HORTIN II Co Innovation Programme

*Towards cost effective, high quality value chains*

# Influence of nursery, Actara drench and variety on transplant raising and yield of hot pepper.

HORTIN-II Research Report nr. 8

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The purpose of the HORTIN-II programme is to contribute to the development of cost effective high quality value chains for vegetables and fruits. Among others this can be achieved when technology development takes place in close collaboration between public institutions, farmers and private companies.

On the Indonesian side the programme is carried out by the Indonesian Centre for Horticultural Research and Development (ICHORD), Jakarta, with the Indonesian Vegetable Research Institute (IVEGRI), Lembang, and the Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD) in Bogor.

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# Executive summary

In 2008 an experiment was carried out to test the effect of nursery construction, variety and transplant raising method on transplant quality and yield of hot pepper. The experiment took place from February 20 till September 3 at Brebes, Central Java. Transplants of the open pollinated variety Tit Segitiga and of the hybrid variety Gada $F_1$ were raised in nurseries and compared with direct sowing on emergence and yield.
With the use of transplants less seeds were required to obtain a similar plant density as was present with direct sowing. Seed costs were reduced by at least 60%. With transplant use, yield levels per square meter were equal or higher then at direct sowing. Especially at Tit Segitiga yield levels with transplant use were higher, while at Gada yield levels were quite the same. Yield levels of Gada F1 were higher as compared to the yield of Tit Segitiga. Fruit weight and appearance of both varieties was similar.
Three different containers, 128 and 70 module trays and simple plastic bags were compared as container for transplant raising. Percentage emergence and percentage of usable transplants was the highest when using plastic bags.
Effect of drenching transplants with Actara 25 WG (Thiamethoxam 250 g/kg) was tested on thrips and whitefly control. However, in this experiment no differences in pest control ere present.
Adding 100 mg nitrogen per litre media did not result in transplants of better quality or in better yield levels.
A simple table nursery construction was compared with a similar construction but then placed directly on the soil. Results indicated that transplant raising in a table construction gives a better emergences.

# 1 Introduction

In 2007 HORTIN-II was started in order to improve the supply chain of the selected crops shallot, hot pepper and sweet pepper. A main constraint in the hot pepper supply chain is the lack of good starting material. Besides. pests and diseases are hampering the cultivation resulting in low yield levels and often causing crop failures. About 20% of the hot pepper production on Java takes place at Brebes in central Java. Hot pepper is considered as a secondary crop by the local farmers and is used to intercrop with shallot, which is considered as the main crop. Rotation takes place with rice and sugar cane. In general the climate in Brebes is suitable for hot pepper cultivation except for the months December and January when heavy rainfall is present. Main hot pepper season only starts after rice harvest in April.
Currently hot pepper is direct seeded where 5 seeds are sowed per planting hole in order to secure one plant per plant position. This means that only 20% of the seed is used. Farmers' practice includes also the use of local open pollinated varieties with, at the moment, the main variety Tit Segitiga. Source of seeds is mostly from farmer saved seeds. Due to the high seed requirement of direct sowing, farmers' rarely use hybrid varieties since seed costs will be too high.
With the introduction of transplants less seeds are required. Transplants are raised under protected conditions where germination conditions are better as compared to the field conditions. At transplanting per planting hole one plant is planted. Risk on missing plants is therefore reduced. Since less seeds are needed to obtain a same plant density as with direct sowing, the use of better high yielding hybrid varieties will be within reach of the farmers. With transplant raising in protected structures pest and disease pressure will be reduced, and seedling quality will be improved. Higher yield levels may be achieved as compared to yield levels with direct sowing.
For transplant raising a number of factors are influencing results. Raising conditions should be optimal in order to obtain a maximum of usable transplants. This means that nursery construction needs to be investigated and also the type of container in which the seedlings are raised, as well the media for filling the containers. Since margins of hot pepper cultivation are low, and cash flow of farmers is limited, investment costs for transplant raising should be in line with prospected profits. As a result the nursery construction should be made of cheap materials and also the components for the media should be inexpensive and locally available. For the media decided was to select rice husk, manure and top soil as components for preparing the media. These components are readily available at the test site at reasonable prices. In previous experiments established was that the media consisting of 1 volume part of top soil and 1 volume part of manure showed the best emergence and highest amount of usable transplants.
In 2007 observed was that results were greatly influenced by pests, mainly thrips and *helicoverpa*. Commonly those pests are controlled by repeated field applications of insecticides. Frequent spraying, up to twice a week, is common practice, but the effect of these sprayings seems to be limited. To protect the seedlings against thrips and white fly, drenching with a systemic insecticide may result in an effective pest control. With drenching the insecticide is present at the right place and at the right time. Actara 25 WG (thiamethoxam 25%) is a systemic insecticide with an excellent control of thrips, white fly and aphids. Experiments carried out by Syngenta with drenching in hot pepper showed good results in controlling white fly and thrips. Another method to reduce pest pressure could be the introduction of border crops. With a border cop the in-flight of insects may be reduced. However, with border crops also competition with the main crop will occur for nutrients and space, thus limit yield of the main crop.

With this experiment the aim was to:

- Test the effect of nursery type on emergence, transplant quality and yield
- Test the effect of variety on seedling production and yield
- Test the effect of type of container on seedling raising
- Test the effect of adding additional nitrogen to the media on seedling raising
- Test the effect of drenching seedlings with Actara

## 1.1 Acknowledgements

The research was done in close cooperation with farmers in Brebes. PT EWINDO supplied materials for the nursery construction and seeds of the hybrid hot pepper variety Gada $F_1$. Mr. Rien Rodenburg, director R&D of EWINDO, offered valuable advice on hot pepper cultivation. PT Syngenta also assisted the research by supplying pesticides and advice on pest control.
Special thanks are due to Uka and Arifin. They played an important role in carrying out the field work and in assisting with the observations.

## 2 Materials and methods

The experiment was performed in the area of Kersana Brebes (Fig. 1). Brebes is located on the northern coast of Java adjacent to the Java Sea at 7° S and 109° E. The climate can be classified as a humid tropical lowland climate with clear distinguished dry and wet seasons. Soil type can be characterized as a fluvisol with 70% clay.


*Figure 1. Location of the hot pepper cultivation area where the experiment took place.*

For the experiment a field was rented from farmers and the nurseries were constructed at the entrance of the field, while the production fields were located behind the nurseries (Fig. 2). In 2007, on August 10th, three soil samples were taken from the experimental site. The site was divided in three equal sized blocks and sampling was done by taking 5 sub samples along the diagonal of each of the three blocks. Samples were taken from the field of the top layer of 0 – 30 cm depth.

A slightly acid to neutral soil pH-$H_2O$ was present (Table 1). Phosphate content of the soil was present at an excessive level while potassium was present at an adequate medium level. Calcium and magnesium content were both medium to high.

Table 1. Analyse results of soil samples taken in August 2007 at experimental site.

| sample | pH-$H_2O$ | pH-KCl | N (%) Kjeldahl | $P_2O_5$ (ppm) Olsen | K (ppm) MV | Ca | Mg |
|---|---|---|---|---|---|---|---|
| | | | | | | (meq/100g) Ammonium acetate 1N pH 7 | |
| I | 6.5 | 5.8 | 0.13 | 108.2 | 181.8 | 45.74 | 8.55 |
| II | 6.6 | 5.8 | 0.10 | 84.8 | 190.8 | 50.89 | 8.96 |
| III | 6.5 | 5.7 | 0.11 | 99.3 | 178.6 | 52.48 | 8.65 |

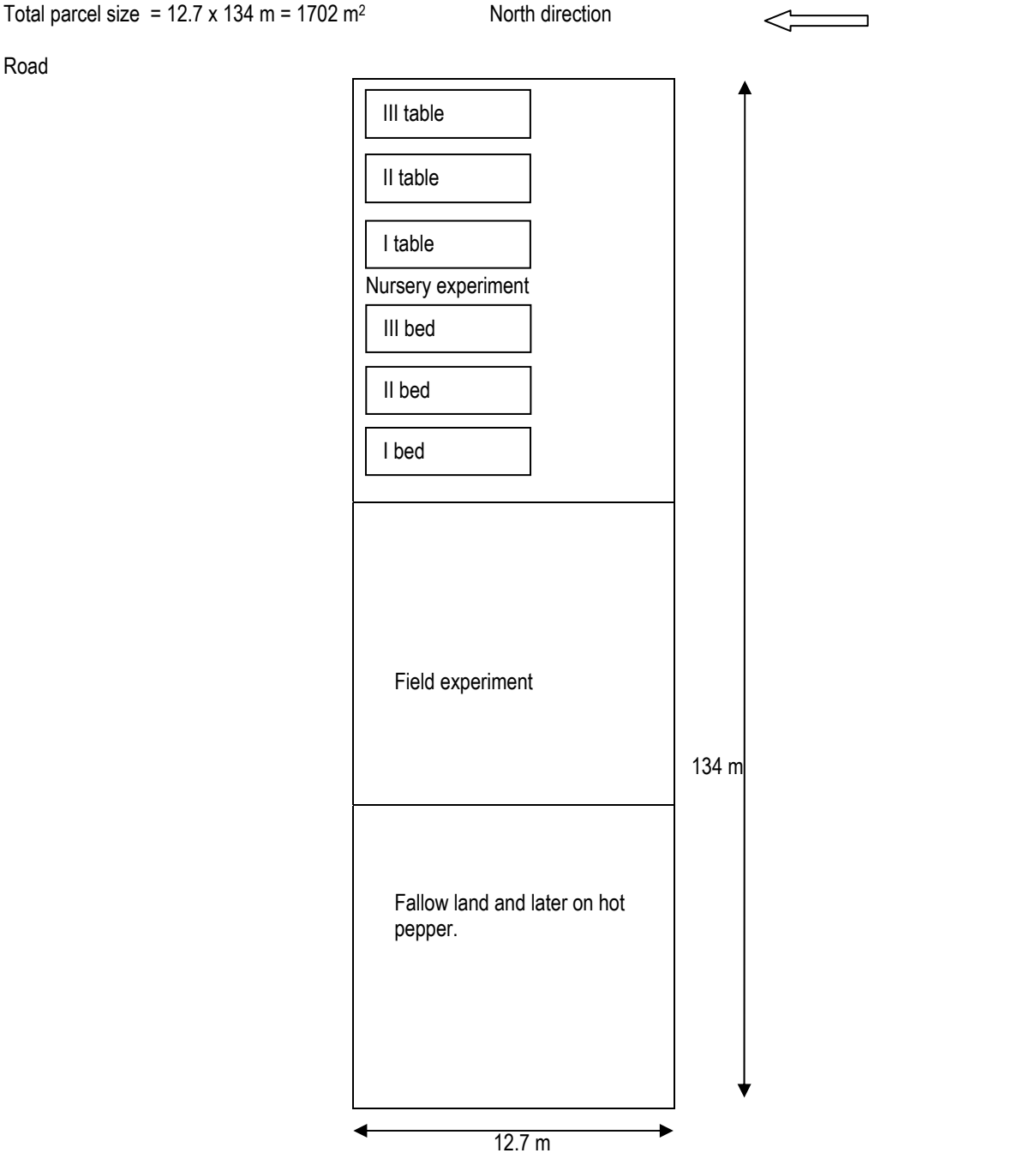



*Figure 2. Layout of the experimental site*

Treatments tested in this experiment are presented in table 2. Not all treatments were combined with each other and in Annex II a complete overview of all treatment combinations is presented. In total two varieties, two nursery types and six raising treatments were tested and compared with direct sowing.

