



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

20973

20973
Final
Report
1994

UNIDO - The United Nations Industrial Development Organization

INDUSTRIAL PROCESSING OF PFAFFIA PRODUCTS

Unido Project No. TF/BRA/91/001
Activity code: J13100

Executed under the Contract No. 92/040

Final Report

December, 1994

Contractor: Agripex Consultoria Ltda.

Industrial Processing of Pfaffia Products

Index

	Page
I. Introduction	1
I.1. Description of the Project and its Background	1
I.2. Justification	1
I.3. Purpose of the Project	2
I.4. Summary of Results, Conclusions and Recommendations	2
II. Preliminary Section	3
II.1. Results from the Research	3
II.2. Conclusions and Recommendations	3
III. The Project	5
III.1 Pfaffia Species	5
III.2. Adopted Actions and Equipment	5
III.3. Details and Findings of the Project	6
III.4. Analyses and Observations	9
IV. Terminal Section	13

ANNEX

Table 01 - Following up the Growth of Pfaffia Roots	A1
Table 02 - Size and Weight of Pfaffia Roots When Harvested	A2
Graphs - Growth of Size and Weight of Pfaffia Roots	A3, A4, A5, A6
Pictures	A7, A8, A9, A10, A11

Industrial Processing of Pfaffia Products
TF/BRA/91/001 - Contract No. 92/040
Activity code: J13100

I. Introduction

1.1 - Description of the Project and its Background

The Industrial Processing of Pfaffia Products Project is of experimental nature in the agriculture and agroindustrial sector. Planting of a vast variety of food products and industrial cash harvests and their transformation into finished, marketable consumer goods contributes a major share to the national economy of Brazil. The intended large scale cultivation and industrial processing of Pfaffia is an entirely new activity within the agricultural sub-sector dealing with medical plants, in combination with the manufacture of natural medicines in the pharmaceutical sub-sector.

The government of Brazil attaches prime priority to maintaining and improving the fauna and flora of the country from the environmental and ecological point of view. While promoting the development of indigenous agricultural-resource based industries the government strategies command that income generation through exploitation of the biosphere must not be harmful to the country's ecological conditions.

The cultivation of Pfaffia plants fulfils this requirement.

In a number of countries, UNIDO (The United Nations Industrial Development Organization) has undertaken many projects with medicinal plants cultivation/harvest and essential oils processing. There are close similarities of technological know-how and technical issues between the technologies and intended cultivation and processing of Pfaffia plants. However, on part of relevant Brazilian research institutions and traditional small planters and users of Pfaffia and its extracts as a natural medicine, some scattered experience exists which sufficiently justify this experimental industrial scale Project.

In order to accomplish this experimental Project it was signed the Contract No. 92/040, signed between UNIDO and Agripex Consultoria Ltda. on August 5th, 1992, according to the Trust Fund TF/BRA/91/001, sponsored by JAIDO (Japan Industrial Development Organization).

1.2 - Justification

The therapeutical Pfaffia is a medicinal herb plant, known as the Brazilian Ginseng with properties apparently higher than the asiatic one.

The Brazilian Ginseng, known under the name of "Paratubo", "Carango" and "Enche papo" has nothing to do with the imported Ginsengs. The Brazilian one belongs to the Amaranthacea's family and the other ones to the Araliacea's family.

Pfaffia (ginseng radix) is one of the crude drugs used in the east as tonic and health medicine. It has several medicinal properties inhibiting growth of certain kinds of cancer cells as well as therapeutical properties combatting bronchitis, cholesterol, diabetes, tuberculosis, skin diseases, constipation and many other diseases.

Extraction of Pfaffia roots from the soil without the necessary technical and scientific care can lead to gradual disappearance of spontaneous occurrences as it happened with medical species like Jabaradi and Fava d'Anta, besides presenting a higher instability in the acquisition of raw material for commercial use: quality, quantity and regularity.

1.3 - Purpose of the Report

This report has the purpose of presenting actions taken during the first experimental phase of the Project and the results and conclusions obtained during 2.5 years of experiments with Pfaffia, from the seedling production, following up of agricultural development of Pfaffia, harvest and industrial processing of its roots.

1.4 - Summary of Results, Conclusions and Recommendations

The Project reached the proposed objective, in relation to its first phase, resulting in harvest of 11,564 Kg of crude roots, which produced around 3,227 Kg of dry roots.

The conclusions is expected to be of high importance for a commercial development of Pfaffia cultivation.

Main findings are as it follows:

- a) Method for producing the seedlings.
The best method is the direct planting in small bags, because it does not cause stress to the roots.
- b) Density of plants per Ha at the field level.
The recommended density is 0.5m x 0.5m spacing between Pfaffia plants at the field.
- c) Period for the harvest of Pfaffia roots.
An adequate period for the harvest is around 1 year after the planting.
- d) Proportion of dry/crude material by industrial processing.
Industrial pilot processing showed that 1kg of crude root produce around 280 gr of dry material

II. Preliminary Section

II.1 - Results from the Research

Although the Project was suspended before the conclusion of the first experimental phase, it was possible to carry out the harvest of the planted *Pfaffia*. It allowed to reach part of the Project objective.

Main reached goals are as it follows.

- a) Harvest of 11,546 Kg of *Pfaffia* roots.
- b) Determination of the proportion of dry/crude root percentage, after the industrial processing, as being around 28%, with 8% of maximum humidity level.
- c) Finding out the best method to produce an appropriate seedling.
- d) Determination of the best period for the harvest, according to the root growth curve.

II.2 - Conclusions and Recommendations

A recommended method to produce appropriate *Pfaffia* seedlings is the direct sowing in the bags, because it does not cause stress to the root, and it allows an uniform growth, producing roots with the same shape as the Korean ginseng.

In the beginning, it was expected that the *Pfaffia* roots would present a certain growth pattern and consequently the roots production volume per Ha would be linear as a function of the number of plants per Ha. Taking into account such assumption it has been determined a forecast of the quantity to be produced by the Project.

The planting design for the experiment at the field, with spacing 3m x 1m and 3m x 0.5 m, intended to provide roots a enough space to grow as well as to become easier the mechanization of the planting and maintenance operations. However, such spacing showed to be inadequate due to the behavior of the roots growth.

It was concluded that it should be recommendable to plant it densely, with a minimum spacing of 0.5m x 0.5m, for the field cultivation, and it would produce more per Ha.

The growth of roots has not been uniform, without any pattern neither in size or in weight, with a high variation (as shown by Table 01 and Graphs in the Annex). It made the production of roots be lower than that has been estimated. This aspect led to the conclusion that the planting design (density of seedlings per Ha) is what can determine a pattern of *Pfaffia* roots growth.

