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BANANA PRODUCTION WITH "PINTO'S PEANUT"(*ARACHIS PINTOI CV AMARILLO*) AND "OREJA DE RATON" (*GEOPHILA REPENS*) AS COVER CROPS.

WIELEMAKER, F., QUIRÓS,

Dole Fresh Fruit International - Standard Fruit Company De Costa Rica S.A.

ABSTRACT

The project studied the effects on banana production (and related gronomical aspects) of two cover crops: *Arachis pintoi* (maní forrajero) and *Geophila repens* (oreja ratón). The project was located in Farm Fortuna, Estrella Valley, since January 1991 until June 1997. In general, no significant differences in production parameters were found between banana plots with cover crops and control plots without them. *Geophila* appears to be a better alternative as cover crop than *Arachis* inside a banana plantation, because *Geophila* maintains its prostrate growth habit throughout the year and it is not a host for nematodes. Weed control can be maintained at acceptable levels under a system of cover crops with important ecological implications. It is very expensive to establish these cover crops as they have not been successfully propagated by seeds.

RESUMEN

El proyecto estudió los efectos sobre la producción de banano (y otros aspectos agronómicos relacionados) de dos coberturas: *Arachis pintoi* (maní forrajero) y *Geophila repens* (oreja ratón). El proyecto se ubicó en Finca Fortuna, Valle de La Estrella, desde enero de 1991 hasta junio de 1997. En general, no se encontraron diferencias significativas en parámetros de producción entre parcelas sembradas con coberturas y parcelas Testigo sin coberturas. *Geophila* parece ser una mejor alternativa como cobertura para bananales que el *Arachis*, porque geophila no cambia su característica de crecimiento rastrero a través del año, y no es un hospedero de nemátodos. El control de malezas se puede mantener en niveles aceptables dentro de un sistema de coberturas, con importantes implicaciones ecológicas. No es barato establecer las coberturas porque no han sido propagadas por semillas en una manera exitosa.

Background:

For a long time, any other plant present in a banana plantation was considered undesirable (a weed). In general weeds can reduce crop production due to competition for water and nutrients, harbor of crop pests and diseases; and in some cases, allelopathic effects as well. However, inter-cropping --growing two or more crops in the same area-- has been practiced since agriculture first started, particularly in small farm systems. The negative effects of keeping the soil completely bare of any cover have also been shown. Cover crops have been used for quite some time in some monoculture crops such as coffee and oil palm. We wanted to investigate the effects of cover crops in a commercial banana plantation. Potential advantages, possible disadvantages and requirements of an ideal cover crop for bananas are listed as following.

Advantages of a cover crop;

- Control of weeds w/o herbicides
- Lowers/stabilizes soil temperature
- Improve physical soil characteristics
- Enhance the soils' biological activity
- Alleviate soil compaction/crust formation
- Maintain or improve the organic matter in the soil
- Improve penetration rate of irrigation water or rainfall
- Fix nitrogen through rhizobium-nodule activity (legumes)
- Control soil erosion (rain drop impaction and water run-off)
- Release plant nutrients in a more available form to the banana crop

The selected cover crop should;

- Tolerate shade
- Tolerate drought
- Resistant to diseases and pests
- Tolerate intensive walking/treading
- Regenerate naturally/self propagating
- Tolerate or outgrow weed competition

Tolerate selective weeding with herbicides

Tolerate of grow through banana crop residues

The selected cover crop should not;

Impede walking ('enredadera')

Need periodic mowing or slashing

Harbor banana diseases or attract pests (host plant)

Climb into the banana pseudostem or followers ('trepadera')

Compete for nutrients with banana crop after establishing full cover

Adversely affect anchorage of banana plant because of surface roots.

The present project tested two plant species (*Arachis pintoi* cv Amarillo and *Geophila repens*) as cover crops in a established banana plantation. Arachis (wild type of peanut) is a prostrate, stoloniferous, perennial legume that forms a dense mat of stolons. *Geophila* (Mouse ear) is an indigenous plant in Central America belonging to the Euphorbiaceae family. It is a shade plant with low growth habit.

Objective: To study the production parameters and potential advantages and disadvantages of two ground covers in an established banana plantation as compared with no cover crop.

TREATMENTS

1- Mechanical weed control -- No cover crop.

2- "Pinto's peanut" as cover crop (*Arachis pintoi* cv Amarillo #18748). Manual weed control as needed.

3- "Mouse ear" as cover crop (*Geophila repens*). Manual weed control as needed.

4- Commercial herbicidal control of weeds.

Project Leaders: Frans Wielemaker, Henry Quirós, Fernando Ramírez & Ricardo Duarte.

DATA TAKEN

1. Stem weight, finger length and calibration
2. Pseudostem circumference, and follower height at shooting
3. Soil and leaf nutrient survey
4. Weed control level.
5. Cover crop coverage.
6. Nematode levels.

