ha also indicated sufficient petiole $\text{NO}_3\text{-N}$. At 101 kg N/ha, CT-NC and NT-NC indicated sufficiency. All other treatments were slightly deficient in petiole $\text{NO}_3\text{-N}$. Those treatments receiving NH_4NO_3 were higher in petiole $\text{NO}_3\text{-N}$ than those which received none, but deficiency was still indicated. At Milan cover by tillage interacted to significantly affect petiole $\text{NO}_3\text{-N}$ content. Petiole $\text{NO}_3\text{-N}$ indicated sufficiency under V at all N rates. Petioles of cotton planted CT-RV and NT-RV at 34 kg N/ha and NT-RV at 67 kg N/ha had sufficient $\text{NO}_3\text{-N}$ content. Petioles of cotton planted in R were lowest in $\text{NO}_3\text{-N}$ followed by NC. Petiole $\text{NO}_3\text{-N}$ tended to increase with

increased N rate, and NT tended to be lower than CT, especially under NC. Under NT-NC at 0 kg N/ha, NH_4NO_3 did not increase petiole $\text{NO}_3\text{-N}$.

All plots on which deficiency was indicated were split and foliar urea was applied to one of the subplots. The third sampling was conducted on August 9 at Jackson and August 6 at Milan. At Jackson there was a significant interaction between cover and N rate.

Petiole $\text{NO}_3\text{-N}$ under CT-V and NT-V was sufficient at 34, 67, and 101 kg N/ha (Figures 41 and 42). The NT-RV and CT-RV treatments at 67 and 101 kg N/ha produced sufficient petiole $\text{NO}_3\text{-N}$. Cotton planted CT-RV at 101 kg N/ha which received foliar urea was in the sufficiency range at this sampling date. NT-NC treatments indicated sufficient petiole $\text{NO}_3\text{-N}$ at 67 and 101 kg N/ha. Petioles of cotton which received foliar urea tended to be slightly higher in $\text{NO}_3\text{-N}$ than those which received no urea.

At Milan only NT-V and NT-RV at 34 kg N/ha resulted in sufficient petiole $\text{NO}_3\text{-N}$, while all other treatments indicated deficiency (Figure 43). Petioles of cotton receiving urea tended to be higher in $\text{NO}_3\text{-N}$ than those receiving no foliar urea; however, foliar urea never increased petiole $\text{NO}_3\text{-N}$ to sufficiency.

Again, plots indicating deficient petiole $\text{NO}_3\text{-N}$ were subdivided and subplots received foliar urea. A fourth sampling was conducted at Jackson on August 25 and at Milan on August 23. At Jackson, cover and N rate had a significant effect on petiole $\text{NO}_3\text{-N}$. Petioles of cotton planted in V at 67 and 101 kg N/ha, as well as that planted in RV at 101 kg N/ha, remained high as compared to other treatments (Figures 44 and 45). Petioles of cotton planted in R were

lowest in $\text{NO}_3\text{-N}$ followed by NC. Those plots which received foliar urea were not significantly higher than those which did not. At Milan nitrogen and cover significantly affected petiole $\text{NO}_3\text{-N}$ content. Petioles of cotton planted in V at 34 kg N/ha and RV at 34 and 67 kg N/ha were highest in petiole $\text{NO}_3\text{-N}$ (Figures 46 and 47). There was no trend for treatments which received foliar urea to be higher in petiole $\text{NO}_3\text{-N}$, except with CT-V or CT-RV.

In 1982 petioles of cotton grown in R were lowest in $\text{NO}_3\text{-N}$ probably due to immobilization of fertilizer N and native soil N by microbes in the decomposition process of plant residue. Where V was a cover, N release was indicated by high levels of petiole $\text{NO}_3\text{-N}$.