The above conclusions were experimentally tested with seedlings produced through an adequate method and planted at field with spacing 0.5m x 0.5m. The plants have been pruned when they reached around 70 cm, in order to control their growth.

During the short observation period (5 months) it was noted that the growth of roots was uniform, and due to a high density of plants per Ha it was expected a large production of roots.

The harvest carried out in August 1994, although the plants had different ages, showed that they had not significantly changed neither in size or in weight in relation to the sample with 342 days (Table 02 in the Annex). It led to the following conclusions:

- a) The Pfaffia roots harvest shall be carried out when they reach around 1 year, from the planting at the field.
- b) If the plant is not timely harvested, the density of plants per Ha decreases, and consequently it reduces the production of Pfaffia roots.

Considering all observed factors it may be concluded that the harvest of 11,564 Kg of Pfaffia roots may be taken as satisfactory.

The industrial processing experiment carried out by ITAL showed that the dry material represents around 28% of the crude root, i.e. 1Kg of crude root results in 280 gr of dry root, therefore, 11,564 Kg of the harvested roots could produce around 3,227 Kg of dry material.

Under these conditions, as the Project planned to produce 6,000 Kg of dry root in 2 cycles, it may be considered that the first phase of the Project was accomplished.

III. The Project

III.1 - Pfaffia Species

Although it has been identified 3 species of Pfaffia, which are Pfaffia Glomerata (Marshland), Pfaffia Iresinoido (Half-Marshland) and Pfaffia Paniculata (Hill), the Project experimented the Pfaffia Iresinoido, according to the request of JAIDO's representative.

III.2 - Adopted Actions and Equipment

The first action taken for the start of the Project was to conceive a scheme and a work plan to be executed in 40 months, period estimated for execution of the Project. The work plan was executed with the following factors.

1. Production Area

Planting and development of activities aiming at the maintenance of 45 Ha in the first 18 months of the Project.

Repetitions of the field experiment, on the same 45 Ha in 18 months subsequent to the first cycle of experimentation, performing, therefore, 90 Ha of total planted area in 2 study cycles.

2. Executed scheme

The experiment was carried out on parcels of 4.5 Ha, with the following variation:

Planting design A - spacing 3m x 1m
(3m between the lines and 1m between the plants)

- Model A1= no fertilizer (4.5 Ha) proof.
- Model A2= limestone (4.5 Ha) proof.
- Model A3= thermosphosphate (4.5 Ha) proof.
- Model A4= organic fertilizer (4.5 Ha) proof.
- Model A5= limestone+thermophosphate+organic fertilizer (4.5 Ha) proof.

Planting design B - spacing 3m x 0.5m
(3m between the lines and 0.5 m between the plants)

- Model B1= no fertilizer (4.5 Ha) proof.
- Model B2= limestone (4.5 Ha) proof.
- Model B3= thermosphosphate (4.5 Ha) proof.
- Model B4= organic fertilizer (4.5 Ha) proof.
- Model B5= limestone+thermophosphate+organic fertilizer (4.5 Ha) proof.

3. Production of Seedlings

It has been estimated the need to produce 250,000 seedlings of *Pfaffia*, considering the planting design.

4. Harvest of Roots

The harvest of each experimental parcel was planned to be made when it reached 12 months from the initial planting.

The production of *Pfaffia* was estimated in around 6,000 Kg of dry roots at the end of 2 planting cycles.

5. Industrial Processing of Roots

The final objective was to research the following parameters:

- Adjustment of drying process on trays.
- Variables: type of cutting density of material, temperature and velocity of drying air, and final humidity of the product.
- Drying parameters: curve of drying velocity and time.
- Final products: humidity, apparent density, adjusted apparent density and granulometry.
- Loss and output of the global as well as the drying process.

6. Equipment

The equipment bought and utilized for the development of the Project were:

- One tractor Valmet 78.
- One plowing harrow type rome 12 x 32.
- One plow for planting.
- One plow type aiveca.
- One subsoiler.
- One agricultural cart for 4 ton.
- One tank cart for 3,000 liters of water.

III.3 - Details and Findings of the Project

According to the plan goal, it was started the works in May 1992, with preparation of the place where it has been installed the nursery for production of seedlings.

The total production of approximately 250,000 *Pfaffia* seedlings resulted from a continuous work of around 6 months, covering operation of substrate for seedlings,

filling of bags, preparation of seed-beds for sowing, replanting of seedlings to the bags, preparations of slips, and sowing in the bags.

As the seedling production was the restrictive factor for the starting of the experiments at the field, we produced seedlings with varied methods, and it has been found afterwards that such production methods are the main factors influencing the future root formation, after trying to produce seedlings by many ways.

The first employed method was to make the seed sowing directly in the bags, already arranged on the seed-beds. The production of seedlings by this way was low, because the germination of many seedlings in each bag required the rejection of the excessive seedlings, in order to keep only one seedling in each bag. This method showed a loss of large quantity of seeds, because the size of *Pfaffia* seeds is tiny and there is no way to control the sowing of one seed in each bag.

The second employed method consisted in preparing a seed-bed and sowing *Pfaffia* seeds. After the germination of seeds, it was allowed that the seedlings reached around 5 cms, and then they were replanted in each bag. It was observed that by such a method the number of seedlings versus the quantity of sowed seeds presented a high level of result.

The third employed method was the propagation by vegetative growing, i.e., through the slip. It has been chosen a mother-*Pfaffia* plant, including its branches, and they were divided into many slips of length about 15 cm, and then planted one in each bag. This method presented the lowest result and the loss of slips by seed-bed reached 20 % of the total planted.

The main factors observed during the works of seedling production are presented below.

- a) The germination of seeds happens between the tenth to fifteenth day of sowing.
- b) An average temperature lower than 18° C causes delay in the germination of seeds and in the development of seedlings.
- c) The first planting of seedlings at the field was made 85 days after the sowing, under the low temperatures in June, July and August 1992.

It has been observed that the production time decreases considerably when the average temperature falls. This fact was observed at the end of September, when no more occurred abrupt decreases of temperature during the night and the morning.

Under average temperature above 22° C, reaching peaks of 32° C, the seedlings developed itself better and they were ready for planting between 45 and 55 days.

The area preparation for the first cycle of experiments on the field was started in the second period of fifteen days of August 1992, and the operations for preparing the soil were the following:

- a) Initial harrowing of the area.
- b) Deep plowing.
- c) Second heavy harrowing.
- d) Levelling for preparation of the planting area with light harrowing.
- e) Furrowing of lines with spacing of 3 meters between each line.
- f) Application of fertilizers in the planting furrows, according to the planned scheme.
- g) Incorporation of fertilizers through the subsoiling operation, inside the furrows, in order to allow the deepening of the input and, consequently, of the Pfaffia roots.