Table 2. Treatments present in the nursery.

| | | |
|---|---|---|
| Variety: | A1: | Tit Segitiga |
| | A2: | Gada $F_1$ |
| Raising | B1: | Transparent plastic bag |
| | B2: | Transparent plastic bag + 100 mg/l media N added |
| | B3: | Modular tray with 128 cells |
| | B4: | Modular tray with 70 cells |
| | B5: | Transparent plastic bag + Actara 25 WG drench |
| | B7: | Broadcasting sowing box |
| Nursery | T: | Table nursery |
| | S: | Soil nursery |
| | F: | Direct sowing – 5 seeds per hole |

## 2.1 Nurseries for raising of seedlings

Two types of nurseries (table and soil) were tested on their effect on emergence of seedlings and seedling quality at transplanting (Figure 3, 4 and 5). The nursery placed directly on the soil showed the same dimensions as the nursery with a table design but lacked the table construction. Surface of each nursery was 1.5 x 7 meter resulting in 10.5 $m^2$. At the soil nursery an insect net was used to cover the bottom to prevent soil insects from entering the nursery and trays were placed directly on this net. Each nursery house was present threefold.

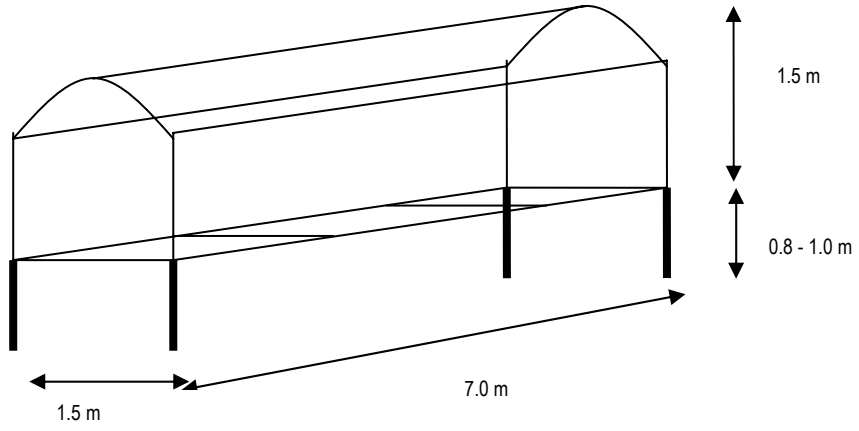



*Figure 3. Schematic view of a table nursery.*

*Figure 4. Inside of the table nursery.*

*Figure 5. Bed or soil nurseries in the front and table nurseries in the back.*

## 2.2 Hot pepper varieties used for the experiment

Two types of varieties were used in the experiments:

- Local open pollinated variety (Tit Segitiga)
- Hybrid variety (Gada $F_1$)

Seeds from Tit Segitiga were obtained locally from farmers while seeds from Gada $F_1$ were received from EWINDO PT at Purwakarta.

## 2.3 Cultivation

### 2.3.1 Intercropping

Hot pepper was intercropped with shallot (Figure 6). In Annex I a lay out for the intercropping pattern as was used in the experiment is presented. Crops were grown on suats or beds, surrounded by ditches. In the experiments each plot consisted of half a suat with a size of 1.5 x 5.7 m. Shallot planting and hoot pepper sowing took place at the same date. Hot pepper seedlings were transplanted 3 to 4 weeks after shallot planting. With direct sowing plant population of both varieties were the same (Table 3). Population density of the hybrid variety with transplanting was half the density present with the OP variety.

Table 3. Number of plants and planting distances for shallot and hot pepper.

| | Plants per plot | Number of rows | Plants per row | Distance within a row | Distance between rows |
|---|---|---|---|---|---|
| Shallot | 260 | 10 | 26 | 21 | 15 |
| Hot pepper (OP) | 100 | 4 | 25 | 21 | 30/60 |
| Hot pepper ($F_1$) plant | 50 | 4 | 13 | 42 | 30/60 |
| Hot pepper ($F_1$) sowing | 100 | 4 | 25 | 21 | 30/60 |

*Figure 6. One Suat or bed containing two experimental plots.*

### 2.3.2 Cultivation practice

Sowing of hot pepper in the field and in the nurseries took place on February 19, 2008 (Table 4). Per plot 200 seeds were sown while with direct sowing 500 seeds were used.
Shallot was planted in the field on February 16th. Transplanting of seedlings raised in the nursery into the field took place on March 28, 2008.

Table 4. General information on the cultivation.

| | | |
|---|---|---|
| Hot pepper sowing | : | February 19th , 2008 |
| Hot pepper transplanting | : | March 28th , 2008 |
| Shallot transplanting | : | February 16th , 2008. |
| Shallot harvest | : | April, 2008 |
| Start hot pepper harvest | : | May 29th, 2008 |
| End hot pepper harvest | : | September 3rd, 2008 |
| Used seeds | : | 200 per plot |
| Direct sowing (5 seeds per sowing position) | : | 500 seeds per plot with Tit Segitiga<br>500 seeds per plot with Gada $F_1$ |
| Plant density | : | Tit Segitiga at 12.2 plants per $m^2$ |
| | | Gada $F_1$ at 12.2 plants per $m^2$ with direct sowing |
| | | Gada $F_1$ at 6.1 plants per $m^2$ with transplanting |

Further cultivation of hot pepper, method of harvesting, amount of fertiliser and pest control took place as farmers' common practice in Kersana Brebes.

## 2.4 Type of containers

For container comparison, three types were tested namely a modular tray with 128 modules per tray, 70 modules per tray and a plastic bag (Fig. 7 and 8). At the 128 module tray the cell shape was pyramidal with a cell content of 13 $cm^3$. For the 70 module tray the cell shape was cylindrical and the cell volume was 20 $cm^3$. Plastic bags could hold a volume of 15 $cm^3$ and holes were punctured in the bottom to provide for drainage.
Besides the already mentioned containers used in this experiment, in the soil nursery also a box with dimensions of 55 cm x 35 cm x 5 cm was loosely filled with media containing one part manure and one part top soil, and seeds were broadcasted sown in this media and raised in this box similar to the seedlings in the trays and plastic bags (Fig. 9).

*Figure 7. Plastic bags and modular tray with 128 cells, used for seedling raising of hot pepper.*

*Figure 8. Plastic bags and modular tray with 70 cells, used for seedling raising of hot pepper.*

*Figure 9. Box with broadcasting sowing, used for seedling raising of hot pepper in the soil nursery only.*

## 2.5 Seedling raising treatments

Components for media were manure, purchased from a nearby farm, and top soil collected from the field near to the nursery. Media was prepared by thoroughly mixing 1 volume part of manure with 1 volume part of top soil. Direct sowing was present as standard common practice reference.
In combination with the plastic bag container the effect of nitrogen adding and Actara 25 WG drench was tested as well. Nitrogen was applied to the media by mixing a nitrogen fertiliser through the already prepared media. Per litre media100 mg of nitrogen was applied.
Actara 25 WG was applied according to the scheme supplied by Syngenta (Table 5).

Table 5. Scheme for applying Actara 25 WG as a drench and consecutive field spraying.

| | Application schedule | Method | Dosage |
|---|---|---|---|
| 1 | 15 – 20 days after sowing | drenching | 0.1 – 0.2 g/l water --- 200 ml solution/plant |
| 2 | 2 – 3 days before transplanting | drenching | 0.1 – 0.2 g/l water --- 200 ml solution/plant |
| 3 | 3 days after transplanting | drenching | 1 – 2 g/l water --- 200 ml solution/plant |
| 4 | 1 week after transplanting | spraying | 4 – 6 g/17 l water |
| 5 | 2 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 6 | 18 days after transplanting | drenching | 1 – 2 g/l water --- 200 ml solution/plant |
| 7 | 3 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 8 | 4 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 9 | 5 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 10 | 6 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 11 | 7 weeks after transplanting | spraying | 4 – 6 g/17 l water |
| 12 | 8 weeks after transplanting | spraying | 4 – 6 g/17 l water |

A complete overview of all treatments carried out in the nursery is presented in Annex II.
After raising the transplants and analysing the results concluded was that results in the table nursery were better as compared to the soil nursery and that with the improved sowing technique a higher emergence percentage was present. Therefore only seedlings raised in the table nursery were transplanted into the field plus the transplants raised in the box with broadcasting sowing in the soil nursery (Table 6). Also Tit Segitiga seedlings raised in a plastic bag with Actara application were transplanted into the field and cultivated in combination with corn border plants around the field. In order to grow the corn, the bed surface was doubled, meaning a bed of 11.4 wide instead of 5.7 m wide was used. Corn was sown on the bed edges on February 19th. Until seven days after transplanting, dead plants at all plots, with the exception of direct sowing, were replaced with left over plants in the nursery.

Table 6. Treatments present in the field.

| Code | Variety | Container | Media |
|---|---|---|---|
| TA1B1 | Tit Segitiga | Plastic bag | Manure+TopSoil |
| TA1B2 | Tit Segitiga | Plastic bag | Manure + Top Soil+100mg/l N |
| TA1B5 | Tit Segitiga | Plastic bag | Manure+TopSoil+Actara |
| TA1B6 | Tit Segitiga | Plastic bag | Manure+TopSoil+Actara+border |
| FA1B8 | Tit Segitiga | - | Direct sowing field |
| TA2B1 | Gada | Plastic bag | Manure+TopSoil |
| TA2B2 | Gada | Plastic bag | Manure+Top soil + 100mg/l N |
| TA2B3 | Gada | Tray 128 | Manure + Top Soil |
| TA2B4 | Gada | Tray 70 | Manure+TopSoil |
| TA2B5 | Gada | Plastic bag | Manure+TopSoil+Actara |
| SA2B7 | Gada | | Broadcast nursery seedbed |
| FA2B8 | Gada | - | Direct sowing field |

## 2.6 Observations

### 2.6.1 Climate

During the experiment temperature was recorded by taking readings at 14.00 p.m. each day on maximum and minimum temperature. One thermometer was placed in one of the nurseries and one outside in the field. Thermometers were placed in a shaded position to avoid direct exposure to sun light. Rainfall data were gathered from Brebes Agricultural Office weather station and measured daily at 6.30 a.m. using a simple rain gauge. Data of these recordings are listed in Annex IV.

### 2.6.2 Nutrient content

On August 7, from the media used for filling the trays and plastic bags a sample was taken for analyse on content of nitrogen, potassium, phosphate, calcium and pH level.

### 2.6.3 Light intensity

During seedling raising, light intensity in Lux was measured with a handheld Lux meter (LX93 from Nieuwkoop) inside and outside the nurseries on February 20 and February 28. Inside each nursery at two spots light intensity was measured and outside each nursery light intensity was measured at one spot (Annex II). Percentage available light inside the nurseries was calculated based on these readings.

### 2.6.4 Nursery observations

Emergence was observed 10, 20 and 30 days after sowing of the treatments. Percentage of normal and abnormal seedlings was calculated.

At transplanting number of normal, usable and abnormal transplants were observed and percentage was calculated as well. Also number of plants with virus symptoms and infected with thrips were observed. At transplanting randomly per plot 15 seedlings were selected, cut off at soil level, and measured for plant length, individual plant weight and number of fully developed leaves.

Plant length was measured from the cut off point to the end tip of a leave of a fully stretched out plant. After drying at 70$^{o}$C for 24 hours the total weight of the 15 plants together was weighed. Percentage dry weight was calculated as well.

### 2.6.5 Harvest observations

Fruits were harvested when mature, and harvesting took every two to five days place depending on the speed of fruit maturing.

At each harvest data per plot number and total weight of harvested fruits was observed. After this fruits were graded in marketable fruits and unmarketable fruits. The number and weight of marketable fruits was observed. At each harvest also the number of present plants per plot was observed.

Based on the observations total fruit number and weight, marketable fruit number and weight per plant and per square meter cultivation surface was calculated. Also share of marketable weight in total yield and average fruit weight was calculated.