Covers strongly affected cotton petiole $\text{NO}_3\text{-N}$. Cotton petioles in R indicated deficiency at all N rates. Cotton petioles in RV remained sufficient longer but became deficient even where 67 or 101 kg N/ha was applied at planting. Cotton petioles in V always indicated sufficiency except NT-V at 0 kg N/ha. Petiole $\text{NO}_3\text{-N}$ was most closely related to applied N under the NC situation. At Jackson tillage did not affect petiole $\text{NO}_3\text{-N}$; however, at Milan NT cotton tended to become deficient sooner. This was especially true in 1981. Foliar urea resulted in greener, taller plants. This can be seen from the height measurements in Tables 3, 4, and 5. Excessive growth of cotton under V or RV with 101 kg N/ha coupled with adequate soil water may have caused lower petiole $\text{NO}_3\text{-N}$ than with 67 kg N/ha at Jackson.

Table 3. Average cotton plant height at Jackson during 1981.

N Rate (kg/ha)	Cover	Tillage	Height (cm)
0	R	NT	103
0	R	CT	105
0	V	NT	133
0	V	CT	134
0	RV	NT	114
0	RV	CT	121
0	NC	NT	113
0	NC	CT	126
34	R	NT	112
34	R	CT	107
34	V	NT	141
34	V	CT	127
34	RV	NT	114
34	RV	CT	125
34	NC	NT	110
34	NC	CT	119
67	R	NT	129
67	R	CT	121
67	V	NT	137
67	V	CT	124
67	RV	NT	128
67	RV	CT	135
67	NC	NT	107
67	NC	CT	114
101	R	NT	126
101	R	CT	124
101	V	NT	146
101	V	CT	128
101	RV	NT	141
101	RV	CT	133
101	NC	NT	116
101	NC	CT	137

Table 4. Average cotton plant height at Milan during 1981.

N Rate (kg/ha)	Cover	Tillage	Height (cm)
0	R	NT	83
0	R	CT	86
0	V	NT	116
0	V	CT	116
0	RV	NT	102
0	RV	CT	109
0	NC	NT	93
0	NC	CT	98
34	R	NT	99
34	R	CT	105
34	V	NT	138
34	V	CT	123
34	RV	NT	144
34	RV	CT	126
34	NC	NT	97
34	NC	CT	110
67	R	NT	105
67	R	CT	110
67	RV	NT	121
67	RV	CT	126
67	NC	NT	103
67	NC	CT	109

Table 5. Average cotton plant height at Milan during 1982.

N Rate (kg/ha)	Cover	Tillage	Height (cm)
0	R	NT	76
0	R	CT	76
0	V	NT	79
0	V	CT	78
0	RV	NT	80
0	RV	CT	83
0	NC	NT	75
0	NC	CT	80
34	R	NT	83
34	R	CT	79
34	V	NT	90
34	V	CT	77
34	RV	NT	90
34	RV	CT	84
34	NC	NT	80
34	NC	CT	76
67	R	NT	84
67	R	CT	76
67	RV	NT	78
67	RV	CT	79
67	NC	NT	78
67	NC	CT	77

Plant Height

Plant height was measured at Milan both years, while it was measured only once at Jackson in 1981 because of severe lodging in 1982.

In 1981 at Jackson there were significant interactions between N rate and tillage, tillage and cover, and N rate by cover. When averaged across cover, cotton planted no-till tended to be taller, and height increased with N rate.(Table 3). Cotton planted in R and NC was shorter than that planted in RV. Cotton planted NT in V was tallest. NT-NC was the shortest. When averaged across tillage, cotton planted in R at 0 kg N/ha was shortest; cotton planted in V at 101 kg N/ha was tallest. Cotton planted in RV and NC was intermediate.

At Milan in 1981 N rate and cover were significant, but there was not an interaction effect. Cotton planted in R was the shortest and that planted in V was tallest (Table 4). Cotton planted in RV was similar in height to that planted in V. Cotton planted in NC was taller than that planted in R. When averaged across cover and tillage, cotton planted in 0 kg N/ha was the shortest and that planted at 34 kg N/ha was tallest.

In 1981 foliar urea had no significant effect on plant height at either location. In 1982 at Milan there was little rainfall (except 32 cm in September) and cotton plants remained short and matured quickly (Table 5). There was a significant interaction between N rate and tillage. Averaged across cover, cotton planted NT

at 34 kg N/ha was tallest and cotton planted NT at 0 kg N/ha was shortest. Cotton planted CT at 67 kg N/ha was close in height to the NT at 0 kg N/ha. Others were intermediate. Again, foliar urea had no significant effect on plant height.