After the mechanical operations, it was made the manual opening of small holes, with 1 meter spacing, the seedling distribution at the field, and, finally, the planting operation.

The experimental parcels of A1 to A5 received 3,300 seedlings per hectare, and at B1 to B5 it was planted 6,600 seedlings per hectare. The planting in each parcel was made on the following dates:

A1 ... 28/Aug/92	B1 ... 14/Dec/92
A2 ... 14/Set/92	B2 ... 28/Jan/93
A3 ... 29/Set/92	B3 ... 02/Feb/93
A4 ... 19/Oct/92	B4 ... 25/Feb/93
A5 ... 02/Nov/92	B5 ... 25/Feb/93

During the implementation of the total experiment, it was decided to collect the product at the field in order to analyse its root system development.

Four plants were collected at random, from each experimental parcel, on the following periods:

- 1st. ... 72 days after the planting.
- 2nd. ... 162 days after the planting.
- 3rd. ... 252 days after the planting.
- 4th. ... 342 days after the planting.

For each sample collecting it has been verified the weight and size of each root system (Table 1 and Graphs).

After the implementation of the first experimental parcel at the field, it was started the maintenance operation of the culture. Each fifteen days the weeds were controlled, i.e. it was carried out a manual weeding on the experiment lines. On the other hand, it was employed the mechanical weeding between these lines, through a tractor and levelling harrow.

For the maintenance operation of the culture it was utilized a large quantity of labor, mainly during the period from September 1992 to December 1993, when UNIDO requested AGRIPLEX to suspend all works being executed in the Project.

III.4 - Analyses and Observations

From the data of Table 1 and Graphs (Following up the Growth of Pfaffia Roots) It may be observed that there is not a defined pattern of root growing in size and weight.

It is not also possible to note a significant difference in the behavior of roots caused by the difference in the utilized inputs in each parcel of the experiment.

Although there is a difference between the parcel A1 (no fertilizer) and the other proofs (A2, A3, A4, and A5), there is not any significant difference between the parcels with fertilizers.

It has been noted that the roots system of the Pfaffia plants in formation did not present a expected shape, i.e. similar to the Korean ginseng. The roots presented a large quantity of small roots around the main root. It was one of the most remarkable finding.

In order to understand the reason why the most of the collected roots presented an excess of small side roots, and others, in small quantity, presented an expected shape, it was analysed each experiment since its initial step.

This investigation showed that such irregularity was related to the seedling production method, according to the following findings.

- 1 - In the case of seedlings obtained from the vegetative reproduction (slip), it has been observed that when they developed the root system, a large number of side small roots grew, and consequently it was developed by the same way at the field (Picture 3 in the Annex).
- 2 - The seedlings obtained through the sowing on seed-beds and traspianted into the bags afterwards also presented a large number of small side roots. When they were analysed, it was found that it occurred due to a stress on the root during the replanting operation (Picture 2).
- 3 - The seedlings produced by the direct planting into the bags were obtained after the rejection of excessive seedlings. It has been observed that the remained seedling in each bag did not suffer any stress and its root system grew uniformly with little quantity of small side roots (Picture 1).

These findings were resulted from solutions employed and they were presented as from the Second Partial Report.

During the period of 342 days the development of the root system was followed up in the experimental parcels implemented at the field. This work has been recorded by pictures and the obtained data are presented in Table 01 and Graph. It was also scheduled the harvest to be carried out when each parcel reached thirteen months from the planting date. The harvest of the first parcel was started on September 28, 1993. In order to research the industrial processing of Pfaffia, it was effected a contract with ITAL (Instituto de Tecnologia de Alimentos), a State research institute, during the period of 4 months.

It was agreed with ITAL that as the root harvest was made, 120 Kg of the roots would be weekly sent to that institution.

The material sent to ITAL would be utilized for researching the Pfaffia industrial processing, and for developing a experimental plant for Pfaffia industrial processing.

Schedule for Delivering Roots to ITAL

Lot	Delivery date for drying	Weight (Kg)	
		Crude	Dry
1st	05/Oct/93	102	34
2nd	13/Oct/93	104	34
3rd	19/Oct/93	65	25
4th	03/Nov/93	95	35

For the root drying process it has been observed the following recommendations:

- Maximum temperature for drying in 60° C.
- Maximum humidity of dry material in 8%.

For the root cutting it has been utilized a cutter with 2 rotatory blades "Ushell". that produced chips with 3mm x 3mm x 1mm(thickness) size.

The roots so obtained was dried in electric chamber with 55° C of temperature, during 4 hours, and at the end of this period the roots presented a humidity of 8%. The proportion of the dry/crude material was around 28% in average.

In December 1993, UNIDO requested AGRIPLEX to suspend the works which were being developed in the Project. However, because of the stage of the Project development in the occasion, AGRIPLEX continued the maintenance of 45 Ha of Pfaffia, which allowed the harvest of the total area of experimental parcels.

The harvest occurred during the month of August 1994, when it was possible to obtain some experimental data from the sample collected according to the following criteria.

It was taken 4 samples at random from each experimental parcel, with total of 100 roots. The result is shown in Table 02 and Graph.

The harvest operation observed the following procedure.

- a) Cutting the external part of Pfaffia plant, through a weeder on the plant line.
- b) Application of subsoiler with 2 rods (60 to 70 cm open between the rods), and deepening of 40 cm in the soil. Such operation allowed the roots to be released from the soil.
- c) Manual operation with a mattock in order to release the roots totally from the soil.
- d) Collecting the harvested roots with tractor and cart, and transporting them to the preparing place.
- e) The preparation consisted in the following operations: cutting of the remaining external part of the plant, leaving only roots, and bagging for transportation. These operations were made at an appropriate place, in order to avoid possible infection of the roots.
- f) All roots were weighed before they were delivered to JAIDO's representatives.

The volume of the harvested roots was 11,564 Kg (11.56 ton), according to the following schedule.

Date of delivery	Volume (Kg)
22/Jul/94	1,215
26/Jul/94	1,198
30/Jul/94	1,865
05/Aug/94	2,331
12/Aug/94	3,217
19/Aug/94	1,738
Total	11,564

The climate of the period preceding the harvest was atypical around the region of Aguas de Santa Bárbara, São Paulo State, where the Project was implemented.

Months of June and August was too dry, with very scarce rain, which came only at the end of August. In the beginning of the third week of July occurred a frost, which damaged all the external part of Pfaffia.

Because of dry and hard soil conditions, the harvest continued over the expected term.

It was observed during the experiment period a competition between *Pfaffia* plants for the aerial space, causing a certain decrease in the density of plants per Ha.

Another remarkable point is the period planned for the harvest. It was planned to start it when each parcel had reached 12 to 13 months. However, such period was extended for more about 12 months, which also caused a notable low density of plants.