MATERIALS

1. Pinto's peanut: *Arachis pintoi* cv Amarillo CIAT #18748.
2. Mouse ear: *Geophila repens*.

METHODS

The project was installed in Section B-9 of Farm Fortuna 2, Estrella Valley. Treatments 1, 2, & 3 started in January 1991 and were installed randomized along two sides of a cable-way; and then, treatment 4 was added in June 1994 in a non-randomized fashion on the two extremes of the experimental area. All treatments had 6 replicates of 25x25 meters plots plus 5-m borders. Cover crops were planted in January, 1991. Planting was done with stolon cuttings (15-20 cm long) which were partially buried in the soil placing 4 cuttings per hole off-centered at 50 cm intervals and at 7-10 cm deep. Approximately 800 Kg of stem cuttings were planted of each cover crop per hectare.

Research personnel collected data on stem weight, stems shot and cut, calculated number of packed boxes, hand class, pseudostem circumference, finger length and calibration, and follower height at shooting. Data were also taken on soil nutrient content (once a year), leaf nutrient levels (3 times a year), root condition and nematode counts in banana, arachis and *Geophila* coverage (twice a year). Agricultural practices, other than weed control, were performed by farm personnel as commercial practice.

Weed control was done mechanically by machete in T1, and by hand-pulling in T2&3 as needed. During the early stages of the project, two cycles of glyphosate (RoundUp) and one of paraquat (Gramoxone) were applied with a weed wiper in T's 2 & 3. In T-4, weeds were controlled by applying glyphosate and paraquat and / or mechanical chapia as was done by the farm.

Data were statistically analyzed using analysis of variance and the the LSD test at 0.1 level of significance; the program used was the Statistix Software 4.1 by the Analytical Software, Inc., MN, USA.

RESULTS AND DISCUSSION

Cover Crops

Within a few months *Arachis* had rooted well; and after 4-5 periods from planting, it covered more than 70% of the area. For the most part, *Arachis* plots were in the range of 50-80% coverage; sometimes the cover was reduced due to defoliation by ants ('zompopas') and army-worms ('medidores'). In addition, throughout 1996 three plots of *Arachis* suffered a gradual loss of plants; replantings were not successful and by the end of the year one plot was left with almost nothing of *Arachis* cover.

Geophila was very slow in establishing itself. Only after 3 years, did it colonized more than 70% of the area. Once established, it was very uniform and stable. No pests of importance were detected in this crop.

Arachis tended to change its growth habit from prostrate (close to the ground) to erect more vertical growth throughout the year. This is in response to the environment. In open areas (canals, house gardens, etc.) or in banana areas where there is poor cover (high light penetration), the *Arachis* grows close to the ground, particularly during summer, forming a dense carpet-like cover. On the other hand, inside banana plantations with abundant leaf cover, *Arachis* tended to grow more vertical reaching for the sunlight (etiolation), particularly during the cloudy months of the rainy season. Consequently, it did not form a dense mat. This erect growth habit is not a good characteristic for a cover crop in a banana plantation, and it may become a nuisance for the workers.

On the other hand, *Geophila* is a shade plant, and under excessive sunlight it will simply die. Under shade, it forms a nice green cover relatively close to the ground. Unfortunately, it is a slow establisher requiring several years to fully colonize an area planted with stolon cuttings. *Geophila* can reproduce by seeds, but it takes even longer time to establish itself. Attempts to stimulate seed germination found limited success.

Weed Control

No formal evaluation of weed control was carried out in this project. Prior to planting a cycle of '*chapia*' was applied to all plots. Weed control was done mechanically (chapia) in T1 every 4 weeks. Two cycles of glyphosate and one of paraquat were applied in the cover crop plots utilizing a weed wiper in the first two years of experiment. Other than that, only hand weeding was done in these plots (cover crops) on as needed basis. During the first two years and most of the third one (1994), weed control was good or acceptable in all plots. After the inclusion of T4 (chemical control), a cycle of paraquat at the commercial dosis was applied every 4 weeks in these plots. Starting in period 11, 1994, until period 06, 1995, high levels of weeds were reported in T4. Gramoxone was not controlling the weeds present (mostly *Blechum pyramidatum*). An evaluation at that moment showed 2 plots of T4 with weed levels above 75%. A cycle of *chapia* was applied to bring the weeds down under control. Thereafter, cycles of paraquat were alternated with cycles of chapia and glyphosate to maintain weeds under control.

Production Parameters

Overall, there were no statistically significant differences in production parameters among treatments. Nevertheless, in the two years following cover establishment, T3-Geophila tended to yield more boxes per hectare per year (Figure 2). However, this advantage appeared to have originated from a pre-treatment condition of more vigorous plants with higher pseudostem circumference (Fig. 3), and a slight tendency for higher stem weight (Fig.1) , hand class (Fig.6) , finger length and calibration (Figs. 7&8). In general, yearly mean stem weight did not show any statistically significant difference among treatments by the LSD test at 0.1 level; except for T1-Mechanical (about 1.5 Kg less) in 1993, and T4-Chemical (over 2 Kg above others) in 1994. In both cases the difference was temporary, and particularly in the case of T4, the difference was likely due to the non-randomization of these plots incorporated in the second quarter of 1994. Stems cut per hectare per year did not show any significant difference among treatments throughout the years (Figure 5). This indicates that ratooning was not influenced by the cover crops. Treatment 4 seemed to have initiated with larger heavier fruit at its late inclusion in the project (2Qtr, 1994); but except for finger calibration of 2nd hand, such advantage disappeared the following year.

