STARTER FERTILIZER SOURCE AND RATE EFFECT ON STAND AND GROWTH OF COTTON

J. E. Matocha, D. L. Coker, F. L. Hopper and X. Liu
Texas A&M Agricultural Research & Extension Center
Corpus Christi, TX

Abstract

The use of starter or "pop-up" fertilizers in the past has produced variable results in influencing crop yields. Factors such as soil moisture at planting and composition of the fertilizer materials have contributed to the erratic results from use of starter fertilizers. Recent research with ammonium polyphosphate (11-37-0) has shown some beneficial effects on growth and lint yield of cotton (*Gossypium hirsutum* L.) when the starter was placed in the seed furrow or surface banding at time of planting. The purpose of this research was to determine the effect of starter fertilizer composition and application rates on cotton seedling emergence and early shoot/root growth at low and medium soil moisture regimes at planting. Treatments consisted of a control, 7-21-0, 5-15-0 and 3-9-0 liquid blends applied directly in the seedrow at 3, 6 and 9 gal./A to an Orelia sandy clay loam. The three blends contained 2.4, 1.4 and 1.0 percent organic acid, respectively, and contained the ammonium orthophosphate form of P. Ammonium polyphosphate (11-37-0) was used as a standard of comparison at rates of 3 and 6 gal./A. Eight seeds were planted in 18 inch rows in trays and plants were grown for 35 days after planting (DAP). All starter fertilizers had a definite effect on cotton seedling emergence and early growth. Ammonium polyphosphate caused a marked delay in emergence even at 3 gal./A during the first five days. Starter mix 3-9-0, at 6 and 9 gal./A, showed significantly less damage than other blends and the 11-37-0. By 11 DAP, no difference among blends was observed but blended starter fertilizer had significantly higher ($P<0.05$) emergence than 11-37-0 which produced less than 20% plant emergence at 6 gal./A. Chlorophyll readings were only slightly higher for starter blends containing organic acids. Seedlings grown under lower soil moisture showed a gradual decrease in plant height as starter rates increased. Starter blends failed to increase dry matter yields of seedlings at 35 DAP when compared to the control but 11-37-0 decreased growth at certain rates. Where adverse effects from starter treatments occurred, they were magnified by lower soil moisture. Further research under field conditions is needed.

Introduction

Previous research in recent years has shown that starter or "pop-up" fertilizer applied in the seed furrow or as a surface band above the seed furrow may significantly increase seedling growth and lint yield of cotton (Funderburg and Burris, 1992; Guthrie, 1991; Howard et al., 1992). Other research has shown reduced stands under conventional tillage with starter applied in seed furrow (Hutchinson et al., 1992). The most common starter fertilizer materials used in most of these studies have been ammonium polyphosphates such as 11-37-0 or 10-34-0. The salt index of many fertilizer materials, may be relatively high and consequently may not be safe for in seed-row placement especially at rates needed to influence early growth. The addition of certain organic extracts to the base materials during their manufacture for the purpose of reducing the toxicity to germination and perhaps to influence the micro environment of the soil surrounding the seedling roots was suggested as possible improved products for seed-row placement.

This study was conducted to determine if starter fertilizer composition and application rates affect rate of cotton seedling emergence and shoot and root growth. Future field research will be based on results of this greenhouse experiment.

Materials and Methods

Short-season cotton (Deltapine 51) was grown in the greenhouse on an Orelia sandy clay loam (fine, montmorillonitic, hyperthermic Typic Ochraqualf) with medium levels of extractable N and P, high exchangeable K, pH 8.1 and organic matter content of 1.7%. The study was conducted in plastic trays which enabled row lengths of 18 inches. Eight seeds were planted per row and stand counts were initiated five days after planting (DAP). Emergence counts were continued daily until 28 DAP in order to closely monitor delay in emergence. Plant height measurements were made at 20 DAP and chlorophyll readings at 28 DAP.