The industrial output of *Pfaffia*, presented in the initial tests carried out by ITAL an average of 28% of dry material in relation to the crude root. According to this output information, it is supposed that from 11,526 Kg of crude root it may be produced 3,227 Kg of dry material, which corresponds to around 50% of the initial goal of the Project.

III.5 - Alternative Spacing Experiment

In order to experiment an alternative planting design it was tested a spacing 0.5m x 0.5m, with seedlings produced by the first method (direct sowing in small bags).

Because of mechanical maintenance of the crop the spacing 0.5m x 0.5m was made for each 3 planting lines, and between these 3 lines it was kept a space of 3 meters (Picture 5).

The plants have been pruned when they reached around 70 cm, in order to control their growth.

During the short observation period of 5 months (Pictures 5, 6, 7, and 8) it was noted that the growth of roots was uniform, and due to a high density of plants per Ha it was expected a large production of roots.

IV - Terminal Section

It was observed during the seedling production process that the most important part is the beginning stage.

If the seedling is produced without stress, it will produce an adequate root.

During the culture development at the field level, it was possible to observe the question of an ideal spacing between the *Pfaffia* plants. This aspect is also an important detail for its root system behavior.

Another important factor is the curve of *Pfaffia* root development, in relation to the ideal point of harvest. The graphics showed that the size of roots has been constant after reaching a certain length. On the other hand, the weight increases until the twelfth month from the planting, but it no more increases significantly in the following months.

It is assumed that the Project successfully reached its first experimental phase, and its second phase should be implemented according to the previous conclusions, in order to confirm the findings and to analyse the economic feasibility of the Project.

The experiment showed that the native *Pfaffia* plant can be commercially cultivated, resulting in about 28% of dry material in relation to the crude root.

Unfortunately, it was not possible to study a complete pilot industrial plant, as it has been planned, because the Project was suspended.

Considerations, conclusions and recommendations expressed in this report show that, through the research, it is feasible to take a native species with therapeutic characteristic as *Pfaffia* and become it productive on a commercial basis, if an adequate agricultural technique is utilized. Consequently, it may become possible a larger number of people to get access to such species, avoiding a predatory extraction of native plants from the natural environment.

ANNEX

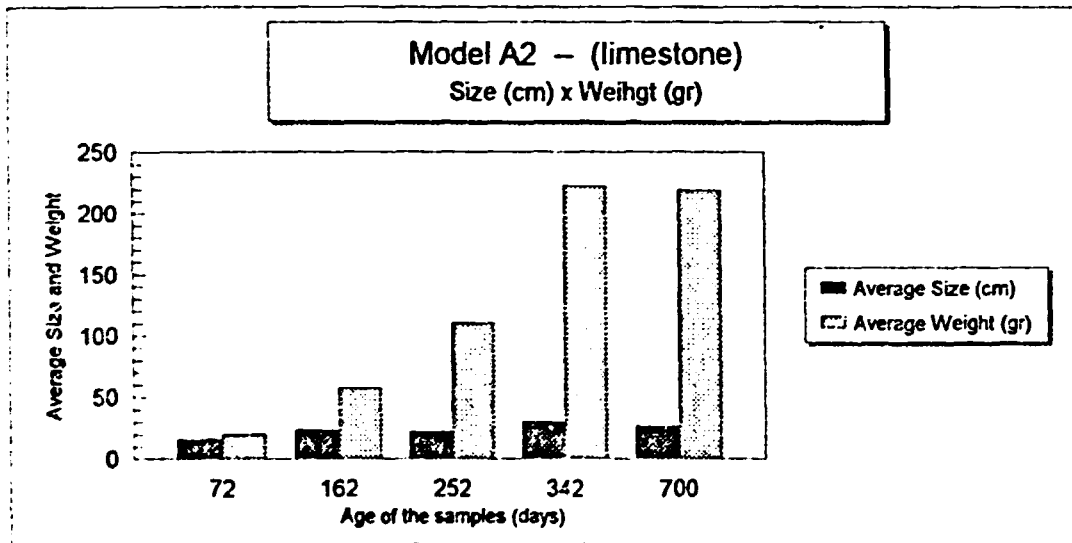
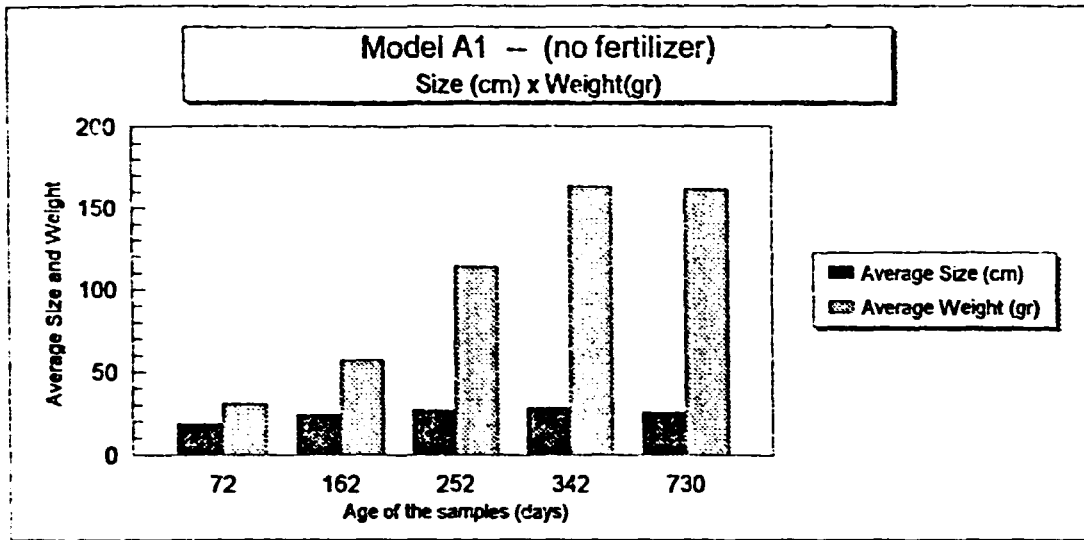
TABLE 01 - FOLLOWING UP THE GROWTH OF PFAFFIA ROOTS