The general decline in stem weight and hand class, as well as the increase in the last hands' finger length, which becomes evident in early 1995, can be explained in good part by the dehanding practice (false+2 hands) in this research project, which was initiated in week 48, 1994.

Follower Height at Shooting

Although not statistically significant, there was a clear tendency for the followers in T3-*Geophila* to show higher values for height at shooting. Contrarily, followers in T2-*Arachis* showed the lowest values for follower height. This might be related to the fact that *Arachis* roots showed very high levels of *Radopholus* since the second year of the experiment (Fig. 4). Nonetheless, and more importantly, such difference was not manifested in any of the production parameters.

Nutrient Analysis

Although all relevant nutrients were analyzed in the banana leaves and in the soil, here we graphically present results only for nitrogen, potassium, and magnesium in the leaves, for the sake of brevity.

Throughout the experimental period, soil pH was close to 5.0; organic matter was around 2-3%; soil calcium was around 25-27 meq/100g, magnesium around 5-7 meq, and potassium 2-3.5 meq/100g soil. Physical-chemical characteristics of a soil are not easily changed. The size and number of plots, plus the quantity of cover crops, appear to be too small to expect a change in soil characteristics.

Leaf nitrogen, potassium, and magnesium, were all above critical levels during the entire experimental period (Figs. 12, 13, & 14). In fact, nitrogen and magnesium increased every year. Potassium, on the contrary, tended to decrease its concentration in the leaves each year. T1-Mechanical appeared to reversed the trend in 1995 showing an increase from about 3.7% in 1994 to 3.9% in 1995.

Fertilizer applications do not appear to have been affected by the cover crops growing around the banana mats. Actually, the fertilizer maintains the 'rodaja' clean (burns the cover crop plants), which allows for nematocide application supervision.

Banana Root and Nematode Survey

There is no clear pattern as far as the amount of live roots determined (Fig. 10). All treatments started with about the same level, and then T3-*Geophila* and T2-*Arachis* appear to altenate between having the highest count of live banana roots and having the lowest count. And then all treatments ended up with about the same levels.

Radopholus was the only species of nematodes present in relevant numbers in the banana roots in all treatments as well as in the roots of *Arachis*. *Geophila* roots did not show significant levels of nematodes (Fig. 11). *Radopholus* remained under relatively low levels in the banana roots of all treatments; including the *Arachis* plots. Impresively, roots of *Arachis* showed incredibly high levels of *Radopholus* right after establishment of the cover crop. Counts in 1996 showed a drastic decline of *Radopholus* in the *Arachis* roots. This is probably the result of the loss of *Arachis* plants in the plots mentioned earlier. Basically the nematodes were dying of hunger, and they did not move toward the banana roots since the counts in banana roots did not detect any particular increase in nematodes unique to this treatment. On the other hand, T3-*Geophila* where nematodes did not penetrate the roots of the cover crop, *Radopholus* levels did not particularly increase in the banana roots. In brief, cover crops do not appear to affect nematode attacks on banana roots.

CONCLUDING REMARKS

The outstanding finding here is that the cover crops tested here did not have any negative effect on plant nor fruit growth. Being stoloniferous plants, *Arachis* and especially *Geophila*, have extremely shallow root systems not likely to reach deep into the soil profile. Absorption of water and nutrients by banana roots takes place mostly in the first 50-60 cm of the soil profile. Cover crops' roots may be sharing about 1/6 the of that volume. This might be part of the reason that *Geophila* and *Arachis* do not appear to be competing significantly with bananas for water and nutrients, as stem weight and other production parameters were not affected.

Geophila is a better alternative as cover crop than *Arachis* inside a banana plantation, basically because *Geophila* maintains its prostrate growth habit throughout the year and it is not a host for the regular banana nematodes. Weeds can be kept at an acceptable level under a cover crop system with important ecological benifits.

When establishing the cover crops, it is very practical to include a few selective herbicide cycles to help the cover crops get established using spot application or by means of a weed-wiper.

Planting stolon cuttings of any of the two cover crops as was done in this experiment is very expensive. More investigation needs to be directed in getting a viable and cheap seed source from both *Geophila* and *Arachis*. Commercially, large areas have been put under a *Geophila* cover crop planting program by planting very wide and off-spaced at 20 x 20 meters. After 4 years the plantation floor is close to completely covered by this cover crop and chemical weed control cycles can be greatly reduced or close to eliminated.

Long term we do not know if a pest or disease may develop on either of these cover crops which could affect the banana fruit. It would take an enormous amount of work and money to remove the complete cover from the plantation floor mechanically or chemically.