Cotton planted in R and NC was shorter and matured earliest. Cotton planted in RV and V grew vegetatively longer and matured later. Tillage alone did not cause a significant difference in cotton plant height, but N rate by tillage as well as tillage by cover interactions did appear. Foliar urea did not significantly affect plant height.

Cotton Lint Yield

In 1981 there were two harvests at Jackson and one harvest at Milan. Percent first harvest and first harvest lint yield at Jackson are presented in Table 6. There was a significant cover by tillage interaction at the first harvest. Cotton planted NT-NC at 34 kg N/ha had the greatest lint yield and greatest percent first harvest. Cotton planted in V, RV, or R had low percent first harvest. Where cotton was planted in a cover, CT plots had a higher percent first harvest and higher first harvest yields. This was not true under NC.

The difference in first harvest lint yield as affected by foliar urea was determined and cover had a significant effect on this difference. These differences were small, however, less than 60 kg/ha and of no practical importance. There was a significant cover by tillage effect on cotton lint yield for the second harvest. Total lint yields for 1981 are shown in Table 7. Where no cover was

Table 6. Percent first harvest and lint yield first harvest obtained from no-tillage and conventionally planted cotton as influenced by foliar urea under rye, vetch, rye-vetch, and no cover at 0, 34, 67, and 101 kg N/ha during 1981 at Jackson, Tennessee.

Cover	No-Tillage				Conventional			
	Foliar Urea %	kg Lint /ha	None %	kg Lint /ha	Foliar Urea %	kg Lint /ha	None %	kg Lint /ha
0 kg N/ha								
NC	59.8+	472	58.9	538	46.9+	347	49.6	409
R	47.3++	252	51.1	258	54.6++	386	55.0	372
RV	51.3++	273	45.7	221	52.9++	388	45.0	287
V	49.3+	301	44.2	291	48.2#	316	54.2	402
34 kg N/ha								
NC	68.9+	757	74.7	790	55.2+	519	59.9	618
R	45.3++	294	48.9	268	55.9++	510	54.2	469
RV	43.9++	230	46.8	243	48.3++	367	47.4	367
V	47.8#	279	51.6	329	55.8#	353	57.9	479
67 kg N/ha								
NC	60.0+	576	75.3	728	64.7+	573	63.0	609
R	48.9++	323	52.6	336	56.8++	456	52.3	448
RV	47.5+	287	43.1	237	50.5+	430	48.5	358
V	46.5#	242	47.8	264	51.5#	339	46.8	386
101 kg N/ha								
NC	66.3+	600	64.4	637	55.5#	393	57.9	416
R	48.6++	370	46.2	311	51.8++	419	48.0	384
RV	36.3+	170	39.0	202	43.3+	292	45.6	358
V	40.6#	196	47.3	261	54.8#	402	52.8	392

†22.4 kg/ha urea (10 kg N/ha) applied once.

++22.4 kg/ha urea (10 kg N/ha) applied twice.

#Foliar fertilization not necessary based on petiole analysis.

Table 7. Lint yields of no-tillage and conventional cotton as influenced by foliar urea under rye, vetch, rye-vetch, and no cover at 0, 34, 67, and 101 kg N/ha during 1981 at Jackson, Tennessee.

Cover	Cotton Lint Yield, kg/ha			
	No-Tillage		Conventional	
	Foliar Urea	None	Foliar Urea	None
0 kg N/ha				
NC	790+	913	740+	823
R	531++	503	708++	676
RV	532++	482	730++	636
V	612+	659	*	698
34 kg N/ha				
NC	1098+	1057	939+	1032
R	604++	548	912++	865
RV	522++	519	759++	775
V	*	609	*	731
67 kg N/ha				
NC	960+	967	886+	967
R	659++	638	802++	856
RV	604+	551	851+	738
V	*	536	*	693
101 kg N/ha				
NC	905+	989	*	713
R	760++	673	806++	801
RV	469+	516	674+	786
V	*	517	*	738

[†]22.4 kg/ha urea (10 kg N/ha) applied once.