## 2.7 Statistical information

The experiment was carried out as a complete randomized experiment with block structure in three replications (Annex II and III).
Results were analysed with ANOVA (analysis of variance) by using the statistical program Genstat for Windows 11th edition.

# 3 Results

## 3.1 Climate

During transplant raising was on average the minimum temperature about 20°C (Figure 10). Maximum temperature was between 35 and 40°C. Temperatures inside the nurseries did not differ much from the outside minimum temperature. Maximum temperature was on average 1 to 2 degrees higher. Between de temperature measured in soil nursery or table nursery no notable differences were present.

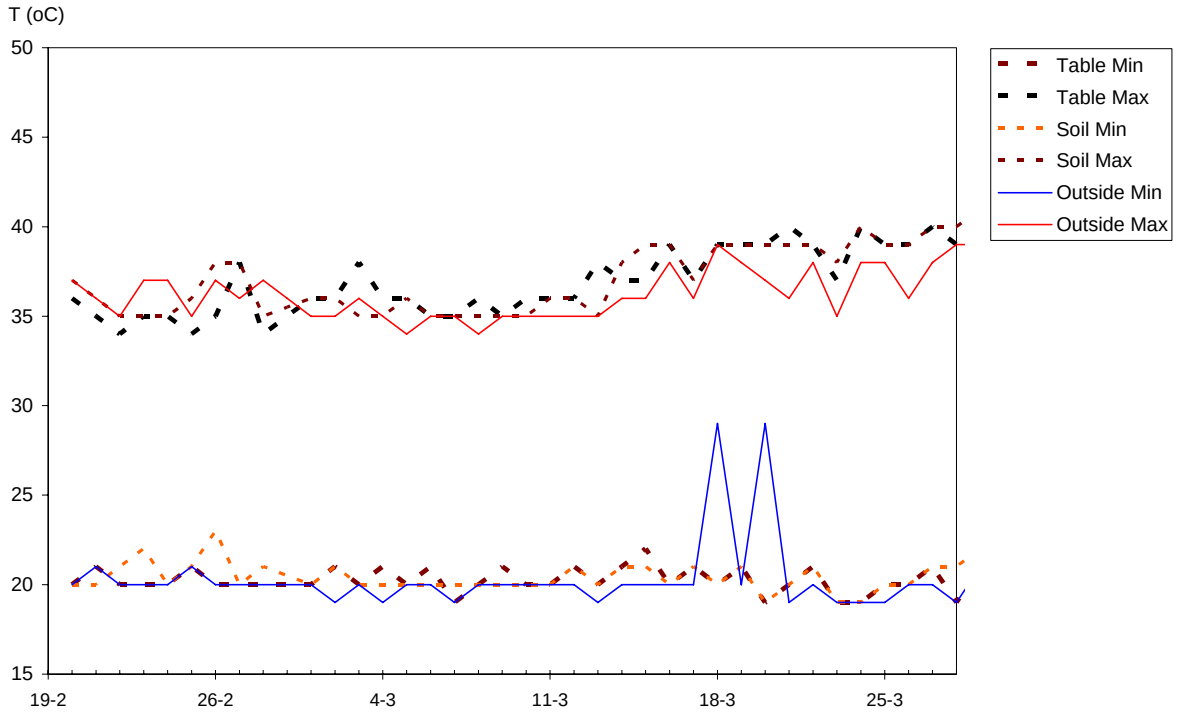



*Figure 10. Maximum and minimum temperature (°C) inside both nurseries and outdoor temperature during transplant raising.*

At the time of transplant raising rainfall was present resulting in lower temperatures as compared to later periods (Fig. 11). Until the end of April precipitation amounted to over 800 mm. After April not much precipitation as recorded anymore. Till the end of April maximum temperature was between 35 and 40°C. After April till the beginning of September maximum temperature increased to 40 – 45°C.

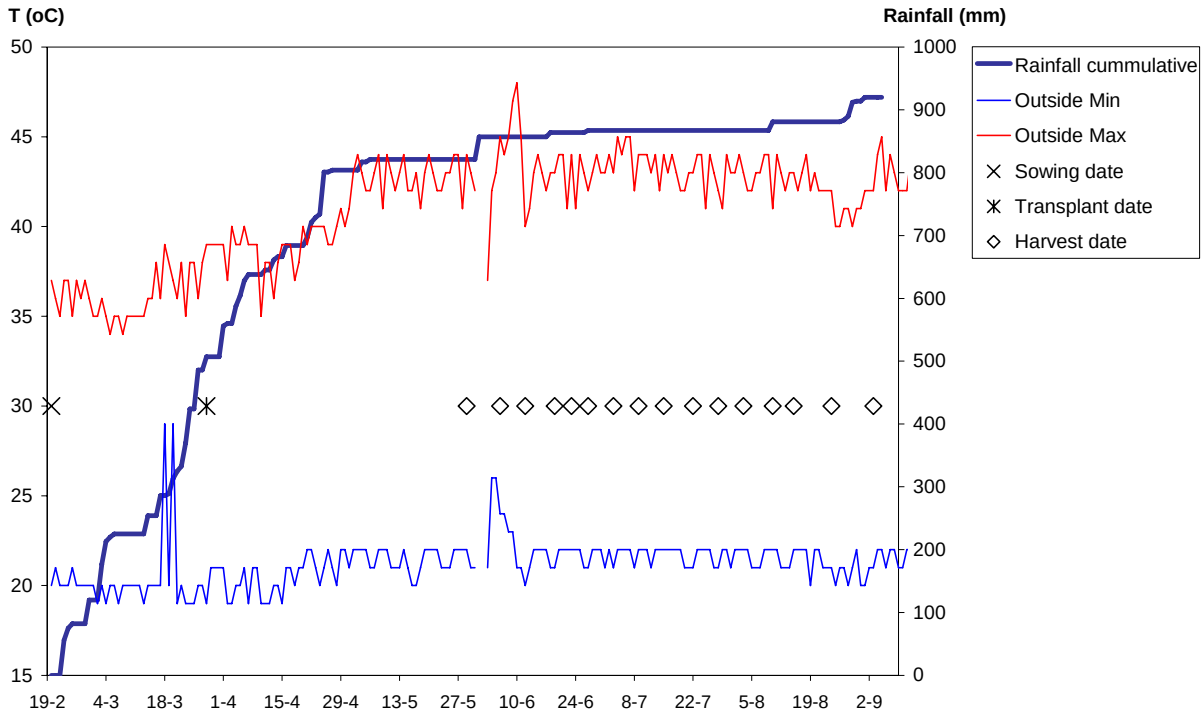



*Figure 11. Cumulative rainfall (mm)and maximum and minimum temperature (°C) during the experiment.*

## 3.2 Light levels

On February 20 average light intensity was 72% of the outside light intensity. On February 20 the average inside light intensity was with 71% almost the same. With the presence of high light intensity levels outside, for transplant raising it is not a big problem when inside light levels are decreased with 25%.

## 3.3 Nutrient content of media

The used media in this experiment was the combination of top soil with manure (TS+M) (Table 7). The pH of this media is alkaline with a pH-$H_2O$ of 7.2. For vegetable seedling production a pH of 5.6 to 6.0 is advised. Total nitrogen content is about 0.5 % or 500 mg per 100 gram media. Nitrate content was not measured, but content should be 30 to 75 mg per litre substrate. When nitrogen content is too high, a very vigorous growth of the seedlings can occur, resulting in weak seedlings which are vulnerable to diseases and damping off.

Table 7. Nutrient content of media/substrate samples taken in August 2007.

| Media | pH-$H_2O$ | pH-KCl | N (%) | $P_2O_5$ (%) | $K_2O$ (%) | CaO (%) | MgO (%) |
|---|---|---|---|---|---|---|---|
| Rice husk (RH) | 7.6 | 7.2 | 0.43 | 0.36 | 0.77 | 0.17 | 0.06 |
| Manure (M) | 7.7 | 7.4 | 0.72 | 1.74 | 1.77 | 4.99 | 1.61 |
| Top soil (TS) | 6.7 | 5.9 | 0.16 | 0.02 | 0.03 | 1.15 | 0.23 |
| RH + M | 7.7 | 7.3 | 0.68 | 1.46 | 1.22 | 3.55 | 1.15 |
| TS + M | 7.2 | 6.8 | 0.48 | 0.78 | 0.89 | 2.24 | 1.54 |
| RH + M + TS | 7.4 | 6.9 | 0.48 | 0.87 | 1.00 | 2.48 | 1.30 |

## 3.4 Seedling raising results

### 3.4.1 Percentage normal seedlings

#### 3.4.1.1 After 10 days

Percentage seedlings observed 10 days after sowing was at Gada on average higher as at Tit Segitiga (Table 8). This was especially the case at the treatments at the table nursery. At direct sowing and the soil nursery no differences between the two varieties were present.

Tit Segitiga treatments in both soil and table nursery did not show different percentages compared to direct sowing. Gada raised in plastic bags in the table nursery showed a higher percentage then direct sowing. Emergence in trays was similar to direct sowing.
With Gada, treatments in the table nursery showed a higher percentage normal seedlings compared to the results in the soil nursery for the respective treatments, with the exception of the tray with 70 modules. At the table nursery Gada showed a higher percentage of seedlings in the 70 module tray compared to the 128 module tray. A higher percentage of normal seedlings was present at he soil nursery with broadcasting in a box compared to the 128 module tray.

Table 8. Percentage normal seedlings after 10 days.

| | | Variety (V) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment (T) | | Gada | | | | | | | | | | Tit Segitiga | | | | | | | | | Average |
| | Direct | 28.3 | | | | | d | e | | | | 8.3 | a | b | c | d | | | | | 18.3 |
| Soil | Plastic bag (PB) | 13.5 | a | b | c | d | | | | | | 3.5 | a | b | | | | | | | 8.5 |
| | PB + 100 mg/l N | 10.7 | a | b | c | d | | | | | | 2.0 | a | | | | | | | | 6.3 |
| | Tray 128 cells | 2.5 | a | b | | | | | | | | 1.2 | a | | | | | | | | 1.8 |
| | Tray 70 cells | 8.5 | a | b | c | d | | | | | | 0.5 | a | | | | | | | | 4.5 |
| | PB+ Actara | 8.8 | a | b | c | d | | | | | | 5.3 | a | b | c | | | | | | 7.1 |
| | Box broadcast | 26.0 | | | | d | | | | | | 7.7 | a | b | c | d | | | | | 16.8 |
| Table | Plastic bag (PB) | 70.3 | | | | | | | | g | | 15.3 | a | b | c | d | | | | | 42.8 |
| | PB + 100 mg/l N | 62.7 | | | | | | | f | g | | 12.3 | a | b | c | d | | | | | 37.5 |
| | Tray 128 cells | 48.5 | | | | | | e | f | | | 5.0 | a | b | c | | | | | | 26.8 |
| | Tray 70 cells | 24.7 | | | c | d | | | | | | 1.0 | a | | | | | | | | 12.8 |
| | PB+ Actara | 73.3 | | | | | | | | g | | 23.2 | | b | c | d | | | | | 48.3 |
| Average | | 31.5 | | | | | | | | | | 8.0 | | | | | | | | | 18.9 |

| | LSD | p= |
|---|---|---|
| Treatment | 14.7 | <0.001 |
| Variety | 6.0 | <0.001 |
| T*V | 20.8 | <0.001 |

### 3.4.1.2 After 20 days

After 20 days the percentage of seedlings of both varieties raised in the soil nursery for both varieties were not higher then the percentage present at direct sowing (Table 9). No differences between varieties were present with raising in the soil nursery. At the table nursery, Gada showed a higher emergence percentage at all treatments than direct sowing. Tit Segitiga showed only for the treatment plastic bag with Actara a higher percentage than direct sowing. Gada showed a higher percentage of emergence after 20 days at the treatments with raising in a plastic bag only , plastic bag with Actara or the 70 module tray than at the respective treatments with the variety Tit Segitiga.