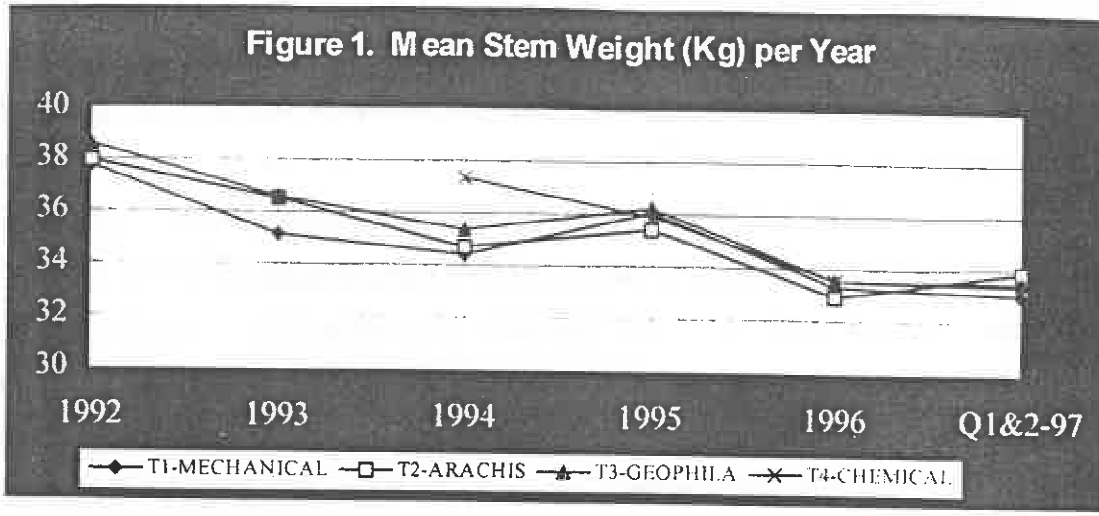
Figure 1. Mean Stem Weight (Kg) per Year
40
38
36
34
32
30
1992
1993
1994
1995
1996
Q1&2-97
T1-MECHANICAL
T2-ARACHIS
T3-GEOPHILA
T4-CHEMICAL

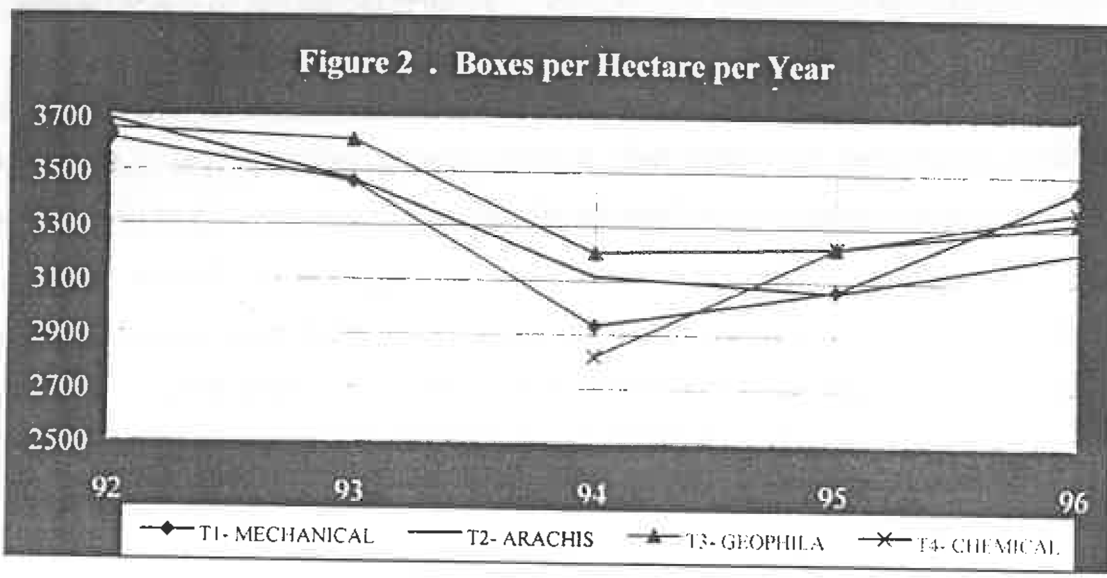
Figure 2 . Boxes per Hectare per Year
3700
3500
3300
3100
2900
2700
2500
92
93
94
95
96
T1- MECHANICAL
T2- ARACHIS
T3- GEOPHILA
T4- CHEMICAL

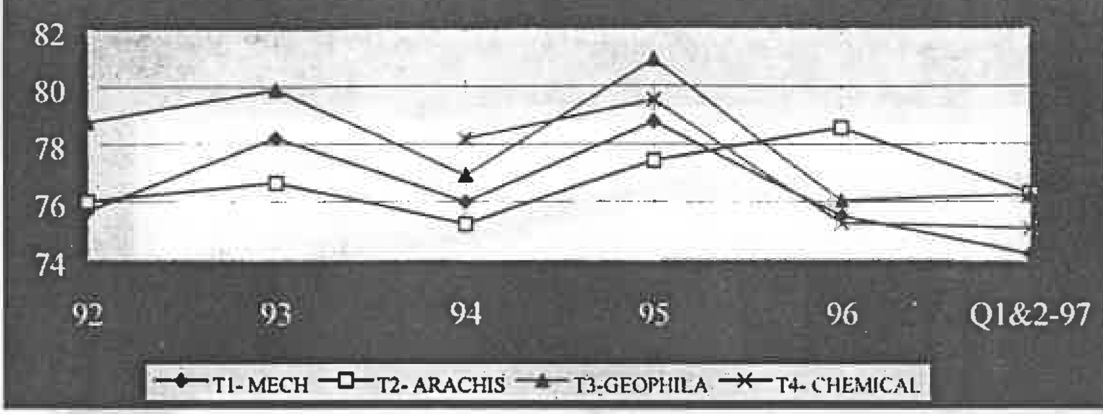

Figure 3 . Pseudostem Circumference at Shooting (cm)