To simulate starter fertilizer applications under field conditions, all four starter fertilizers were applied as solutions directly in the seed furrow at planting. A total of 12 treatments were used in the study. The treatments comprised of a control (0-0-0), 7-21-0; 5-15-0 and 3-9-0 liquid blends applied at 3, 6, and 9 gal./A, respectively. In addition, treatments included 3 and 6 gal./A of ammonium polyphosphate (11-37-0). No other fertilizer was added to the soil. The blended materials were composed primarily of ammonium orthophosphates with varying levels of organic extracts with the 7-21-0, 5-15-0 and 3-9-0 containing 2.4, 1.7 and 1.0% organic acid extracts, respectively. These materials were formulated by industry personnel.

Prior to planting and treatment application, the soil moisture levels were adjusted to 25% of field capacity in one half of the trays and to 40% of field capacity in the second half. Soil moisture levels were maintained at 32%

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and 60% of field capacity, respectively, throughout the experiment by watering trays up to the prescribed weights.

Air temperatures in the greenhouse were maintained at those levels normally present in the field at planting (March 1).

Whole plants were harvested at 35 DAP and roots were separated from shoot, dried in a forced draft oven and weighed.

Results and Discussion

Stand Establishment

At five days after planting (DAP) when soil moisture was limited, seedling emergence was highly erratic with most treatments showing zero percent emergence. At the same time but under adequate soil moisture, conventional starter (11-37-0) at both the low and medium rates produced about 20% of the stand of cotton measured in the control (no starter). Under identical conditions, all three of the amended starter materials at 3 gal./A had a substantially greater emergence than 11-37-0 with no major differences between these three sources (Fig. 1). At 6 gal./A, the first two amended starters (7-21-0 and 5-15-0) caused significantly lower stands than the 3-9-0. The 3-9-0 + 1% organic extract even at 9 gal./A produced emergence at 5 days close to 60% of the control.

At 11 DAP all amended starters produced essentially the same results showing close to 100% emergence (Fig. 2). The conventional source (11-37-0), however, even at 3 gal./A showed less than 60% emergence and only 20-30-% at 6 and 9 gal./A.

Under reduced soil moisture, no significant difference in stand among treatments was recorded at 11 DAP for the 3 gal./A (Fig. 3). At 6 gal./A, 11-37-0 caused severe injury to stand while the 3-9-0 material and the 5-15-0 material had emergence greater than conventional starter (11-37-0).

Under adequate soil moisture at 28 DAP, essentially identical emergence was measured for all three blended starters at low and medium rates with an average of 85% of the control (Fig. 4). However, the 7-21-0 produced very low emergence at 9 gal./A rate. An approximate 50% reduction in stand at 3 gal./A and 70% reduction at 6 gal./A was measured when 11-37-0 was used as starter.

Differences in emergence persisted at 28 DAP when soil was maintained at low soil moisture (Fig. 5). The 11-37-0 at 6 gal./A caused a severe decrease in emergence as rates increased from 3 gal/Ac. Under this lower soil moisture regime the higher analysis blended starters gave erratic results with 7-21-0 decreasing emergence substantially at 9 gal./A. Low composition starters such as 3-9-0 consistently produced relatively good emergence even at 9 gal./A.

Plant Height

In general, at adequate soil water, all treatments produced taller plants than at low soil water, especially in the control (Figures 6-7). Ammonium polyphosphate (11-37-0) produced plants with greater height at 6 gal./A than at 3 gal./A. No significant change in heights was observed due to rates with the new sources of starter fertilizers.

Chlorophyll

At adequate soil water, chlorophyll readings taken at 27 DAP showed only a slight difference between 11-37-0 and the blended starters. Starter rates above 3 gal./A generally had no effect on chlorophyll (Fig. 8). Reducing soil water essentially had no effect on chlorophyll and, similarly to conditions of adequate soil water, caused only slight differences due to starter fertilizer composition (Fig. 9).