⁺⁺22.4 kg/ha urea (10 kg N/ha) applied twice.

*Foliar fertilization not necessary based on petiole analysis.

present, total lint yields from CT and NT were not different. Where a cover was present CT cotton was higher in total lint yield. Cotton in V covers tended to grow vegetatively and yields were low. These yields were lowest at 67 and 101 kg N/ha.

Tillage had a significant effect on second harvest difference due to foliar urea. NT cotton lint yields were increased by additional N. CT cotton lint yields were decreased by additional N. Again, these differences were minimal and of no practical importance.

The 1981 total lint yields at Milan are shown in Table 8. There was a significant cover by tillage effect on lint yield. Cotton planted CT-NC had higher lint yields than that planted NT-NC. Under both NT and CT, cotton yields were highest at 0 kg N/ha, followed by 67 and 34 kg N/ha. Where R was the cover, cotton lint yields under CT were highest at 34 kg N/ha followed by 67 and 0 kg N/ha. Under NT yields increased with N rate, but they were always lower than CT plots. Where RV was the cover, lint yields were higher where cotton was planted CT than under NT. Cotton planted in V always yielded higher under CT and yields decreased with increasing N rate.

A significant cover by tillage interaction effect was also evident in lint yield differences due to foliar urea. Where R was a cover lint yields increased 65 kg/ha under CT and decreased 26 kg/ha under NT. Under V foliar urea caused lint yields to be increased 47 kg/ha under NT and decreased 78 kg/ha under CT. Under RV and NC, yields were increased by foliar urea. Foliar urea

Table 8. Lint yields of no-tillage and conventional cotton as influenced by foliar urea under rye, vetch, rye-vetch, and no cover at 0, 34, and 67 kg N/ha during 1981 at Milan, Tennessee.

Cover	Cotton Lint Yield (kg/ha)			
	No-Tillage		Conventional	
	Foliar Urea	None	Foliar Urea	None
0 kg N/ha				
NC	501++	606	732++	768
R	394++	383	731++	599
RV	385++	392	697++	515
V	493++	365	577+	655
34 kg N/ha				
NC	614++	541	876++	741
R	460++	570	820++	743
RV	270++	245	487+	556
V	232++	267	*	477
67 kg N/ha				
NC	758+	559	691+	762
R	616++	651	794+	673
RV	438++	396	678+	493

⁺22.4 kg/ha urea (10 kg N/ha) applied once.

⁺⁺22.4 kg/ha urea (10 kg N/ha) applied twice.

*Foliar fertilization not necessary based on petiole analysis.

increased lint yields of cotton planted NT-RV by 20 kg/ha and CT-RV by 99 kg/ha. Lint yields under NT-NC were increased by 56 kg/ha and under CT-NC by 10 kg/ha.

Cotton planted under NC yielded high and tillage did not cause a significant difference in yields. Where a cover was present, lint yields of cotton planted CT were higher than that planted NT. Cotton planted in V grew vegetatively partly due to increased available N and yields were low.

In 1982 there was only one harvest at Jackson and two harvests at Milan. Total lint yields at Jackson are presented in Table 9. There was a significant cover by tillage interaction and a significant cover by N rate interaction. Cotton planted in NC had the highest lint yields with CT being only slightly higher than NT. Where a cover was present CT yielded higher than NT. These differences were most evident under RV and V. Where V was the cover yields tended to decrease with increasing N rate. Under RV yields significantly declined at 101 kg N/ha. There was not a significant effect on change in lint yield due to foliar urea.

In 1982 at Milan there were two harvests. Percent first harvest and total lint yield are presented in Table 10. Nitrogen interacted with tillage to influence first harvest lint yields. A significant cover effect on first harvest lint yields was also present. Cotton planted in NC yielded highest followed by R. Cotton planted in RV and V yielded lowest. Cotton planted NT yielded highest at higher N rates. Cotton planted in NC and R matured earlier as evidenced by percent first harvest. Cotton planted in V and RV had

Table 9. Lint yields of no-tillage and conventional cotton as influenced by foliar urea under rye, vetch, rye-vetch, and no cover at 0, 34, 67, and 101 kg N/ha during 1982 at Jackson, Tennessee.