Table 9 . Percentage normal seedlings after 20 days.

| | | Variety | | |
|---|---|---|---|---|
| | Treatment | Gada | Tit Segitiga | Average |
| | Direct | 33.3 b c d e | 33.8 b c d e f | 33.6 |
| Soil | Plastic bag (PB) | 19.5 a b c | 11.0 a | 15.3 |
| | PB + 100 mg/l N | 12.3 a b | 24.2 a b c d | 18.3 |
| | Tray 128 cells | 3.3 a | 8.3 a | 5.8 |
| | Tray 70 cells | 10.0 a | 5.7 a | 7.8 |
| | PB+ Actara | 10.5 a | 25.2 a b c d | 17.8 |
| | Box broadcast | 25.7 a b c d | 36.2 c d e f g | 30.9 |
| Table | Plastic bag (PB) | 82.7 j | 49.8 e f g h | 66.3 |
| | PB + 100 mg/l N | 72.0 i j | 55.3 f g h i | 63.7 |
| | Tray 128 cells | 59.3 h i | 42.7 d e f g h | 51.0 |
| | Tray 70 cells | 58.8 h i | 26.0 a b c d | 42.4 |
| | PB+ Actara | 84.3 j | 56.3 g h i | 70.3 |
| Average | | 39.3 | 31.9 | 35.3 |

| | LSD | p= |
|---|---|---|
| Treatment | 15.6 | <0.001 |
| Variety | 6.4 | 0.013 |
| T*V | 22.0 | 0.015 |

### 3.4.1.3 After 30 days

On average a higher percentage of seedlings after 30 days were present at Gada than at Tit Segitiga (Table 10). With raising in the soil nursery the treatments of both varieties did not show higher percentages than present at direct sowing. With raising in the table nursery, the plastic bag treatments did show higher percentages of normal seedlings, while the tray treatments did not show higher percentages compared to direct sowing. Compared to the plastic bag treatments lower percentages were present with raising in plastic trays.
Treatments in the table nursery showed higher percentage of normal seedlings than the identical raising treatments in the soil nursery.

Table 10. Percentage normal seedlings after 30 days.

| | | Variety | | | |
|---|---|---|---|---|---|
| | Treatment | Gada | Tit Segitiga | Average | |
| | Direct | 33.7 | 33.5 | 33.6 | c d |
| Soil | Plastic bag (PB) | 19.0 | 13.3 | 16.2 | a b |
| | PB + 100 mg/l N | 14.7 | 25.7 | 20.2 | a b c |
| | Tray 128 cells | 3.3 | 8.3 | 5.8 | a |
| | Tray 70 cells | 10.5 | 5.5 | 8.0 | a |
| | PB+ Actara | 10.7 | 26.0 | 18.3 | a b c |
| | Box broadcast | 30.3 | 31.2 | 30.8 | b c d |
| Table | Plastic bag (PB) | 82.7 | 51.2 | 66.9 | e |
| | PB + 100 mg/l N | 71.8 | 56.0 | 63.9 | e |
| | Tray 128 cells | 58.8 | 33.3 | 46.1 | d |
| | Tray 70 cells | 59.0 | 27.0 | 43.0 | d |
| | PB+ Actara | 83.3 | 55.7 | 69.5 | e |
| Average | | 39.8 | 31.4 | 35.3 | |

| | LSD | p= | |
|---|---|---|---|
| Treatment | 17.0 | <0.001 | |
| Variety | 6.9 | 0.010 | |
| T*V | 24.0 | 0.053 | NS |

#### 3.4.1.4 At transplanting

At the time of transplanting all treatments in the soil nursery showed a percentage of normal seedlings not higher than the percentage present with direct sowing (Table 11). Gada showed at the table nursery for all treatments a higher percentage then at direct sowing. Between treatments almost no differences were present. Only the plastic tray with 128 modules showed a lower percentage compared to the plastic bag treatment. Raising treatments in the table nursery of the variety Tit Segitiga showed an equal or lower percentage of seedlings compared to direct sowing. Seedlings raised in the 70 module tray did show a lower percentage than the percentages present at all plastic bag treatments. Only at the table nursery the raising treatment in plastic bag, plastic bag plus Actara and raising in trays a higher percentage of seedlings was present at Gada as compared to the respective treatments at Tit Segitiga.

Table 11. Percentage of normal seedlings at transplanting.

| Treatment | | Variety: Gada | | Variety: Tit Segitiga | | Average |
|---|---|---|---|---|---|---|
| Direct | | 33.9 | d e f g | 33.7 | d e f g | 33.8 |
| Soil | Plastic bag (PB) | 19.2 | a b c d e | 13.7 | a b c d e | 16.4 |
| | PB + 100 mg/l N | 14.8 | a b c d e | 26.3 | a b c d e | 20.6 |
| | Tray 128 cells | 3.3 | a | 8.5 | a b c | 5.9 |
| | Tray 70 cells | 10.7 | a b c d | 5.3 | a b | 8.0 |
| | PB+ Actara | 10.7 | a b c d | 27.3 | b c d e | 19.0 |
| | Box broadcast | 30.8 | c d e f | 31.2 | c d e f | 31.0 |
| Table | Plastic bag (PB) | 84.5 | j | 52.3 | f g h | 68.4 |
| | PB + 100 mg/l N | 73.0 | h i j | 56.2 | g h | 64.6 |
| | Tray 128 cells | 60.0 | h i | 34.7 | e f g | 47.3 |
| | Tray 70 cells | 61.5 | h i j | 27.5 | b c d e | 44.5 |
| | PB+ Actara | 83.2 | i j | 56.5 | g h | 69.8 |
| Average | | 40.5 | | 32.0 | | 35.9 |

| | LSD | p= |
|---|---|---|
| Treatment | 17.0 | <0.001 |
| Variety | 6.9 | 0.007 |
| T*V | 24.0 | 0.030 |

### 3.4.2 Fresh weight

Fresh weight of direct sowing was higher compared to the nursery treatments (Table 12). At direct sowing Gada showed a higher fresh weight than Tit Segitiga. At the table nursery per variety no differences in fresh weigh were present between treatments. Gada, when raised in a plastic bag with 100 mg N per litre media, showed a higher fresh weight then Tit Segitiga. Other treatments did not differ from each other in fresh weight. With raising in the soil nursery, fresh weight of Tit Segitiga and Gada was not different, except with broadcasting in a sowing box where the fresh weight of Tit Segitiga was higher than that of Gada.

In the soil nursery the fresh weight of Gada seedlings raised in the 128 module tray, was lower than that of seedlings raised in plastic bag or in a plastic bag plus additional N to the media. Fresh weight of Tit Segitiga seedlings raised with broadcasting sowing first, was higher than fresh weigh of Tit Segitiga seedlings raised in the 128 modular tray.

Table 12. Fresh weight of seedlings at transplanting (g).

| Treatment | | Variety: Gada | | Variety: Tit Segitiga | | Average |
|---|---|---|---|---|---|---|
| | Direct | 35.6 | i | 18.4 | h | 27.0 |
| Soil | Plastic bag (PB) | 4.5 | c d e f | 3.5 | a b c d e f | 4.0 |
| | PB + 100 mg/l N | 6.1 | e f g | 3.6 | a b c d e f | 4.8 |
| | Tray 128 cells | 0.7 | a b | 1.9 | a b c d | 1.3 |
| | Tray 70 cells | 3.7 | a b c d e f | 3.1 | a b c d e | 3.4 |
| | PB+ Actara | 1.3 | a b c | 3.8 | a b c d e f | 2.6 |
| | Box broadcast | 0.6 | a | 5.7 | e f g | 3.2 |
| Table | Plastic bag (PB) | 6.9 | f g | 4.1 | b c d e f | 5.5 |
| | PB + 100 mg/l N | 8.1 | g | 3.7 | a b c d e f | 5.9 |
| | Tray 128 cells | 4.9 | d e f g | 5.8 | e f g | 5.3 |
| | Tray 70 cells | 5.9 | e f g | 5.5 | e f g | 5.7 |
| | PB+ Actara | 6.9 | f g | 3.5 | a b c d e f | 5.2 |
| Average | | 7.1 | | 4.8 | | 5.6 |

| | LSD | p= |
|---|---|---|
| Treatment | 2.4 | <0.001 |
| Variety | 1.0 | <0.001 |
| T*V | 3.4 | <0.001 |

### 3.4.3 Dry weight

Dry weight of seedlings from direct sowing of both Gada and Tit Segitiga was higher than the dry weight of seedlings raised in the nurseries (Table 13). Dry weight of Gada seedlings raised in plastic bag, 128 modular tray and plastic bag plus Actara was higher in the table nursery than of seedlings raised with identical treatments in the soil nursery. Between the two nurseries no differences in dry weight were present between similar treatments of the variety Tit Segitiga.

Table 13. Dry weight of seedlings at transplanting (g).

| Treatment | | Variety: Gada | | Variety: Tit Segitiga | | Average |
|---|---|---|---|---|---|---|
| | Direct | 4.5 | j | 2.3 | i | 3.4 |
| Soil | Plastic bag (PB) | 0.6 | a b c d e f | 0.5 | a b c d e | 0.5 |
| | PB + 100 mg/l N | 0.8 | c d e f g h | 0.5 | a b c d e f | 0.7 |
| | Tray 128 cells | 0.1 | a | 0.3 | a b c | 0.2 |
| | Tray 70 cells | 0.6 | b c d e f g | 0.5 | a b c d e | 0.6 |
| | PB+ Actara | 0.2 | a b | 0.5 | a b c d e | 0.3 |
| | Box broadcast | 0.1 | a | 0.8 | c d e f g h | 0.4 |
| Table | Plastic bag (PB) | 1.1 | g h | 0.3 | a b c d | 0.7 |
| | PB + 100 mg/l N | 1.2 | h | 0.6 | a b c d e f | 0.9 |
| | Tray 128 cells | 0.7 | c d e f g | 0.9 | e f g h | 0.8 |
| | Tray 70 cells | 0.9 | e f g h | 0.8 | d e f g h | 0.8 |
| | PB+ Actara | 1.0 | f g h | 0.5 | a b c d e | 0.8 |
| Average | | 1.0 | | 0.7 | | 0.8 |

| | LSD | p= |
|---|---|---|
| Treatment | 0.3 | <0.001 |
| Variety | 0.1 | <0.001 |
| T*V | 0.5 | <0.001 |

In the soil nursery the dry weight of Gada seedlings raised in the 70 module tray was higher than that of seedlings raised in 128 module tray or raised in the box with broadcasting. Seedlings raised in a plastic bag with additional

N added to the media, showed a higher dry weight than the seedlings raised in the 128 module tray, plastic bag plus Actara or raised in the box with broadcasting. In the table nursery only the seedlings raised in the 128 module tray showed a lower dry weight than the seedlings raised in a plastic bag with 100 mg N per litre media. Tit Segitiga seedlings raised in the soil nursery did not differ from each other in dry weight. In the table nursery raised seedlings in the 128 module tray showed a higher dry weight than seedlings raised in a plastic bag.

### 3.4.4 Plant length

Direct sown raised seedlings were taller than seedlings raised in nurseries (Table 14). All treatments of the variety Tit Segitiga showed a same plant length. No differences were present between nurseries or between raising treatments of Tit Segitiga.
Gada seedlings raised in 128 module tray and in plastic bag with Actara drench compared showed taller plants in the table nursery compared to the respective treatments in the soil nursery. In the soil nursery plant length of seedlings raised in plastic bag and in plastic bag plus 100 mg N was more than the length of seedlings raised in 128 module tray, plastic bag with Actara and in a box. Seedlings raised in a 70 module tray showed taller seedlings than seedlings raised in a 128 module tray. In the table nursery seedlings raised in plastic bag with 100 mg N were taller than those raised in a 128 module tray, but this length was not different from the plant length of seedlings raised with other plastic bag treatments.