Plant Growth

Dry matter yields of plant seedling tops and roots are presented in Figures 10-11 for adequate soil water. Data show a sharp decrease in both tops and roots with 3 gal./A of the conventional starter (11-37-0). All three starter blends at 3 gal./A produced significantly greater growth than the 11-37-0. This is reflected in both root and top yields. As starter rates were increased to 9 gal./A, the 7-21-0 blend showed a substantial decrease while the 5-15-0 and the 3-9-0 appeared to have no adverse effect on yield of the whole plant. Although the blended starters produced improved seedling vigor and better growth than the standard 11-37-0 starter fertilizer, comparisons with the control (no starter) showed little or no advantage from any starter materials used.

Growth comparisons of the starter materials under low soil water largely showed similar trends in response to those when soil water was adequate. However, in general plant growth averaged across most treatments was less with reduced soil water when soil moisture became limiting than with adequate soil water (Figs. 12-13). Response due to starter blends appeared wider than at the higher soil water level. It is noteworthy that use of the starter blends appeared to reduce the deleterious effect of moisture stress on growth indicating perhaps more efficient soil water use (Figs. 10-11 vs. Figs. 12-13). This is represented by a sharper drop in seedling growth in the no starter treatment when soil moisture was limiting.

Summary

To summarize in general the effects of these starter materials, the average of the three blended starters were compared with the standard 11-37-0 on the major parameters (Table 1). From these data it is obvious that starter addition has substantial effects on seedling emergence and shoot and root growth. At adequate soil water and low rate of starter (3 gal./A) stands establishment was improved in excess of 35% and shoot and root growth was more than doubled with the use of ammoniated orthophosphate blended with the organic acid as compared to the standard 11-37-0. With increased rate of starters (6 gal./A), the influence of starter composition on plant emergence widened. With limited soil water, 6 gal./A of 11-37-0 produced a drastic reduction in stand and shoot/root growth. Finally, chlorophyll in the seedlings appeared to be improved only by low rates of blended starters when soil water was adequate.

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Table 1. Treatment comparision summary on the influence of starter fertilizer composition and rate on root/shoot growth, relative stand and chlorophyll readings.

Comparison	Rate (gal./Ac)	Root Dry Wt (gm/row)	Shoot Dry Wt. (gm/row)	Stand 1/ (%)	Chlorophyll (meter)
Adequate Soil Moisture					
Control	0	0.85	1.55		32.6
Avg. over starters	3	0.89	1.38	97	35.8
Standard (11-37-0)	3	0.45	0.69	61	33.8
Avg. over starters	6	0.73	1.33	98	31.7
Standard (11-37-0)	6	0.74	0.98	30	30.4
Avg. over starters	9	0.62	1.09	72	30.3
Low Soil Moisture					
Control	0	0.85	0.64		33.8
Avg. over starters	3	0.55	1.06	75	36.1
Standard (11-37-0)	3	0.52	1.29	75	35.7
Avg. over starters	6	0.63	1.22	70	36.8
Standard (11-37-0)	6	0.19	0.38	13	33.7
Avg. over starters	9	0.50	0.78	44	35.2

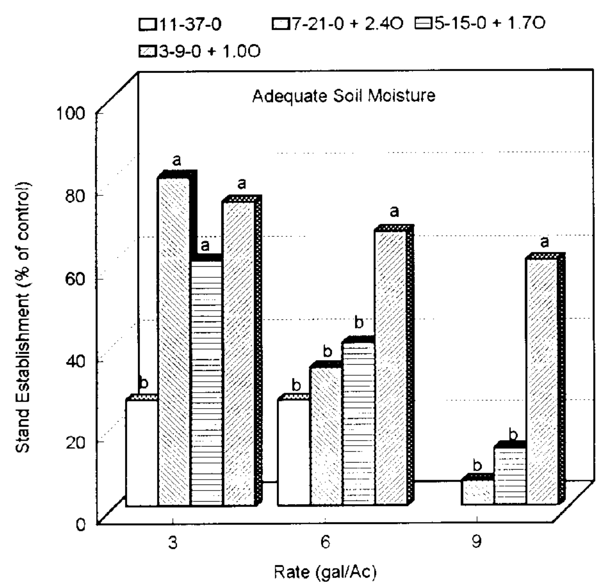

Fig. 1. Effect of composition and rate of starter fertilizers on relative stand establishment at 5 days after planting.