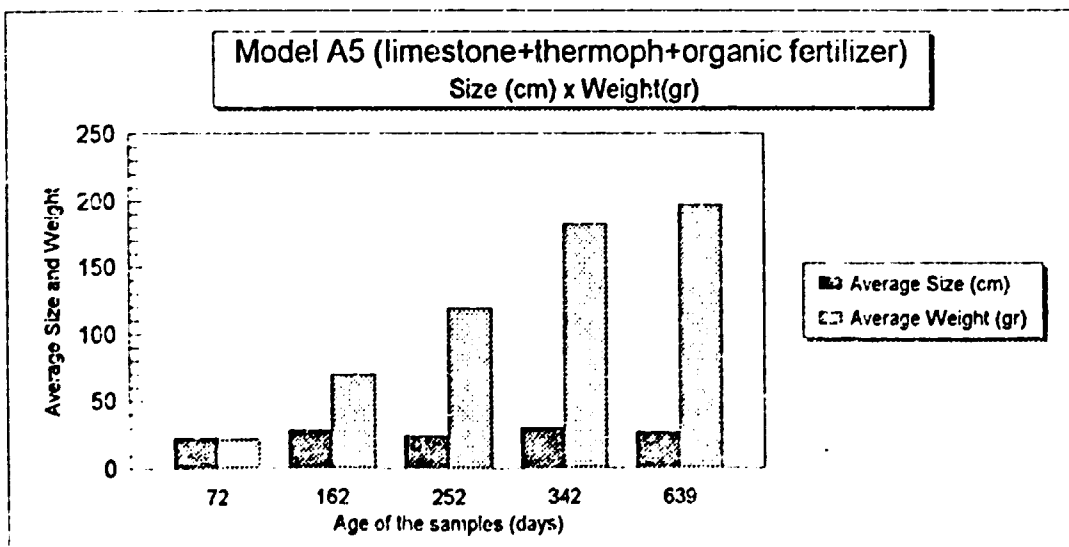
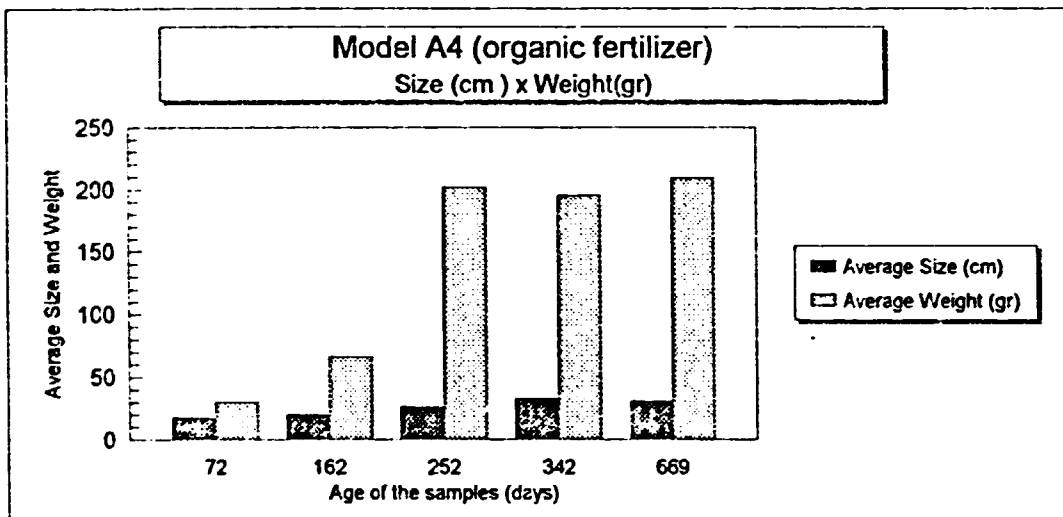
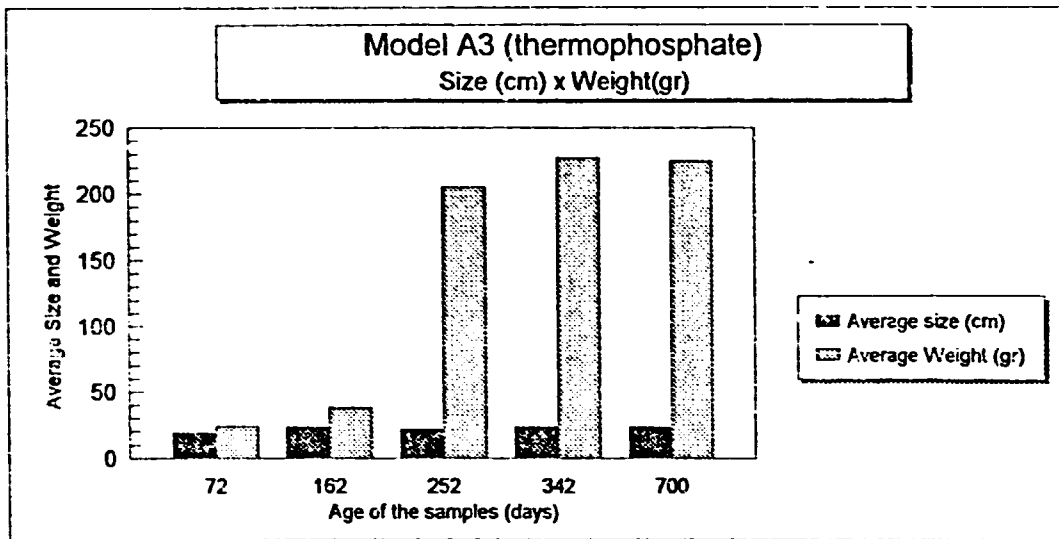
Planting/ Parameter	Sampling with 72 days				Sampling with 162 days				Sampling with 252 days				Sampling with 342 days			
	1A	2A	3A	4A	1A	2A	3A	4A	1A	2A	3A	4A	1A	2A	3A	4A
A1 Weight (gr)	41	28	23	32	70	54	42	63	115	129	108	102	112	120	170	251
Size (cm)	18	21	17	19	23	24	23	25	28	29	26	25	26	28	28	32
A2 Weight (gr)	22	19	20	18	69	52	65	44	74	235	78	55	243	230	269	148
Size (cm)	21	13	17	13	24	22	25	23	23	22	21	21	32	28	28	32
A3 Weight (gr)	19	22	18	37	43	38	40	31	125	175	277	244	215	175	277	244
Size (cm)	16	21	17	22	25	21	28	20	28	16	19	23	29	23	24	18
A4 Weight (gr)	42	35	17	28	87	52	77	49	260	267	197	84	355	110	155	161
Size (cm)	18	22	16	14	26	17	21	17	32	29	28	16	36	32	35	29
A5 Weight (gr)	22	25	20	19	116	46	48	68	183	120	101	73	293	222	53	161
Size (cm)	23	24	21	22	24	34	27	28	21	28	25	23	27	32	29	32
B1 Weight (gr)	41	29	15	16	75	41	18	23	127	257	114	144	160	212	235	154
Size (cm)	29	23	17	16	24	28	23	25	32	24	29	35	36	38	44	38
B2 Weight (gr)	28	32	20	23	74	163	30	50	77	139	142	67	178	141	218	469
Size (cm)	27	25	18	21	25	30	22	27	29	34	36	19	29	39	37	32
B3 Weight (gr)	14	25	10	28	145	65	117	78	250	365	158	166	422	325	270	194
Size (cm)	16	21	15	21	29	25	27	27	39	39	31	27	39	37	30	32
B4 Weight (gr)	51	42	32	27	212	255	159	195	478	330	392	261	213	291	301	457
Size (cm)	26	24	25	25	27	44	34	32	42	40	35	47	31	35	28	33
B5 Weight (gr)	25	33	35	46	70	251	141	207	256	240	248	221	304	293	432	192
Size (cm)	20	27	20	23	33	31	29	31	46	35	39	28	42	38	37	31