Table 14. Plant length of seedlings at transplanting (cm).

| | | Variety | | |
|---|---|---|---|---|
| Treatment | | Gada | Tit Segitiga | Average |
| Direct | | 16.9 j | 12.5 i | 14.7 |
| Soil | Plastic bag (PB) | 6.9 d e f g | 6.0 b c d e | 6.4 |
| | PB + 100 mg/l N | 7.6 e f g h | 6.0 b c d e | 6.8 |
| | Tray 128 cells | 4.0 a | 5.1 a b c d | 4.6 |
| | Tray 70 cells | 6.3 c d e | 6.0 b c d e | 6.2 |
| | PB+ Actara | 4.7 a b c | 6.1 b c d e | 5.4 |
| | Box broadcast | 4.2 a b | 6.9 d e f g | 5.5 |
| Table | Plastic bag (PB) | 8.7 f g h | 6.8 d e f | 7.8 |
| | PB + 100 mg/l N | 9.4 h | 6.1 b c d e | 7.7 |
| | Tray 128 cells | 6.8 d e f | 7.0 d e f g | 6.9 |
| | Tray 70 cells | 6.9 d e f g | 6.6 c d e | 6.7 |
| | PB+ Actara | 8.8 g h | 6.3 c d e | 7.5 |
| Average | | 7.6 | 6.6 | 6.9 |

| | LSD | p= |
|---|---|---|
| Treatment | 1.3 | <0.001 |
| Variety | 0.5 | 0.004 |
| T*V | 1.9 | <0.001 |

### 3.4.5 Number of leaves

With direct sowing a higher number of leaves was present than with transplant raising in the nursery (Table 15). Number of leaves of Gada seedlings raised in the soil nursery was lower as compared to respective treatments in the table nursery with the exception of seedlings raised in 70 module tray. In the table nursery no differences in plant length between treatments were present. In the soil nursery, the plant length of seedlings raised in the 70 module tray was higher compared to the other treatments in the soil nursery. Plant length of seedlings raised in plastic bag with 100 mg N per litre media was the shortest of all treatments.
Number of leaves of all treatments with Gada in the soil nursery was lower than the number present with Tit Segitiga seedlings except for the 70 module tray and plastic bag were number of leaves was not different between variety. In the table nursery, Gada seedlings raised in plastic bag and in plastic bag plus additional nitrogen were taller than in the same way raised Tit Segitiga seedlings.

Tit Segitiga seedlings raised in the table nursery in plastic bag showed a shorter plant length compared to the other treatments. A similar result was present in the soil nursery, where seedlings raised in plastic bag were shorter than seedlings of the other treatments.

Table 15. Number of leaves of seedlings at transplanting.

| | | Variety | | |
|---|---|---|---|---|
| | Treatment | Gada | Tit Segitiga | Average |
| | Direct | 12.1 l | 10.29 k | 11.2 |
| Soil | Plastic bag (PB) | 5.0 b c d | 4.83 b c | 4.9 |
| | PB + 100 mg/l N | 2.7 a | 7.03 f g h i j | 4.9 |
| | Tray 128 cells | 5.8 c d e | 6.47 e f g h | 6.1 |
| | Tray 70 cells | 7.5 g h i j | 7.17 f g h i j | 7.3 |
| | PB+ Actara | 4.0 b | 7.10 f g h i j | 5.6 |
| | Box broadcast | 6.1 d e f | 7.57 h i j | 6.8 |
| Table | Plastic bag (PB) | 7.8 i j | 4.67 b c | 6.3 |
| | PB + 100 mg/l N | 8.1 j | 6.50 e f g h | 7.3 |
| | Tray 128 cells | 7.4 g h i j | 7.30 g h i j | 7.3 |
| | Tray 70 cells | 7.3 g h i j | 7.43 g h i j | 7.4 |
| | PB+ Actara | 7.9 j | 7.10 f g h i j | 7.5 |
| Average | | 6.8 | 6.9 | 6.8 |

| | LSD | p= |
|---|---|---|
| Treatment | 0.8 | <0.001 |
| Variety | 0.3 | 0.106 |
| T*V | 1.1 | 0.003 |

### 3.4.6 Presence of thrips and virus

Percentage of seedlings with thrips infection symptoms were the highest with direct sowing (Table 16). Between variety no significant differences were present. At the nurseries some seedlings showed thrips symptoms but the percentage of seedlings was very low and in most cases severity of symptoms was very low compared to the severity observed in the direct sowed seedlings. Between treatments no differences in thrips attack were present.

Table 16. Percentage of seedlings infected with thrips at transplanting.

| | | Variety | | | |
|---|---|---|---|---|---|
| | Treatment | Gada | Tit Segitiga | Average | |
| | Direct | 7.3 | 9.9 | 8.6 | b |
| Soil | Plastic bag (PB) | 0.0 | 0.0 | 0.0 | a |
| | PB + 100 mg/l N | 0.0 | 0.0 | 0.0 | a |
| | Tray 128 cells | 0.0 | 0.0 | 0.0 | a |
| | Tray 70 cells | 0.0 | 0.0 | 0.0 | a |
| | PB+ Actara | 0.0 | 0.0 | 0.0 | a |
| | Box broadcast | 0.0 | 0.0 | 0.0 | a |
| Table | Plastic bag (PB) | 0.2 | 0.3 | 0.3 | a |
| | PB + 100 mg/l N | 0.7 | 1.2 | 0.9 | a |
| | Tray 128 cells | 0.0 | 0.0 | 0.0 | a |
| | Tray 70 cells | 0.2 | 0.2 | 0.2 | a |
| | PB+ Actara | 0.0 | 0.7 | 0.3 | a |
| Average | | 0.7 | 0.9 | 0.8 | |

| | LSD | p= | |
|---|---|---|---|
| Treatment | 1.2 | <0.001 | |
| Variety | 0.5 | 0.237 | NS |
| T*V | 1.8 | 0.690 | NS |

Percentage of seedlings with virus symptoms was the highest at direct sowing (Table 17). No differences between treatments in the nursery and variety were present.

Table 17. Percentage of seedlings with virus symptoms at transplanting.

| | | Variety | | | |
|---|---|---|---|---|---|
| | Treatment | Gada | Tit Segitiga | Average | |
| | Direct | 3.6 | 3.3 | 3.5 | b |
| Soil | Plastic bag (PB) | 0.0 | 0.0 | 0.0 | a |
| | PB + 100 mg/l N | 0.0 | 0.0 | 0.0 | a |
| | Tray 128 cells | 0.0 | 0.0 | 0.0 | a |
| | Tray 70 cells | 0.0 | 0.0 | 0.0 | a |
| | PB+ Actara | 0.0 | 0.3 | 0.2 | a |
| | Box broadcast | 0.0 | 0.0 | 0.0 | a |
| Table | Plastic bag (PB) | 0.0 | 0.0 | 0.0 | a |
| | PB + 100 mg/l N | 0.0 | 0.2 | 0.1 | a |
| | Tray 128 cells | 0.0 | 0.0 | 0.0 | a |
| | Tray 70 cells | 0.0 | 0.0 | 0.0 | a |
| | PB+ Actara | 0.0 | 0.2 | 0.1 | a |
| Average | | 0.3 | 0.3 | 0.3 | |

| | LSD | p= | |
|---|---|---|---|
| Treatment | 0.4 | <0.001 | |
| Variety | 0.2 | 0.757 | NS |
| T*V | 0.6 | 0.990 | NS |

## 3.5 Harvest results

### 3.5.1 Yield

Yield of Gada was with direct sowing 153.9 gram per plant (Table 18). Yield of all nursery treatments of Gada were higher than that of direct sowing. Seedlings raised in module trays showed a higher yield per plant than seedlings raised in a box and in a plastic bag with Actara. At Tit Segitiga none of the nursery treatments showed a higher yield than direct sowing. Yield with direct sowing was for both varieties the same, yield for nursery treatments was at Gada higher than at Tit Segitiga.

Table 18. Total hot pepper production in gram per plant.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 153.9 b | 135.3 a b | 144.6 |
| Plastic bag | 268.7 c d | 152.7 b | 210.7 |
| Plastic bag + 100 mg/l N | 256.9 c d | 141.4 a b | 199.1 |
| Plastic bag + Actara | 238.4 c | 159.8 b | 199.1 |
| Plastic bag + Actara + border | - | 116.1 a | 116.1 |
| 70 module tray | 279.3 d | - | 279.3 |
| 128 module tray | 279.0 d | - | 279.0 |
| Box broadcasting | 239.9 c | - | 239.9 |
| Average | 245.2 | 141.1 | 201.8 |
| p= | <0.001 | | |
| LSD= | 28.4 | | |

Marketable yield was with direct sowing for both Gada and Tit Segitiga the same (Table 19). All nursery treatments of Gada showed a higher marketable yield per plant than present with direct sowing. Marketable yield of both module tray treatments was higher compared to broadcasting sowing in a box and to the yield with raising

in a plastic bag with Actara application. Tit Segitiga nursery treatments did nod show higher yields compared to direct sowing. Yield of seedlings raised in a plastic bag with Actara application cultivated with corn as a border crop was even lower than present with direct sowing.

Table 19. Marketable yield in gram per plant.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 125.6 b | 107.4 b | 116.5 |
| Plastic bag | 225.2 d e | 125.0 b | 175.1 |
| Plastic bag + 100mg/l N | 210.0 c d e | 114.5 b | 162.2 |
| Plastic bag + Actara | 194.2 c | 129.2 b | 161.7 |
| Plastic bag + Actara + border | - | 81.1 a | 81.1 |
| 70 module tray | 227.3 e | - | 227.3 |
| 128 module tray | 228.9 e | - | 228.9 |
| Box broadcasting | 201.6 c d | - | 201.6 |
| Average | 201.8 | 111.4 | 164.2 |
| p= | <0.001 | | |
| LSD= | 25.5 | | |

Marketable yield per square meter was for all transplants of Gada the same (Table 20). Transplants raised in plastic bag with nitrogen amended to the media or with Actara drench showed a lower yield compared to direct sowing. Also transplants raised with broadcasting in a box showed a lower yield than with direct sowing. Tit Segitiga seedlings raised in a plastic bag with Actara drench showed higher yields than direct sowing of Tit Segitiga . Hot pepper plants cultivated on a bed with border plants showed a lower yield than direct sowing.

Table 20. Total hot pepper production in gram per square meter.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 1800.1 d e | 1583.1 b c d | 1691.6 |
| Plastic bag | 1571.6 b c d | 1785.7 d e | 1678.7 |
| Plastic bag + 100mg/l N | 1502.1 b c | 1653.7 c d e | 1577.9 |
| Plastic bag + Actara | 1394.2 b | 1869.4 e | 1631.8 |
| Plastic bag + Actara + border | - | 890.1 a | 890.1 |
| 70 module tray | 1633.2 b c d e | - | 1633.2 |
| 128 module tray | 1631.4 b c d e | - | 1631.4 |
| Box broadcasting | 1403.0 b | - | 1403.0 |
| Average | 1562.2 | 1556.4 | 1559.8 |
| p= | <0.001 | | |
| LSD= | 239.4 | | |

Marketable yield per square meter of direct sown Gada plants was higher compared to the yield of transplants raised in plastic bag with either Actara or nitrogen application and to the yield of seedlings raised with broadcasting in a box (Table 21).