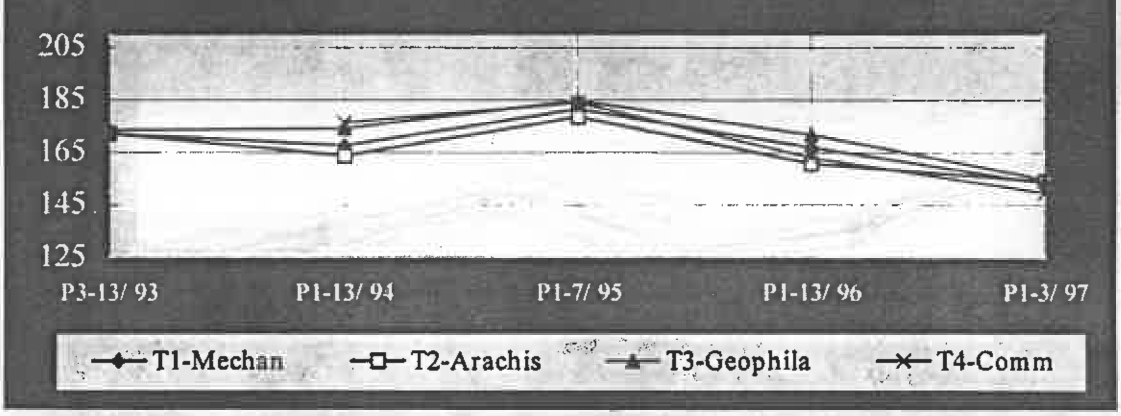

Figure 4. Mean Follower Height (cm) at Shooting

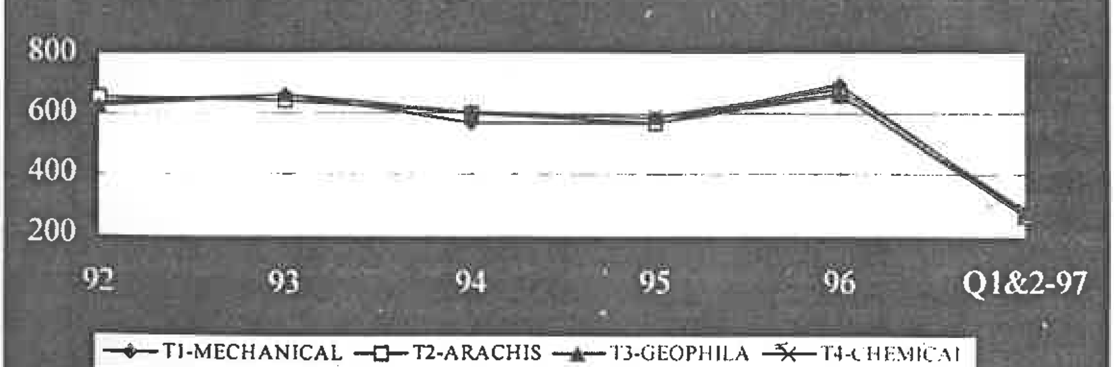

Figure 5 . Stems Cut per Hectare per Year

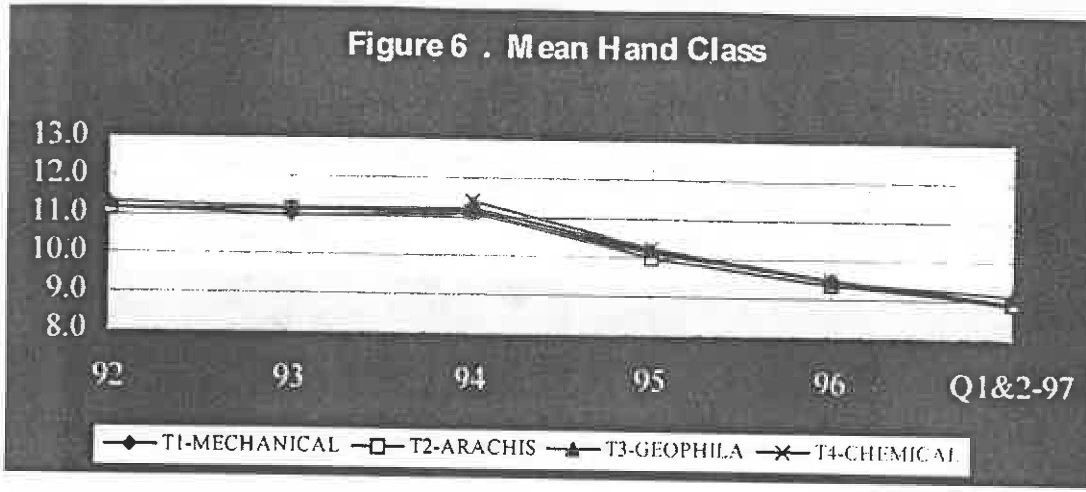
Figure 6 . Mean Hand Class
13.0
12.0
11.0
10.0
9.0
8.0
92
93
94
95
96
Q1&2-97
T1-MECHANICAL
T2-ARACHIS
T3-GEOPHILA
T4-CHEMICAL