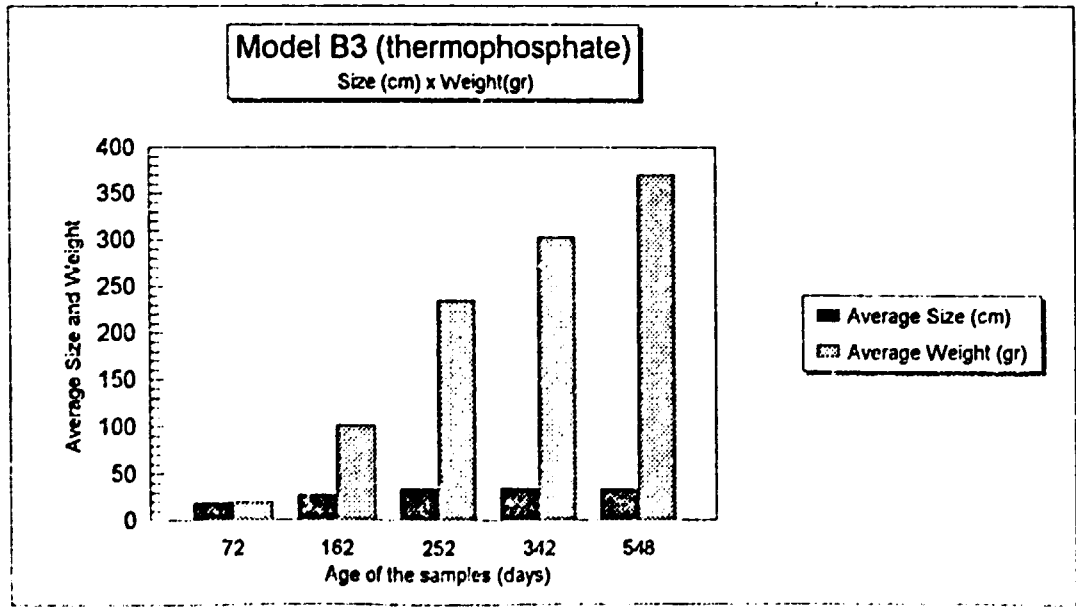
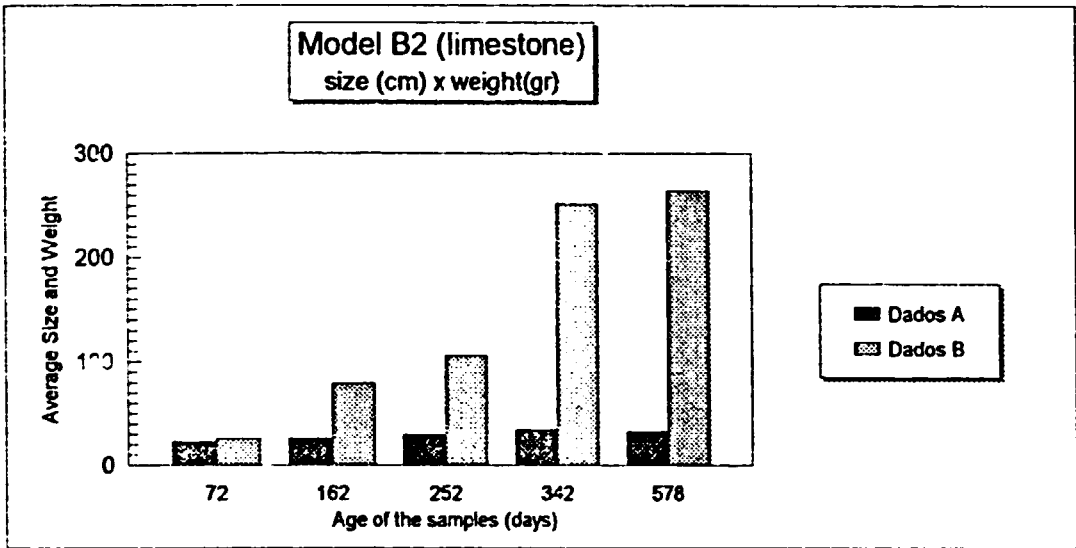
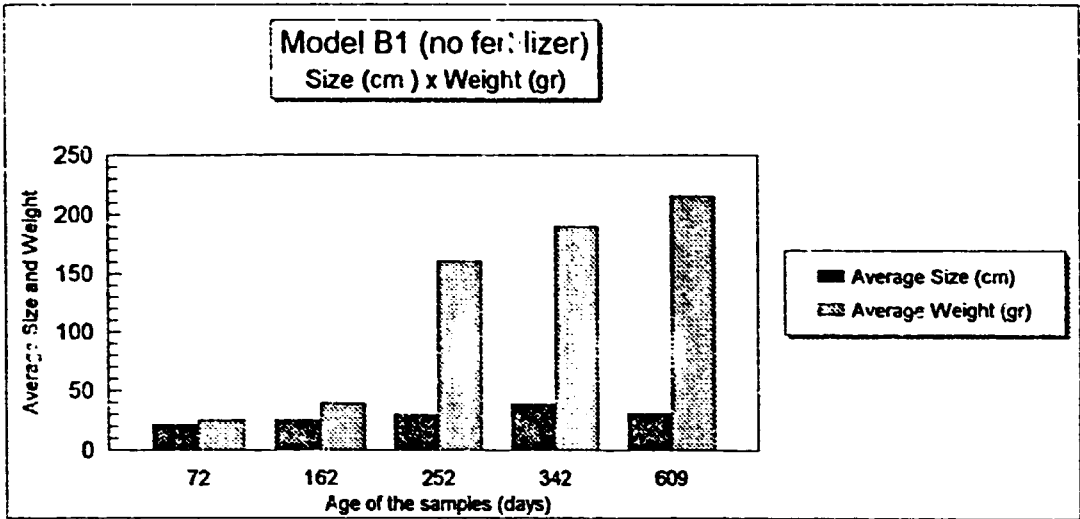
TABLE 02 - SIZE AND WEIGHT OF PFAFFIA ROOTS WHEN HARVESTED