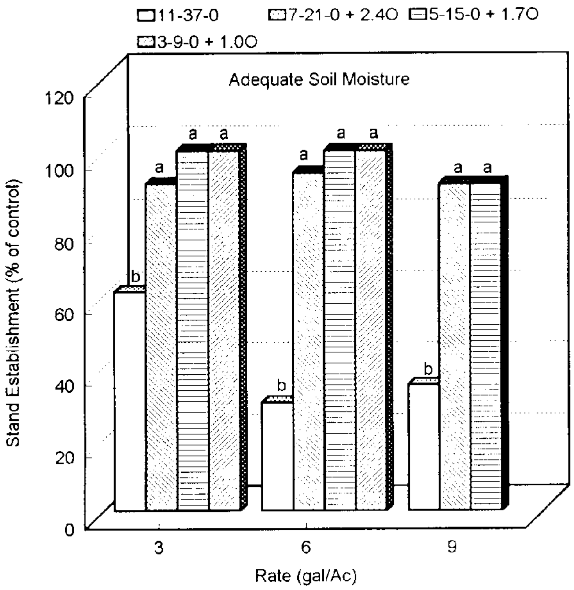

Fig. 2. Effect of composition and rate of starter fertilizers on relative stand establishment at 11 days after planting.

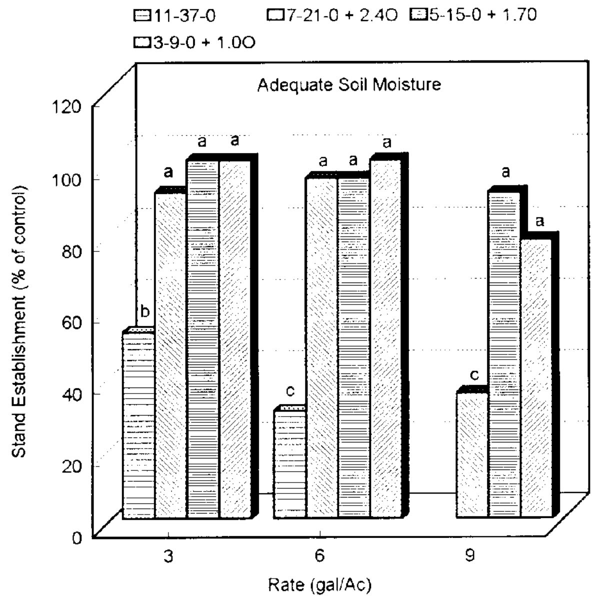

Fig. 4. Effect of composition and rate of starter fertilizers on relative stand establishment at 28 days after planting.

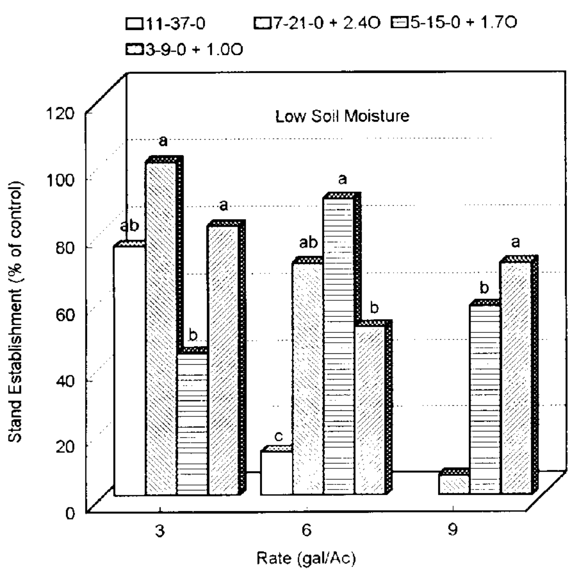

Fig. 3. Effect of composition and rate of starter fertilizer on relative stand establishment at 11 days after planting.