Table 21. Marketable yield in gram per square meter.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 1468.4 c d | 1256.1 b c | 1362.3 |
| Plastic bag | 1317.2 b c d | 1462.3 c d | 1389.8 |
| Plastic bag + 100mg/l N | 1228.1 b | 1338.6 b c d | 1283.4 |
| Plastic bag + Actara | 1135.9 b | 1511.7 d | 1323.8 |
| Plastic bag + Actara + border | - | 638.7 a | 638.7 |
| 70 module tray | 1329.1 b c d | - | 1329.1 |
| 128 module tray | 1338.3 b c d | - | 1338.3 |
| Box broadcasting | 1178.8 b | - | 1178.8 |
| Average | 1285.1 | 1241.5 | 1266.9 |
| p= | <0.001 | | |
| LSD= | 222.5 | | |

Between nursery treatments no differences in marketable yield were present.
At Tit Segitiga, the yield of transplants raised in plastic bag with Actara drench was higher than that of direct sowing. In combination with border plants however, the yield was lower than at direct sowing.
Production per plant with direct sowing of Tit Segitiga showed a similar trend as the production present at production of transplants raised in plastic bags (Fig. 12). Production of all treatments increased from June 20 and levelled off after July 26. With cultivation of Gada, production per plant of transplants raised in plastic bags at a plant density of 6.1 plants per square meter was quite higher compared with direct sowing of Gada at 12.2 plants per square meter.

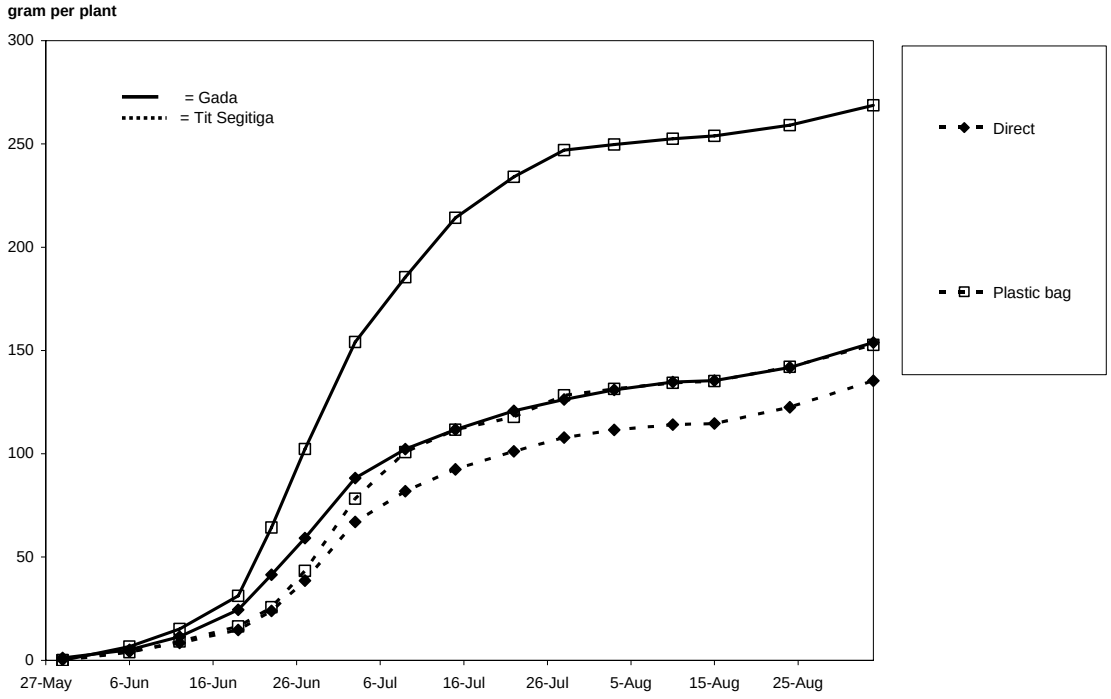



*Figure 12. Cumulative yield of Gada and Tit Segitiga transplants raised in plastic bags and direct sowing.*

All nursery treatments showed a similar trend in cumulative production per plant for both Gada (Fig. 13) and Tit Segitiga (Fig. 14).

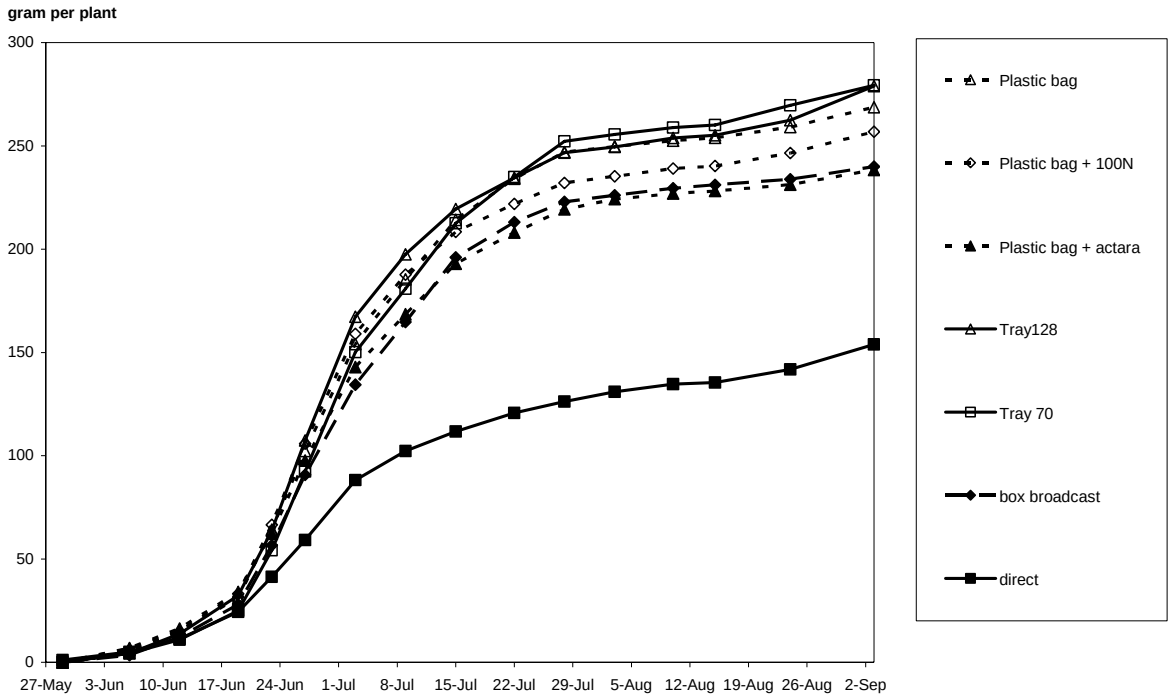



*Figure 13. Cumulative yield of Gada.*

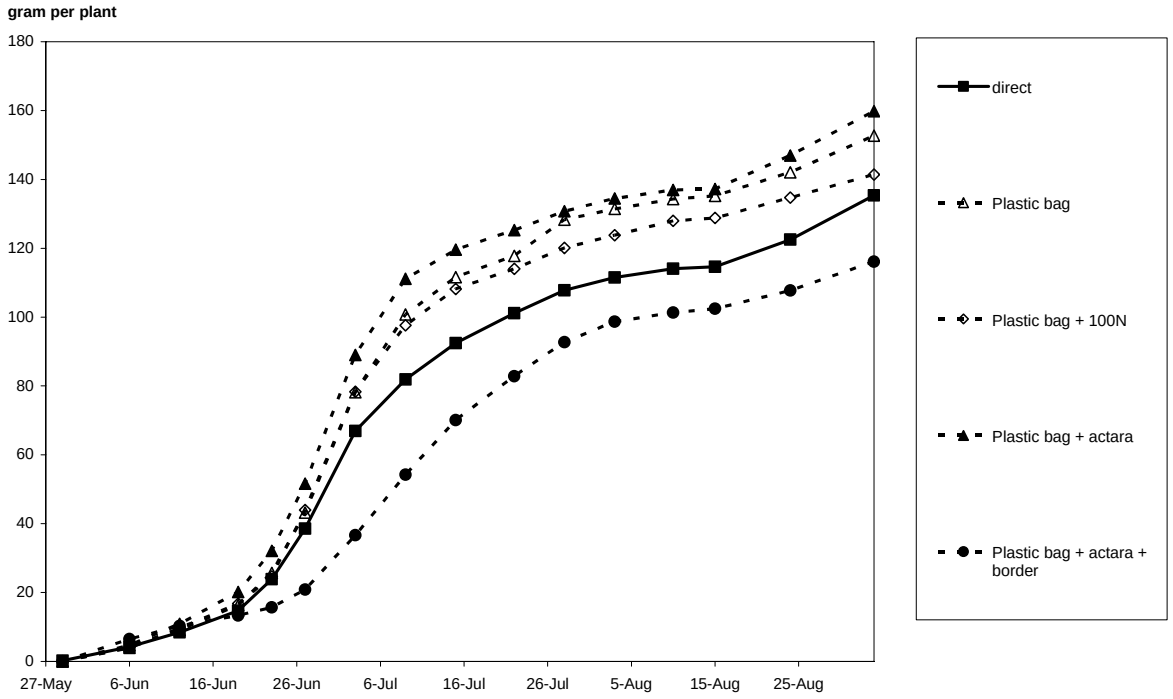



*Figure 14. Cumulative yield of Tit Segitiga.*

### 3.5.2 Fruit number

Total fruit number harvested per plant was for all treatments of Tit Segitiga the same (Table 22). Gada transplants showed a higher number of harvested fruits per plant than at direct sowing. Transplants raised in a 128 module tray showed higher numbers than transplants raised in plastic bag with 100 mg nitrogen per litre media and transplants raised in a box with broadcasting.

Table 22. Total fruit number per plant.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 29.1 b | 20.5 a | 24.8 |
| Plastic bag | 54.4 d e | 21.4 a | 37.9 |
| Plastic bag + 100mg/l N | 49.6 c d | 20.8 a | 35.2 |
| Plastic bag + Actara | 51.5 c d e | 23.1 a | 37.3 |
| Plastic bag + Actara + border | - | 20.6 a | 20.6 |
| 70 module tray | 53.2 c d e | - | 53.2 |
| 128 module tray | 55.0 e | - | 55.0 |
| Box broadcasting | 48.1 c | - | 48.1 |
| Average | 48.7 | 21.3 | 37.3 |
| p= | <0.001 | | |
| LSD= | 5.3 | | |

Per plant a same number of marketable fruits were present at all treatments of Tit Segitiga (Table 23). Compared to Gada a lower number was present at Tit Segitiga. With cultivation of Gada, a higher number of marketable fruits per plant was present at the transplants compared to direct sowing. Transplants raised in plastic bag with additional N showed a lower fruit number then transplants without additional N raised in plastic bags. Transplants raised in trays showed a similar fruit number as transplants raised in plastic bags.

Table 23. Marketable fruit number per plant.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 23.6 b | 15.3 a | 19.4 |
| Plastic bag | 45.9 d | 16.2 a | 31.0 |
| Plastic bag + 100mg/l N | 40.3 c | 16.1 a | 28.2 |
| Plastic bag + Actara | 42.0 c d | 17.4 a | 29.7 |
| Plastic bag + Actara + border | - | 14.2 a | 14.2 |
| 70 module tray | 43.6 c d | - | 43.6 |
| 128 module tray | 46.0 d | - | 46.0 |
| Box broadcasting | 39.8 c | - | 39.8 |
| Average | 40.2 | 15.8 | 30.0 |
| p= | <0.001 | | |
| LSD= | 4.4 | | |

Per square meter total fruit number of direct sown Tit Segitiga was higher than with cultivation of transplants raised in plastic bag with Actara drench and border plants (Table 24).