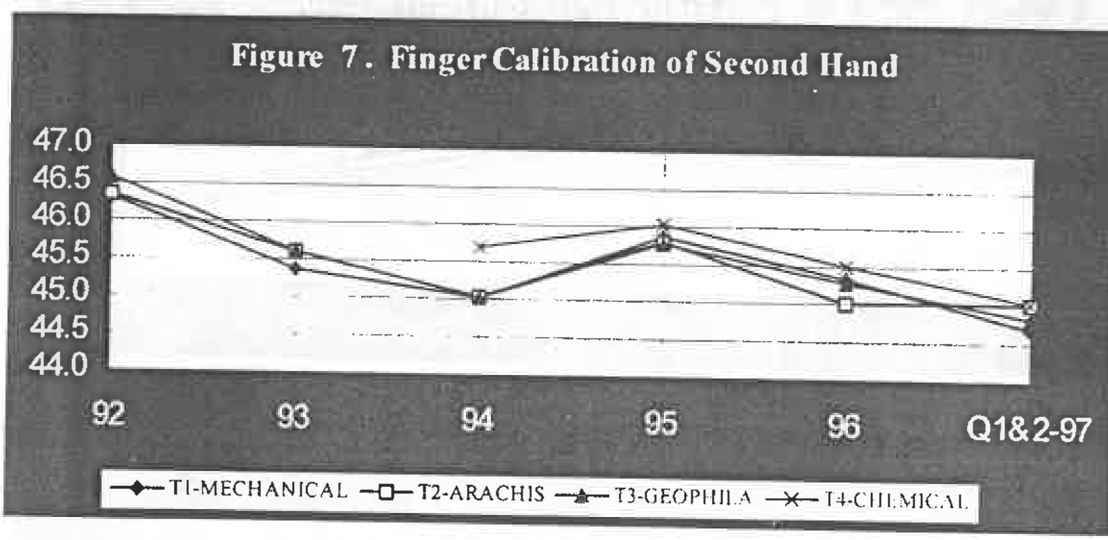
Figure 7. Finger Calibration of Second Hand
47.0
46.5
46.0
45.5
45.0
44.5
44.0
92
93
94
95
96
Q1&2-97
T1-MECHANICAL
T2-ARACHIS
T3-GEOPHILA
T4-CHEMICAL