Cover	Cotton Lint Yield, kg/ha			
	No-Tillage		Conventional	
	Foliar Urea	None	Foliar Urea	None
0 kg N/ha				
N	911 ⁺⁺	1004	1135 ^{#++}	1016
R	864 ⁺⁺	840	1228 ^{#++}	1025
RV	731 ⁺⁺	630	1191 ⁺	1130
V	875 ⁺	753	1063 ⁺	1182
34 kg N/ha				
N	1346 ⁺⁺	1245	1288 ⁺⁺	1291
R	1116 ^{#++}	1119	1389 ⁺⁺	1182
RV	608 ⁺	790	1267 ⁺	1240
V	*	690	*	1074
67 kg N/ha				
N	*	937	1173 ⁺⁺	1419
R	1266 ⁺⁺	1051	1292 ⁺⁺	1243
RV	*	647	*	1290
V	*	514	*	937
101 kg N/ha				
N	*	988	1186 ⁺	1145
R	1258 ⁺⁺	1168	1272 ⁺⁺	1138
RV	*	476	1326 ⁺	1039
V	*	430	*	1234

⁺22.4 kg/ha urea (10 kg N/ha) applied once.

⁺⁺22.4 kg/ha urea (10 kg N/ha) applied twice.

[#]50 kg ammonium nitrate (16.8 kg N/ha) as soil application.

*Foliar fertilization not necessary based on petiole analysis.

Table 10. Percent first harvest and total lint yield of no-tillage and conventional cotton as influenced by foliar urea under rye, vetch, rye-vetch, and no cover at 0, 34, and 67 kg N/ha during 1982 at Milan, Tennessee.

Cover	No-Tillage				Conventional			
	Foliar Urea %	kg Lint /ha	None %	kg Lint /ha	Foliar Urea %	kg Lint /ha	None %	kg Lint /ha
0 kg N/ha								
NC	88	808++	91	717	92	1035++	92	1024
R	88	914++	91	776	92	1043++	92	911
RV	73	752++	74	620	83	860++	83	871
V	72	752+	69	688	79	749+	76	831
34 kg N/ha								
NC	93	964++	92	1018	92	991++	92	1011
R	87	874++	87	952	88	977++	89	987
RV	*	*	61	572	85	849+	84	776
V	*	*	62	603	*	*	77	716
67 kg N/ha								
NC	93	1023++	93	1048	91	969++	92	967
R	88	950++	88	906	93	959++	93	1037
RV	79	774+	82	934	83	996++	84	890

+22.4 kg/ha urea (10 kg N/ha) applied once.

++22.4 kg/ha urea (10 kg N/ha) applied twice.

*Foliar fertilization not necessary based on petiole analysis.

lower percent first harvest. Foliar urea did not significantly effect a difference in first harvest lint yields. Cotton planted in V and RV had high second harvest yields followed by R and NC. This indicates that cotton planted in R and NC matured early. Cotton planted in NT had higher second harvest yields as compared to CT. This indicates that where covers were present on the surface cotton maturity was delayed. Again, foliar urea did not effect a significant change in lint yield.

Cotton lint yields were greatest at both locations when cotton was planted in NC. Lint yields were not different under CT and NT where there was NC. Cotton lint yields tended to be lowest under V followed by RV and R. Where a winter cover was present CT cotton outyielded NT cotton. Cotton grown in V grew vegetatively, was later maturing, and yielded low especially at higher N rates. Cotton grown in NC and R matured earliest. In 1981 foliar urea had a statistically significant effect on change in lint yield, both positive and negative, but differences due to foliar urea tended to be minimal and were of no practical significance. In 1982 foliar urea did not cause a significant change in lint yield at either location.

CHAPTER V

CONCLUSION

RV provided the greatest amount of residue followed by R alone. V always provided the least dry matter and was highest in moisture. The heavier residue of RV reduced soil temperature and increased soil water in the surface layer of the soil. Generally, soil temperature under RV did not get as low or as high as that under NC. Soil temperatures under R or V were intermediate.