PLANTING/ PARAMETER		SAMPLING				AGE OF THE SAMPLES
		1A	2A	3A	4A	
A1 - NO FERTILIZER	weight (gr)	174	109	116	136	24 MONTHS
	size (cm)	28	24	27	23	
A2 - LIMESTONE	weight (gr)	328	133	145	270	23 MONTHS
	size (cm)	31	25	22	27	
A3 - THERMOPHOSPHATE	weight (gr)	302	354	101	143	23 MONTHS
	size (cm)	25	27	24	18	
A4 - ORGANIC FERTILIZER	weight (gr)	379	181	137	141	22 MONTHS
	size (cm)	35	30	32	26	
A5 - LIMESTONE + THERMOPHOSPHATE + ORGANIC FERTILIZER	weight (gr)	230	166	221	172	21 MONTHS
	size (cm)	27	23	25	31	
B1 - NO FERTILIZER	weight (gr)	298	250	128	187	20 MONTHS
	size (cm)	32	37	29	25	
B2 - LIMESTONE	weight (gr)	109	272	258	418	19 MONTHS
	size (cm)	33	31	27	39	
B3 - THERMOPHOSPHATE	weight (gr)	393	460	331	296	18 MONTHS
	size (cm)	36	34	29	35	
B4 - ORGANIC FERTILIZER	weight (gr)	273	310	217	303	17 MONTHS
	size (cm)	32	34	25	30	
B5 - LIMESTONE + THERMOPHOSPHATE + ORGANIC FERTILIZER	weight (gr)	254	344	343	285	17 MONTHS
	size (cm)	29	39	41	31	

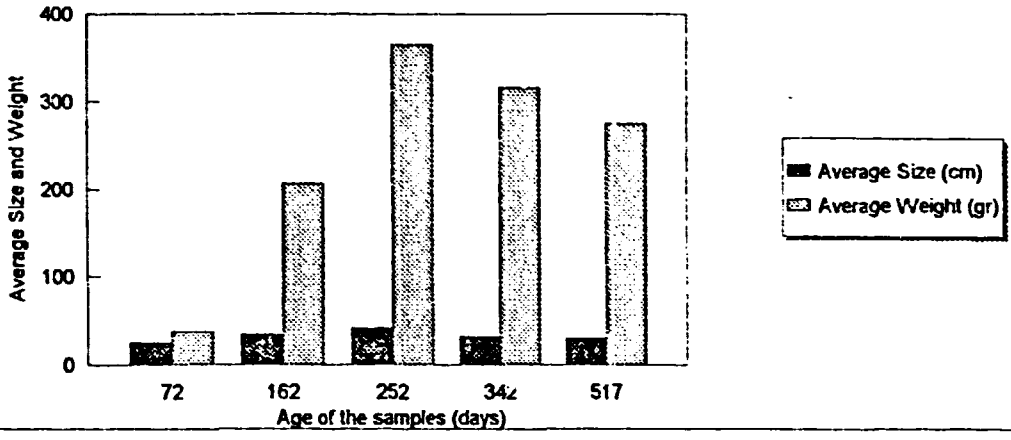
GRAPHS - Growth of Size and Weight of Pfaffia Roots
(source Table 01 and 02)



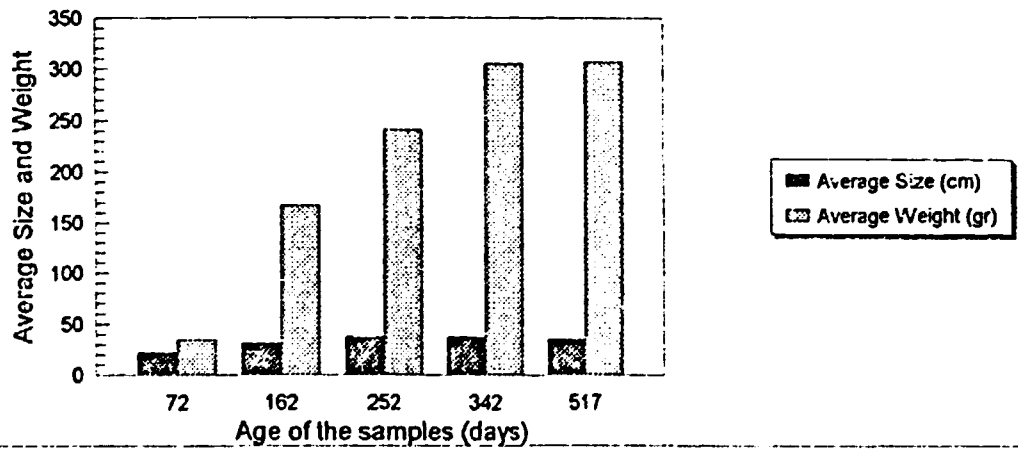




Model B4 (organic fertilizer)
Size (cm) x Weight(gr)



Model B5 (limestone+thermoph. +organic fertilizer)
Size (cm) x weight(gr)

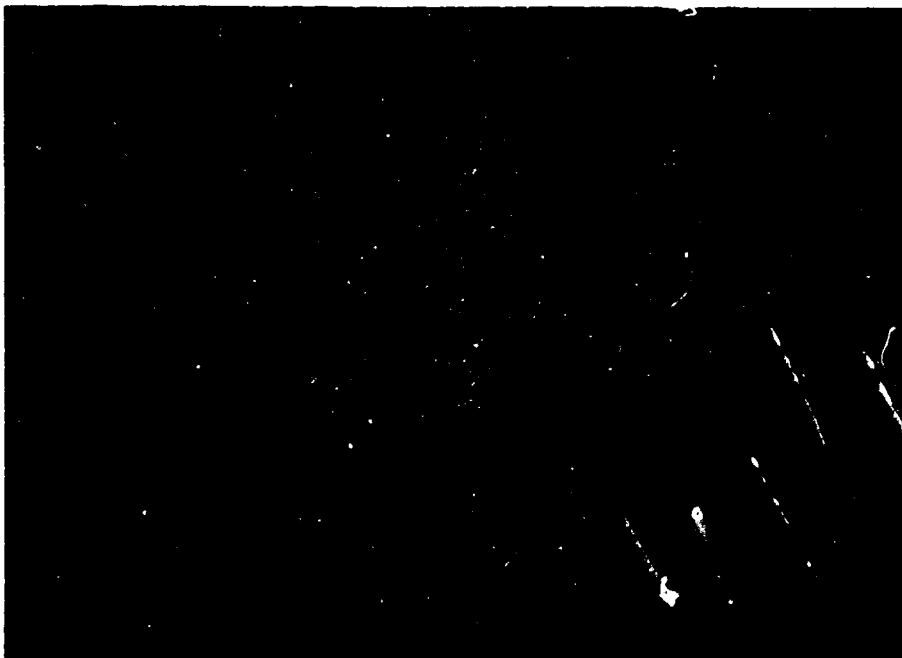


Industrial Processing of Pfaffia Products

PICTURES



(1) Pfaffia roots produced by the first method (direct sowing in small bags)