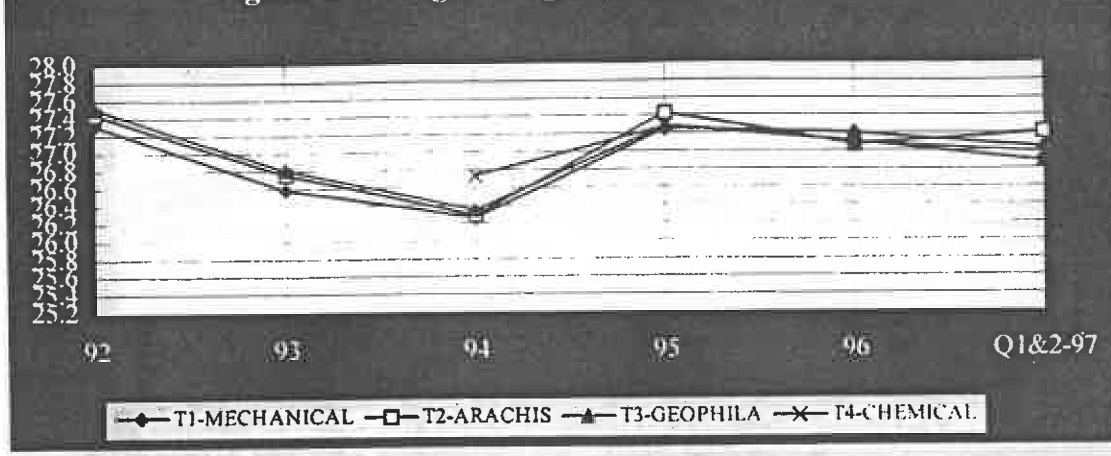

Figure 8 . Finger Length (cm) of Second Hand

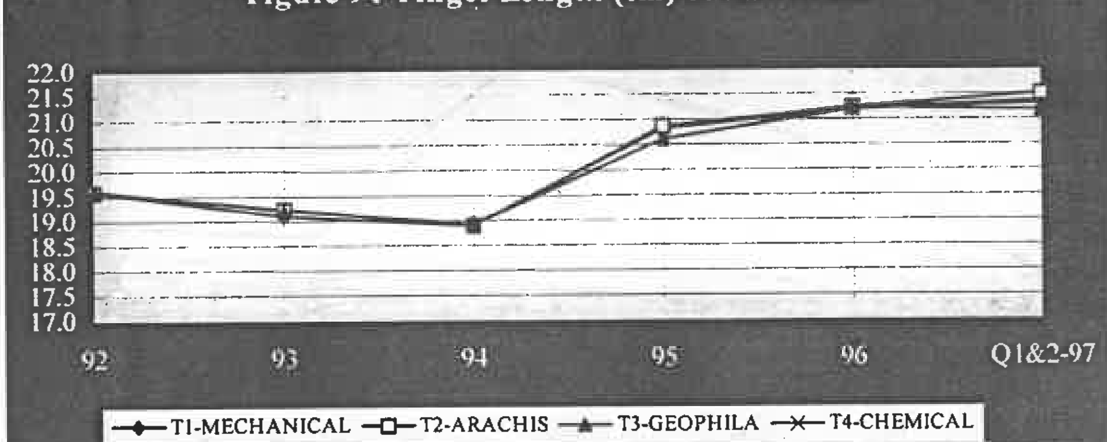

Figure 9 . Finger Length (cm) of Last Hand

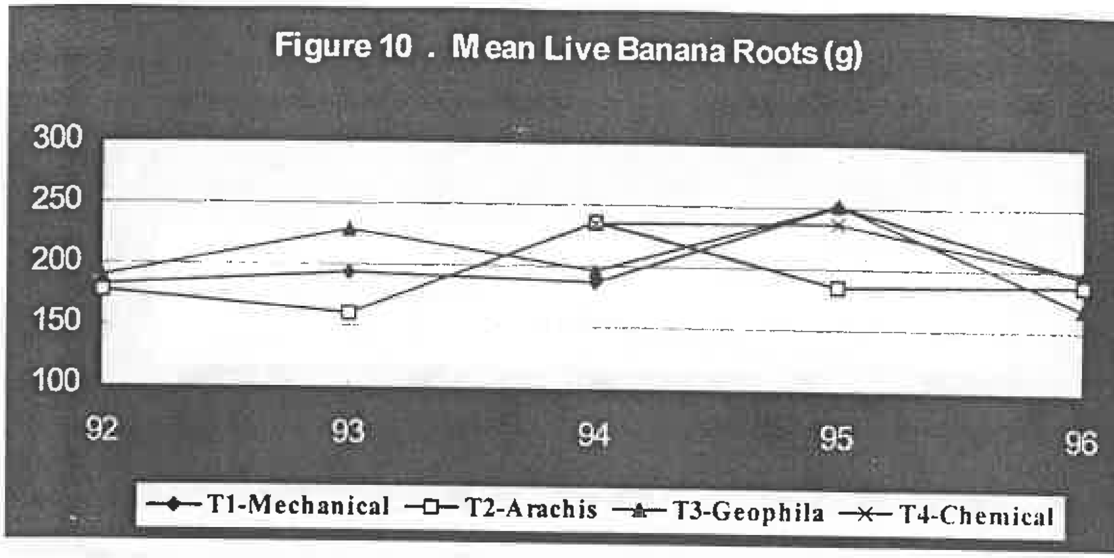
Figure 10 . Mean Live Banana Roots (g)
300
250
200
150
100
92
93
94
95
96
T1-Mechanical
T2-Arachis
T3-Geophila
T4-Chemical

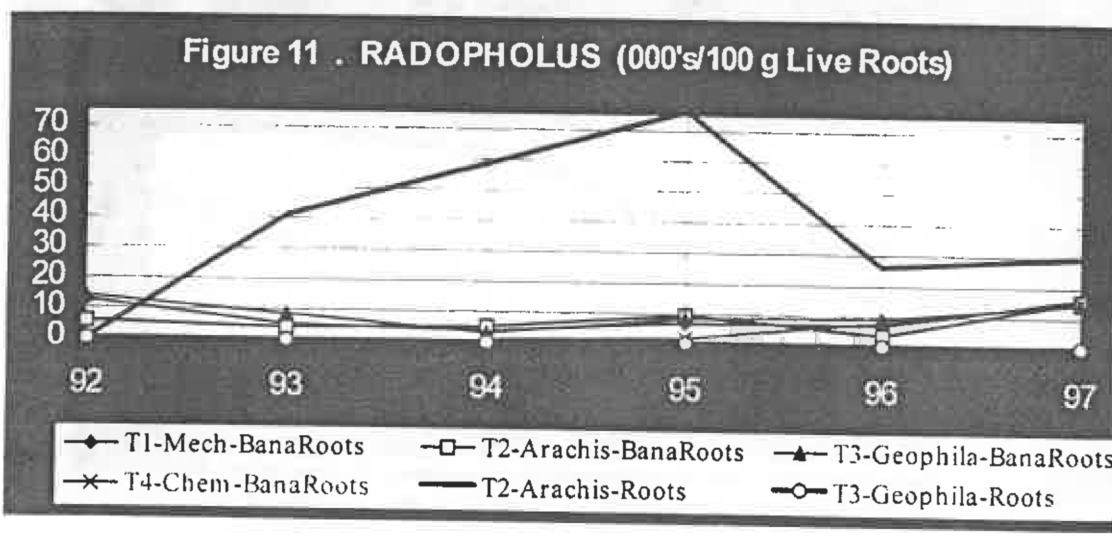
Figure 11 . RADOPHOLUS (000's/100 g Live Roots)
70
60
50
40
30
20
10
0
92
93
94
95
96
97
T1-Mech-BanaRoots
T2-Arachis-BanaRoots
T3-Geophila-BanaRoots
T4-Chem-BanaRoots
T2-Arachis-Roots
T3-Geophila-Roots