Early in the season soil moisture under winter cover and NC were similar. A significant soil water deficit was not measured in the cover situations. As cotton grew in killed covers, the covers provided a barrier to evaporation and no-till treatments remained higher in surface soil water throughout the season as compared to conventionally tilled treatments.

The presence of covers also affected the $\text{NO}_3\text{-N}$ in the soil. Soil $\text{NO}_3\text{-N}$ tended to be enhanced by the vetch cover. Rye cover was lowest in soil $\text{NO}_3\text{-N}$. Soil $\text{NO}_3\text{-N}$ under NC was affected by N rates. Surface soil $\text{NO}_3\text{-N}$ was highest under CT under all covers which indicated that tillage stimulated the microbial decomposition of soil organic matter and/or residue. Less N was immobilized possibly with residue incorporation. Where covers remained on the surface decomposition was slowed. Lower soil temperature under covers probably slowed decomposition rate. The effect of possible plant uptake differences due to treatments makes further conclusions difficult.

At Jackson cover interacted with N to influence petiole $\text{NO}_3\text{-N}$ both years. At Milan, cover, tillage, and N interacted to influence petiole $\text{NO}_3\text{-N}$ both years. According to petiole analysis cotton grown in V remained sufficient in petiole $\text{NO}_3\text{-N}$ except at 0 kg N/ha. This was evidence that N was being released from vetch cover. Cotton in R became deficient at all N rates. This was probably due to immobilization of N during microbial decomposition of dry matter. Cotton in RV remained sufficient longer, but it eventually became deficient at all N rates. Petiole $\text{NO}_3\text{-N}$ under NC was most correlated with applied fertilizer N. Tillage did not affect cotton petiole $\text{NO}_3\text{-N}$ at Jackson, but at Milan NT tended to become deficient sooner. Foliar urea resulted in visually greener plants did not bring petiole $\text{NO}_3\text{-N}$ into the sufficiency range.

Cotton planted in V was the tallest; cotton planted in R and NC was shortest. That planted in RV was intermediate. Plant height tended to increase with increased N rate. Cotton planted NT tended to be taller than that planted CT. Foliar urea did not significantly affect plant height.

In 1981 lint yields at Jackson were highest where cotton was planted in NC. Cotton planted in NC matured earliest as indicated by high percent first harvest. Cotton planted in V and RV grew vegetatively and matured later. Lint yields were lowest where V was the cover. Where a cover was present CT cotton outyielded NT cotton. Where cotton was planted in NC, NT and CT yields did not differ. Cover as well as tillage had a significant effect on yield

differences caused by foliar urea. These differences were both positive and negative but were small and of no practical significance.

At Milan cover and tillage interacted to influence lint yield. Cotton yielded highest under NC followed by R. Cotton yielded lowest under V followed by RV. In all cases cotton planted NT yielded less than that planted CT. Cover and tillage also interacted to influence yield differences caused by foliar urea. Increases and decreases in lint yield were erratic and the majority of the differences were of no practical significance.

In 1982 cover and tillage as well as cover and N rate interacted to influence lint yields at Jackson. Cotton planted in NC had the highest lint yields with CT being somewhat higher than NT. Where a cover was present, CT outyielded NT. This difference was maximized where V or RV was the cover crop. Foliar urea did not result in a significant change in lint yield.

At Milan N and tillage interacted to influence first harvest lint yields. Cotton planted in NC yielded highest followed by R. Cotton planted in RV and V yielded lowest. Cotton planted NT yielded highest at higher N rates. Cotton planted in V and RV had higher second harvest yields followed by R and NC. Earlier maturity of cotton in R and NC was indicated. Cotton planted NT had a higher second harvest yield than that planted CT partly because it was later maturing. Where a cover was present on the surface, maturity tended to be delayed. Foliar urea did not effect a significant difference in lint yields at either harvest.

At both locations in both years, cotton planted NT in a cover tended to have a lower lint yield than that planted CT. Where no winter cover was present, tillage was not necessary to produce maximum yields. Foliar urea influenced lint yield slightly both negatively and positively in 1981, but it had no influence on lint yield in 1982.

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