Table 24. Total fruit number per square meter.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 340.8 g | 240.0 b | 290.4 |
| Plastic bag | 317.8 e f g | 250.0 b c | 283.9 |
| Plastic bag + 100mg/l N | 289.9 d e f | 243.5 b | 266.7 |
| Plastic bag + Actara | 301.2 d e f | 270.2 b c d | 285.7 |
| Plastic bag + Actara + border | - | 151.2 a | 151.2 |
| 70 module tray | 311.2 e f g | - | 311.2 |
| 128 module tray | 321.5 f g | - | 321.5 |
| Box broadcasting | 281.5 c d e | - | 281.5 |
| Average | 309.1 | 231.0 | 276.6 |
| p= | <0.001 | | |
| LSD= | 36.4 | | |

Fruit number of other treatments did not differ from direct sowing. With Gada the number of fruits of direct sowing did not differ from the number present with transplants raised in plastic bag and in trays. Fruit number of transplants raised in plastic bag with additional nitrogen or with an Actara drench was lower than at direct sowing. Number of marketable fruits per square meter of Tit Segitiga was lower than that of Gada (Table 25). In combination with border plants, transplants raised in plastic bag with Actara showed a lower number than with the cultivation without border plants. Gada transplants raised in plastic bag with additional nitrogen and Gada transplants raised in box with broadcasting showed a lower number of marketable fruits compared to the number present with direct sowing of Gada. Compare to the number present with broadcasting and with plastic bag with 100 mg N per litre media, a higher number was present with transplants raised in 128 module trays then

Table 25. Marketable fruit number per square meter.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 275.9 f | 179.0 b | 227.5 |
| Plastic bag | 268.5 e f | 189.2 b | 228.9 |
| Plastic bag + 100mg/l N | 235.9 d e | 188.9 b | 212.4 |
| Plastic bag + Actara | 245.8 d e f | 203.0 b c | 224.4 |
| Plastic bag + Actara + border | - | 106.5 a | 106.5 |
| 70 module tray | 254.7 d e f | - | 254.7 |
| 128 module tray | 268.8 f | - | 268.8 |
| Box broadcasting | 232.7 c d | - | 232.7 |
| Average | 254.6 | 173.3 | 220.8 |
| p= | <0.001 | | |
| LSD= | 32.8 | | |

### 3.5.3 Share of marketable yield in total production

Percentage of marketable yield was for all Gada treatments the same (Table 26). With Tit Segitiga, only the treatment with border plants showed a lower share of marketable yield than present with direct sowing.

Table 26. Percentage marketable production in total production.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 72.9 c | 70.6 b c | 71.8 |
| Plastic bag | 70.4 b c | 66.8 a b | 68.6 |
| Plastic bag + 100mg/l N | 68.0 b c | 68.4 b c | 68.2 |
| Plastic bag + Actara | 69.1 b c | 70.0 b c | 69.5 |
| Plastic bag + Actara + border | - | 62.3 a | 62.3 |
| 70 module tray | 68.7 b c | - | 68.7 |
| 128 module tray | 69.4 b c | - | 69.4 |
| Box broadcasting | 68.6 b c | - | 68.6 |
| Average | 69.6 | 67.6 | 68.8 |
| p= | 0.1 | | |
| LSD= | 5.5 | | |

### 3.5.4 Fruit weight

Average fruit weight of Tit Segitiga was higher than that of Gada (Table 27). At Tit Segitiga no difference in fruit weight was present between treatments. At Gada the fruit weight of transplants raised in plastic bag with Actara drench, raised in 128 module tray or raised with broadcasting in a box was lower than the weight with direct sowing. Compared to transplants raised in plastic bag no different fruit weight was present at the other treatments.

Table 27. Average fruit weight of total production.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 5.5 c | 6.6 d | 6.0 |
| Plastic bag | 5.0 a b c | 7.1 d | 6.0 |
| Plastic bag + 100mg/l N | 5.1 b c | 6.7 d | 5.9 |
| Plastic bag + Actara | 4.5 a | 6.7 d | 5.6 |
| Plastic bag + Actara + border | - | 6.6 d | 6.6 |
| 70 module tray | 5.3 b c | - | 5.3 |
| 128 module tray | 4.9 a b | - | 4.9 |
| Box broadcasting | 4.9 a b | - | 4.9 |
| Average | 5.0 | 6.8 | 5.7 |
| p= | <0.001 | | |
| LSD= | 0.54 | | |

When looking at average fruit weight of marketable fruits only, the fruit weight of Tit Segitiga is higher than that of Gada (Table 28). Transplants raised in plastic bag showed a higher average fruit weight than direct sowing and was also higher compared to the fruit weight of other transplant raising treatments. Other treatments did not show differences in fruit weight.
Compared to direct sowing of Gada, a lower fruit weight was present at Gada transplants raised in plastic bag with Actara drench, at transplants raised in 70 module tray and raised in a box with broadcasting sowing. Raising in a plastic bag did not show a different fruit weight compared to the other transplant raising treatments.

Table 28. Average fruit weight of marketable fruits.

| | Variety | | |
|---|---|---|---|
| Raising system | Gada | Tit Segitiga | Average |
| Direct | 5.6 c | 6.9 d | 6.2 |
| Plastic bag | 5.1 a b c | 7.9 e | 6.5 |
| Plastic bag + 100mg/l N | 5.4 b c | 7.0 d | 6.2 |
| Plastic bag + Actara | 4.6 a | 7.0 d | 5.8 |
| Plastic bag + Actara + border | - | 7.0 d | 7.0 |
| 70 module tray | 5.5 b c | - | 5.5 |
| 128 module tray | 4.9 a b | - | 4.9 |
| Box broadcasting | 5.1 a b | - | 5.1 |
| Average | 5.2 | 7.2 | 6.0 |
| p= | <0.001 | | |
| LSD= | 0.69 | | |

# 4 Discussion

## 4.1 Effect of transplant use on yield

Raising of seedlings in a nursery showed advantages compared to direct sowing. Firstly, percentage of emergence was especially in the table nursery, higher than at direct sowing. Compared to direct sowing, percentage of usable plants was higher when raising Gada transplants in the table nursery. At Tit Segitiga percentage of usable plants was similar to the percentage present with direct sowing. This means that seeds are used more efficiently. For obtaining 100 plants with direct sowing 500 seeds are required while with raising seedlings in a nursery only 110 seeds are needed. Due to this a reduction in seed use and in costs is possible and the use of more expensive hybrid seeds might be possible.
Fresh weight of seedlings raised in the nurseries was lower compared to the weight of direct sown seedlings. Also plant length was considerably shorter of nursery seedlings as compared to direct sowing. Dry weight was also lower than at direct sowing. Growth in the nursery is limited due to limited growing space in the container and lower light levels inside the nursery and might result in smaller plants as compared to direct sowing. However, start of the harvest and harvest period of transplants is similar to that of direct sowing as can be seen at the cumulative production graphs. Although smaller plants are used for transplanting, plant development stage is the same and they catch up quickly with direct sowing. Yield levels of transplants are similar or better than that of direct sowing. With Gada, comparing results of transplants with direct sowing is somehow difficult due to the difference in plant population between direct sowing and transplants. However, with cultivation of transplants at only 50% of the plant population present with direct sowing, the production per square meter is not different from the production present with direct sowing. Production of plants raised in a nursery first, was almost twice than that of direct sowing. At Tit Segitiga, where a same plant population was used for both direct sowing and transplant use, yield level of transplants was similar to that of direct sowing. Share of marketable yield in production is not influenced by the use of transplants, and with using transplants average fruit weight was similar to direct sowing.
When using transplants, pest and disease pressure can be reduced. Compared to direct sowing, transplants did not show thrips symptoms and almost no virus symptoms were present 3 to 4 weeks after sowing. Farmers can start with healthier plants which eventually might result in a better plant growth and in a shorter field period. As a result it might reduce the total pest pressure when more farmers will use transplants raised in a protected construction. In order to reduce pest pressure even more, production can take place under insect net covers as well. This will no doubt, reduce the complete pest pressure in the area and also pesticide use will be limited.

## 4.2 Effect of nursery on seedling raising

Percentage of normal seedlings in the soil nursery was on average lower compared to the table nursery. After 10 days, only Gada showed higher percentages of normal seedlings in the table nursery than identical treatments in the soil nursery. Tit Segitiga emergence percentages were comparable for both nurseries. At 20 and 30 days after sowing and at transplanting stage, both varieties showed higher emergence percentages in the table nursery than at the same treatments in the soil nursery with some exceptions of Tit Segitiga treatments. Not only emergence and seedling establishment, but also growth of seedlings in the table nursery was better than that in the soil nursery. Fresh weight of Gada seedlings raised in the table nursery was slightly higher than those raised in the soil nursery. Tit Segitiga seedlings showed in both nurseries a same fresh weight. Dry weight of seedlings raised in the table nursery was higher than that of seedlings raised in the soil nursery. Also plants in the soil nursery were slightly shorter than the length of seedlings in the table nursery
This all leads to the assumption that raising conditions in the table nursery are more optimal than in the soil nursery.

## 4.3 Effect of container on seedling raising and yield

Percentage usable seedlings in trays was slightly lower than that in plastic bags. This might be the result of less favourable raising conditions in the trays. Trays are more sensible to watering and it is harder to keep the media at a right moisture level. With increasing experience it is possible to obtain a same emergence and usable seedlings as with raising in plastic bags.
Seedling quality was almost similar for transplants raised in trays or in plastic bags, although seedlings raised in plastic bags were taller than those raised in trays. Fresh weight of seedlings raised in trays was not different from seedlings raised in plastic bag. However, dry weight of seedlings raised in 128 module tray was for Gada quite

low. At Tit Segitiga no differences were present in dry weight between trays or plastic bag seedlings. Perhaps Gada is more sensitive to growing conditions. When conditions are not optimal, differences in transplant parameters might be more pronoun with raising Gada than with raising of Tit Segitiga.
No effect of container choice was observed on percentage of seedlings with thrips or virus symptoms.
In terms of yield, marketable yield, fruit number, cumulative yield or average fruit weight no differences between transplants raised in trays or plastic bag were present. Not so surprisingly, seeing that from all treatments only the best transplants, all having a similar quality, are planted in the field. Weak, low quality plants are omitted from transplanting. Seedlings of a same quality will produce a same yield.

## 4.4 Effect of Actara treatment and border plants

With the use of the Actara 25 WG (thiamethoxam), transplants were drenched twice in the nursery, followed by a drench in the field and field sprayings, no phytotoxic effects were observed. Emergence of seedlings and establishment was equal to results of raising in plastic bags without Actara drench. Also fresh weight and dry weight of seedlings drenched with Actara was equal to that of seedlings without drenching. In the soil nursery, plant length of Gada seedlings treated with Actara was somewhat lower than that of untreated seedlings. No effect on virus or thrips could be observed at transplanting, since the level of infection was also low at untreated.
With Actara, yield per plant or per square meter was not different from untreated. Since pest pressure is quite high, the tested rate and consecutive spraying scheme of Actara might be carried out with a rate too low for an effective control. Although the tested scheme was effective in controlling white fly in tomato as tested by Syngenta it might be not effective in controlling thrips in hot pepper. Since phytototoxicity was not present, a higher rate of Actara can be used and may be more effective compared to the used rates. However, resistance of thrips against thiamethoxam may be present as well in which case a higher rate will have no effect.
With cultivation of hot pepper together with corn border plants, yield levels were significant lower. Also share of marketable fruits was quite lower compared to the cultivation without border plants. With border plants insect in-flight may be prevented but growth of plants is influenced negatively leading to lower yield levels. Border plants compete with the hot pepper plants for nutrients, space and light and in this case it turned out unfavourable for the hot pepper plants. Also the use of border plants resulted in a lower share of marketable fruits as compared to cultivation without border plants. This leads to the assumption that instead of preventing in-flight of insects, insects are rather trapped inside the plots causing more damage than without a border crop.