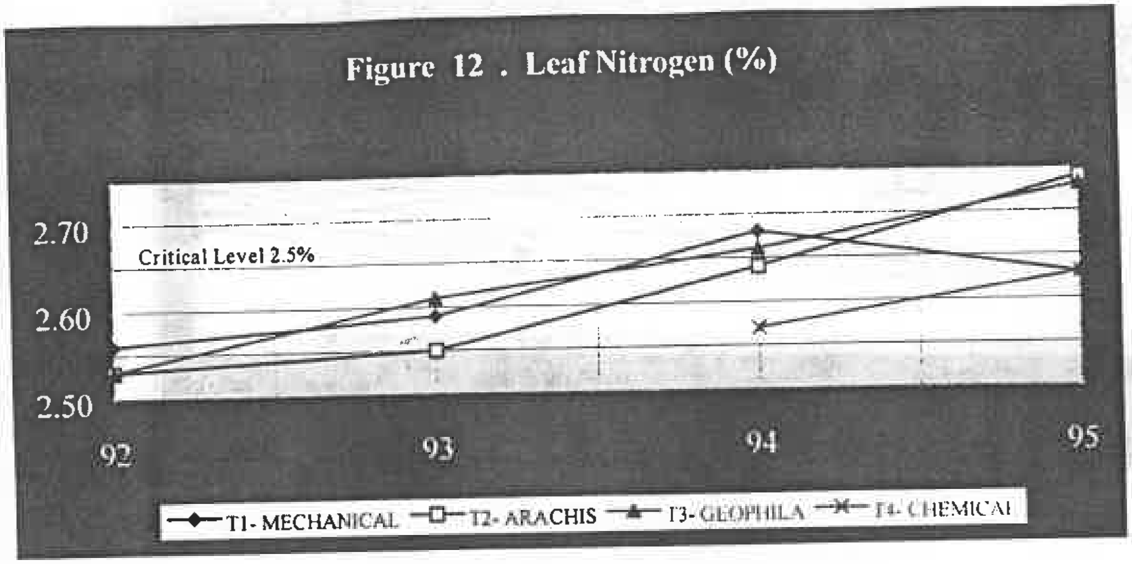
Figure 12 . Leaf Nitrogen (%)
2.70
2.60
2.50
Critical Level 2.5%
92
93
94
95
T1- MECHANICAL
T2- ARACHIS
T3- GEOPHILA
T4- CHEMICAL

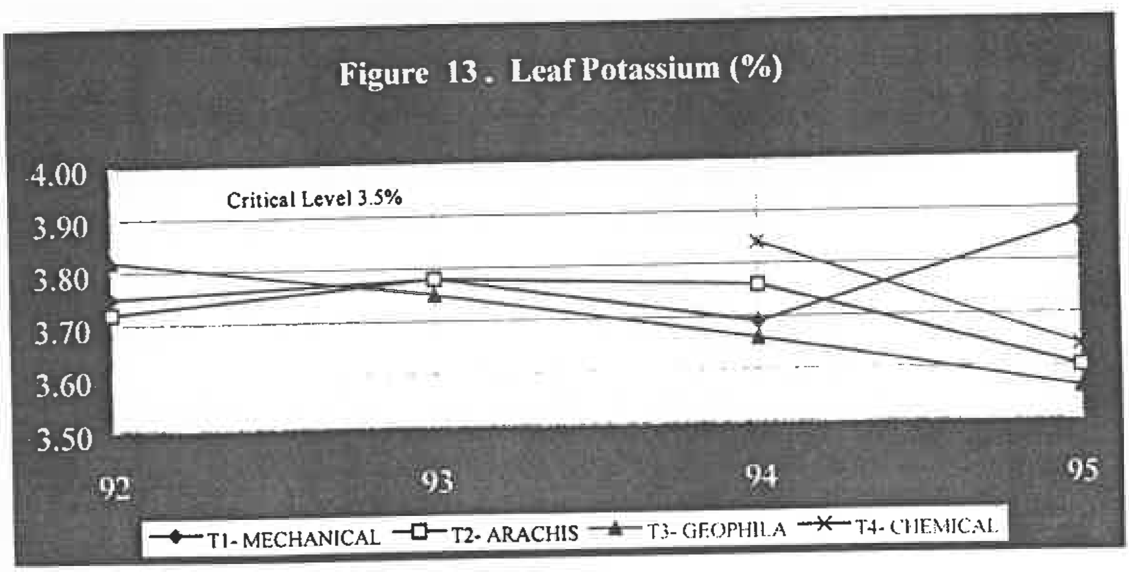
Figure 13 . Leaf Potassium (%)
4.00
3.90
3.80
3.70
3.60
3.50
Critical Level 3.5%
92
93
94
95
T1- MECHANICAL
T2- ARACHIS
T3- GEOPHILA
T4- CHEMICAL

Figure 14. Leaf Magnesium (%)