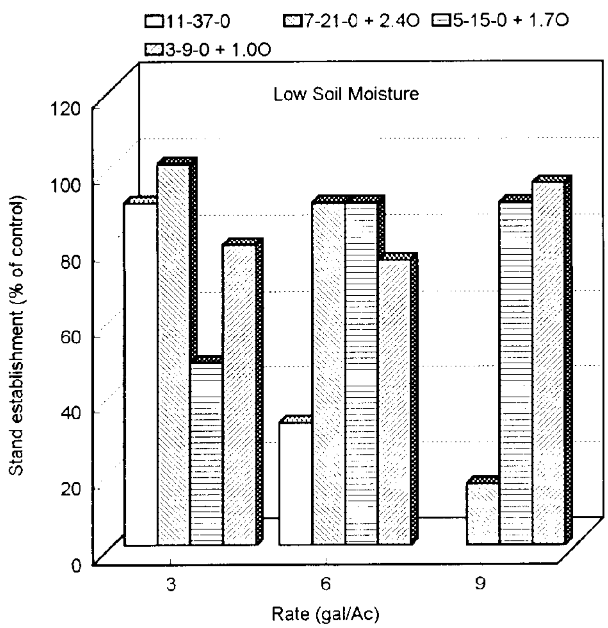

Fig. 5. Effect of composition and rate of starter fertilizers on relative stand establishment at 28 days after planting.

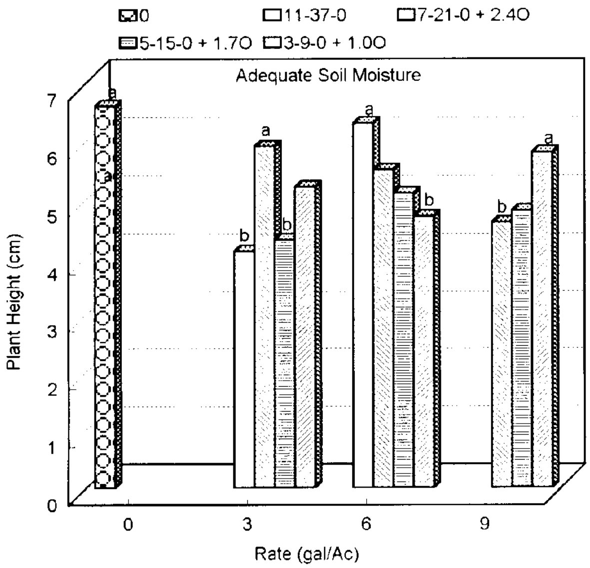

Fig. 6. Effect of composition and rate of starter fertilizers on plant height, 20 days after planting.

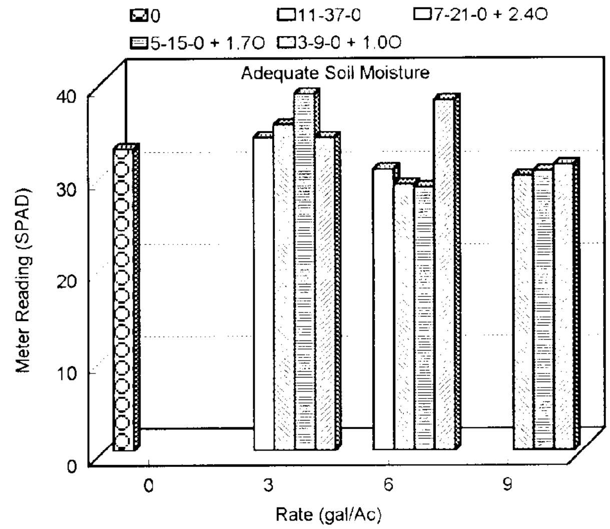

Fig. 8. Effect of starter fertilizers on chlorophyll readings, 27-day old cotton plants.