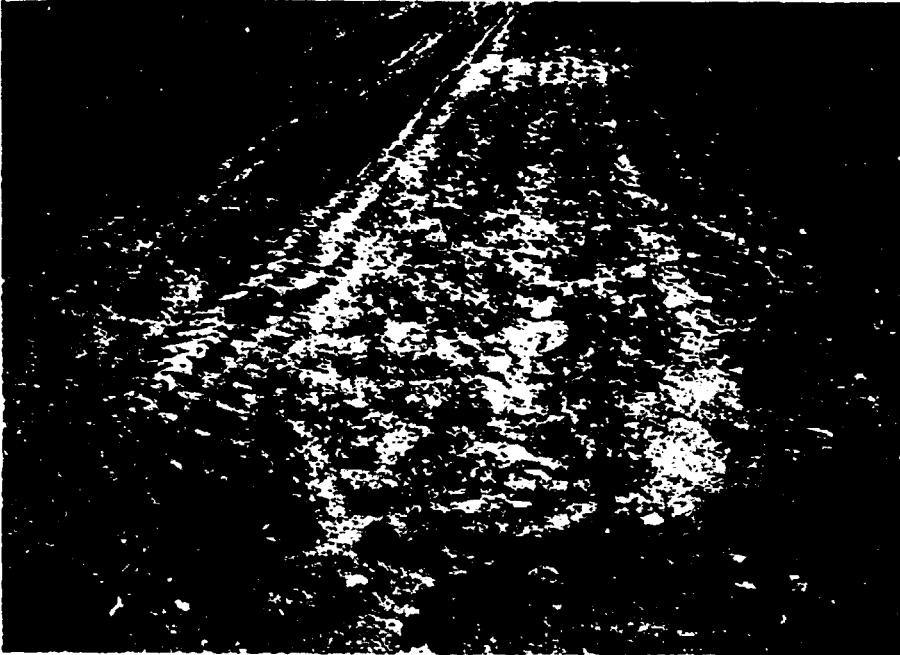
(2) Pfaffia roots produced by the second method (sowing on seed-bed)



(3) Pfaffia roots produced by the third method (slip)



(4) Comparing roots produced by three methods



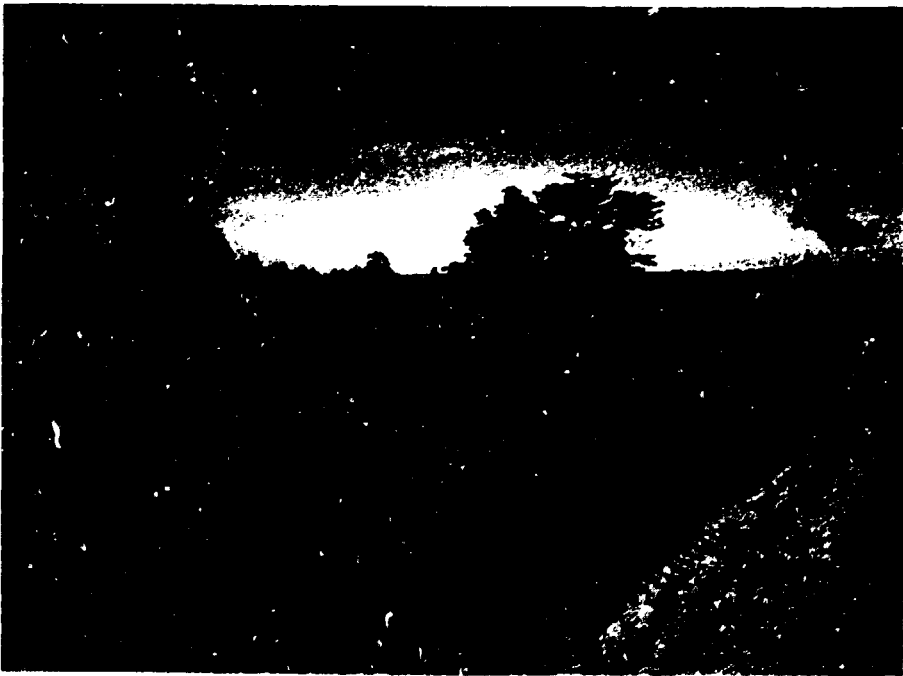
**(5) Planting through the alternative spacing (0.5m x 0.5m),
with seedlings produced by the first method
(20 days after the planting)**



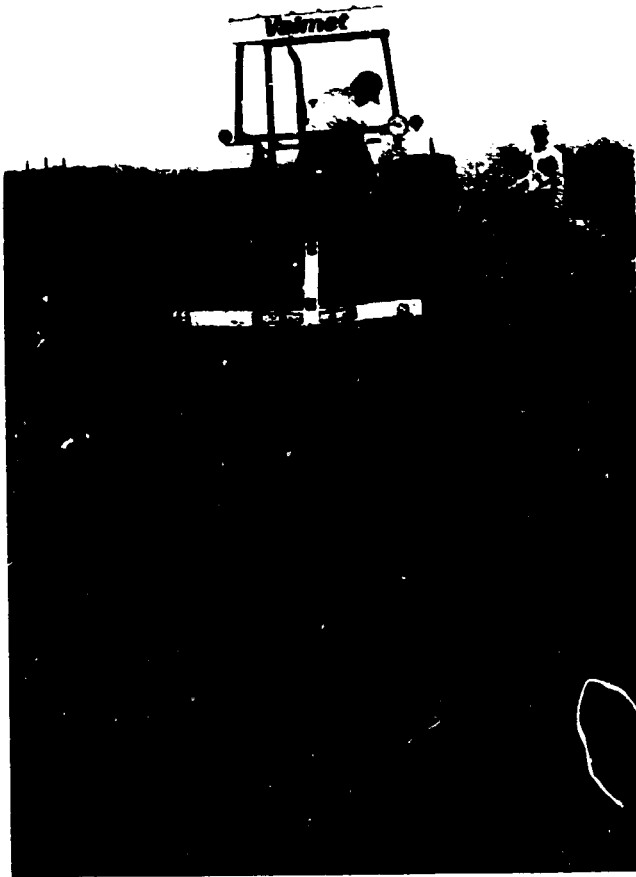
(6) Ditto (33 days after the planting)



(7) Ditto (123 days after the planting)



(8) Ditto (150 days after the planting)



(9) Mechanical harvest operation



(10) Manual harvest operation