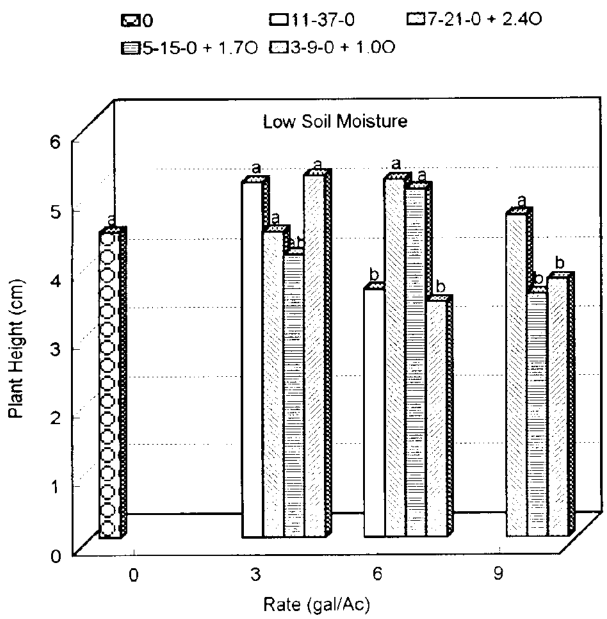

Fig. 7. Effect of composition and rate of starter fertilizers on plant height, 20 days after planting.

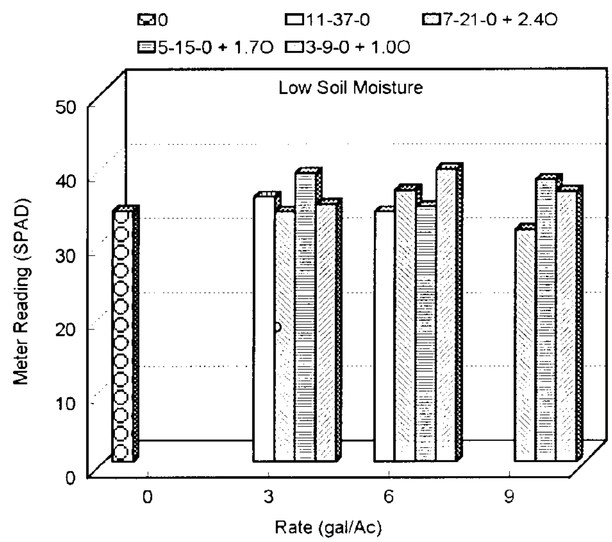

Fig. 9. Effect of composition and rate of starter fertilizers on chlorophyll readings, 27 day old plants.

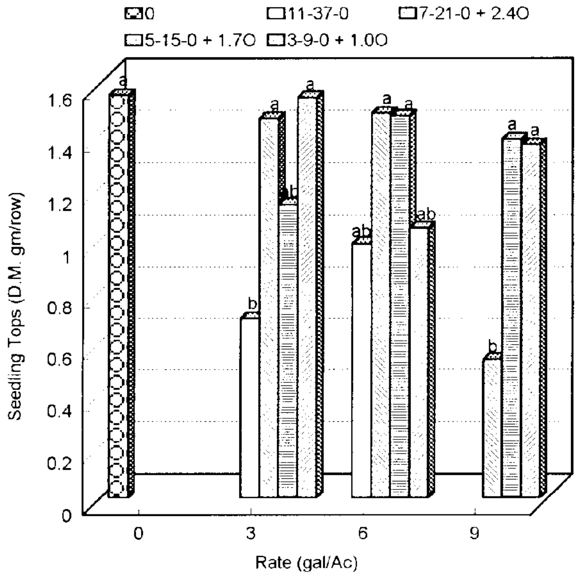

Fig. 10. Effect of composition and rate of starter fertilizers on cotton seedling growth.

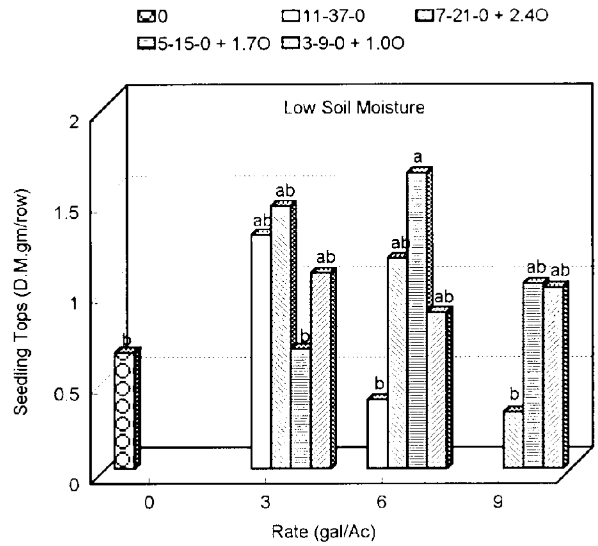

Fig. 12. Effect of composition and rate of starter fertilizers on cotton seedling growth

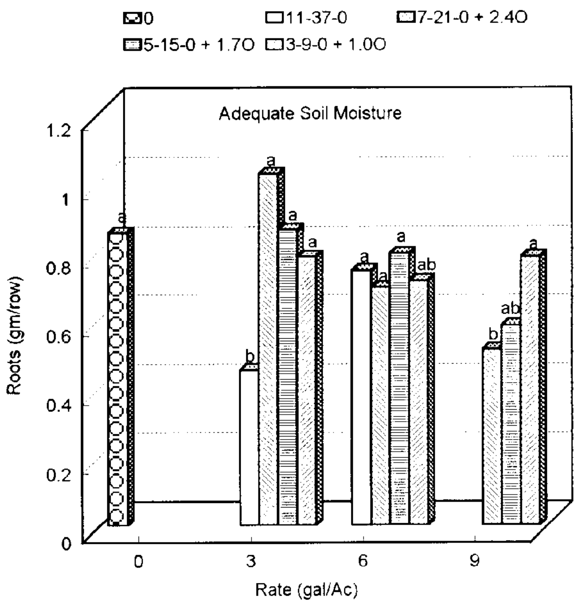

Fig. 11. Effect of composition and rate of starter fertilizers on cotton seedling growth.

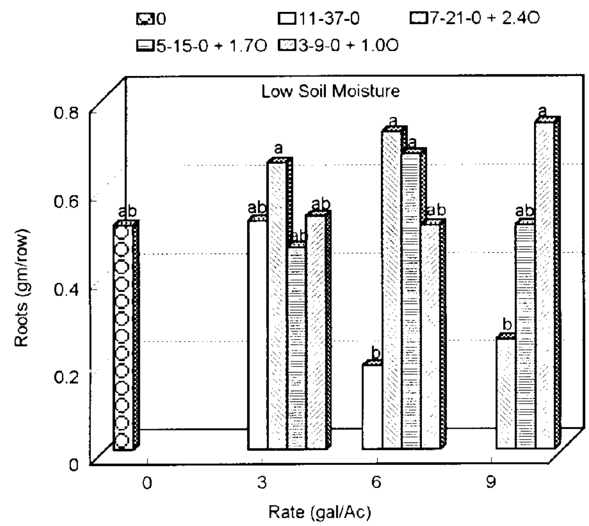

Fig. 13. Effect of composition and rate of starter fertilizers on cotton seedling growth.