## 4.5 Effect of variety on seedling raising and yield

More and better seedlings were present with raising of Gada than with Tit Segitiga. Productivity of Gada was also higher than that of Tit Segitiga.
Percentage emergence and seedling establishment was in general higher with Gada than with Tit Segitiga. Average fresh and dry weight of Gada was higher compared to Tit Segitiga and Gada seedlings were taller than seedlings of Tit Segitiga. Especially when raised at more optimal conditions in the table nursery, Gada performed much better than Tit Segitiga. Compared to open pollinated varieties in general, hybrid varieties possess a better vigour and growth. Besides, seeds of Gada are produced under controlled circumstances focussing on obtaining high quality seeds. Afterwards, seeds are processed and checked on emergence and presence of diseases. Seeds are stored at optimal conditions. In this way only high quality seeds are sold to the farmers. Contrary to this is the way of seed production of Tit Segitiga. Mostly fruits that can not be sold anyway are kept from a production field for seed production. Seeds are harvested from these fruits and kept at ambient temperature till next season.
Tit Segitiga seems to be more susceptible to thrips, but was not significant different from Gada.
Yield levels of Gada were higher than that of Tit Segitiga. With direct sowing, with a same plant density present for both varieties, Gada produced 14% more than Tit Segitiga. Productivity of Gada is quite high since a lot of fruits per plant can be harvested and per square meter the yield at Gada with 6.1 plants per square meter was similar to that of Tit Segitiga with 12.2 plants per meter. Share of marketable yield in the total production was for both varieties the same. Gada produces in general slightly smaller fruits than Tit Segitiga.

## 4.6 Effect of N supplement to media on seedling raising and yield

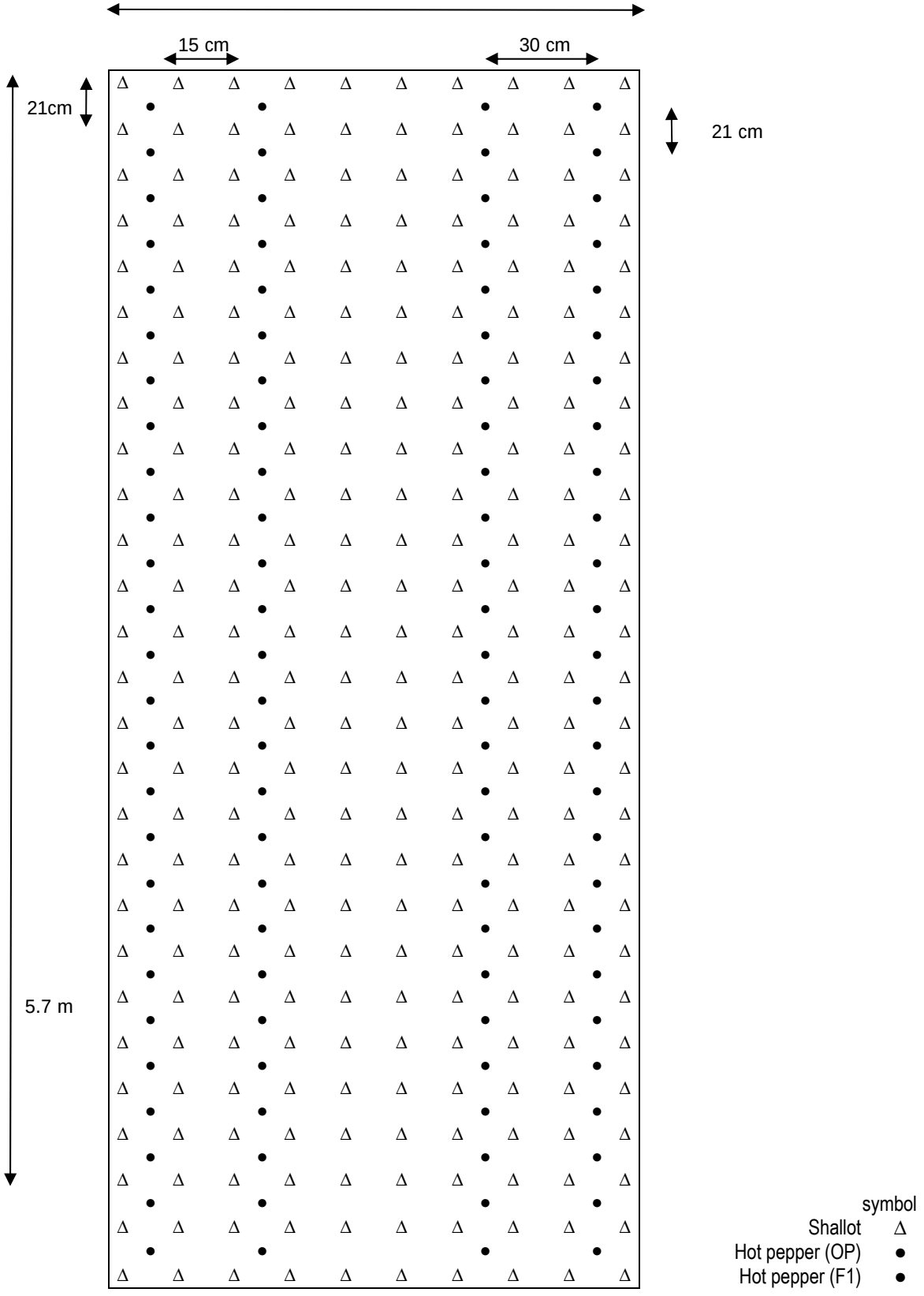
Nitrogen can greatly influence plant growth, transplant establishment in the field and eventual yield. In this experiment observed was that the addition of 100 mg N per litre media did not increase emergence percentage or

percentage of usable transplants. The fresh weight of Gada seedlings raised with supplemental nitrogen as somewhat higher but not significant different from seedlings raised without supplemental nitrogen. At Tit Segitiga fresh weight of seedlings raised with nitrogen was almost the same as the weight of seedlings raised without nitrogen. In the table nursery dry weight of seedlings of both varieties raised with supplemental nitrogen was higher but also not significant different from seedlings raised without nitrogen. With Gada raised in the soil nursery, dry weight of seedlings raised with nitrogen was higher compared to raising without supplemental nitrogen. In plant length no differences were observed between raising with and without supplemental nitrogen.
In yield, fruit number, share of marketable production and fruit weight no differences were present.
It seems that nitrogen content of the used media of manure and top soil is already sufficient to produce good quality seedlings and therefore it is not necessary to add supplemental nitrogen to the media.

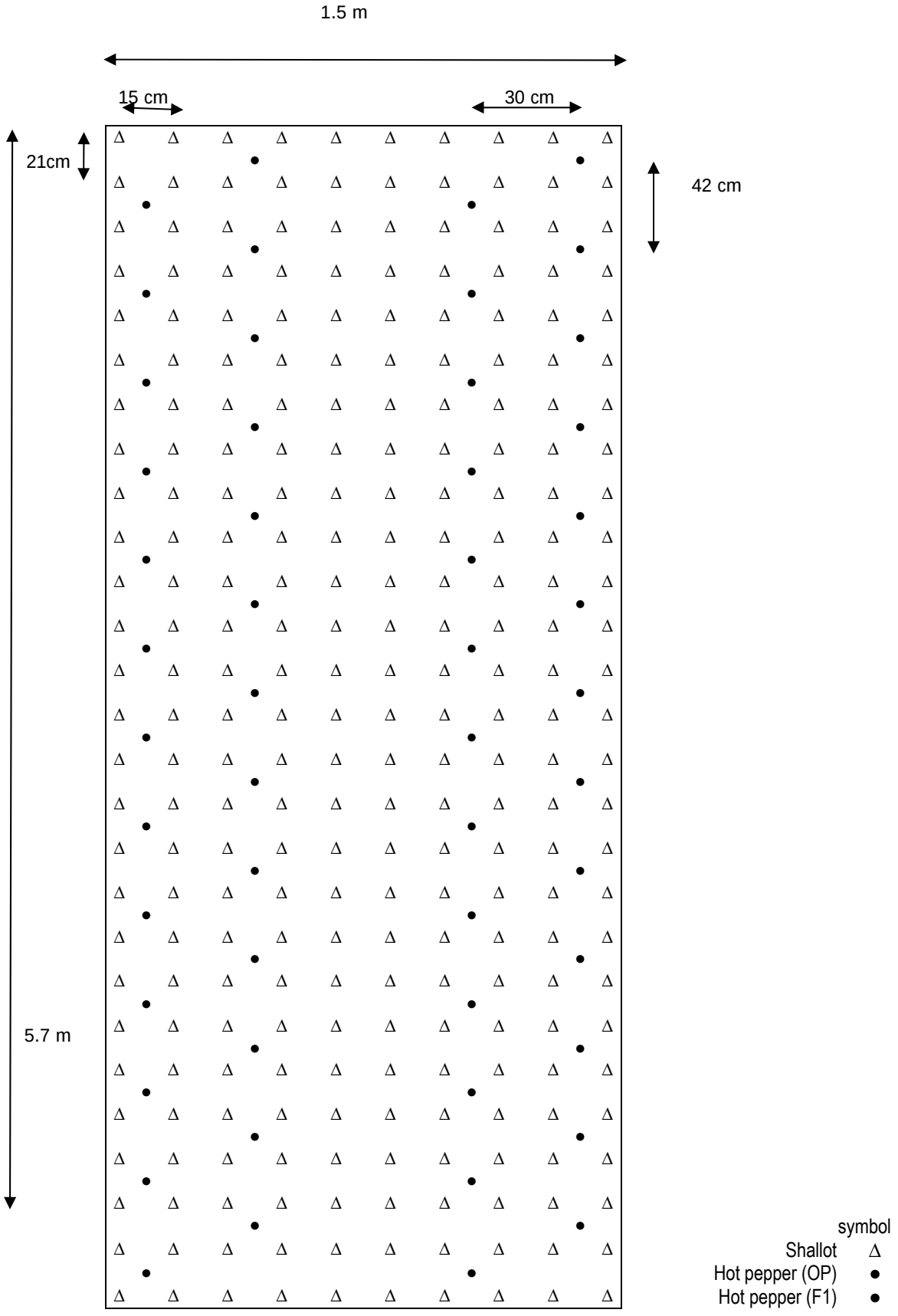
# 5 Conclusions

- With raising of seedlings in a nursery, a higher percentage of seeds will produce a good seedling, thus reducing the amount of seeds needed for cultivation.
- Yield levels of transplants are equal or higher as compared to direct sowing. At transplanting stage, pest pressure is lower with the use of transplants and quality of transplants is better than those obtained with direct sowing.
- A table nursery construction is more favourable than a soil nursery construction for raising transplants. Climatic conditions are presumably better in a table nursery. Besides a table construction is more optimal for plant caring than a soil nursery construction.
- Gada gives more and better transplants compared to Tit Segitiga. Also yield levels of Gada are higher as compared to Tit Segitiga.
- Application of Actara by drenching and field spraying did not result in phytotoxic effects on seedling raising but also did not result in higher yields.
- The use of border plants influence production negatively due to competition for nutrients, light and space. Also it did not reduce incidence of pests and diseases since the share of marketable fruits was even lowerwith the use of border plants as compared to a standard cultivation.
- The used media already contains sufficient nitrogen. A supplement of 100 mg nitrogen per litre media did not result in a better transplant production or in an increased production.

*Annex I. Plant arrangement per plot.*




*Plant arrangement per plot for the open pollinated variety Tit Segitiga (100 plants = 11.7 pl/m2)*




*Plant arrangement per plot for hybrid variety Gada F1 (50 plants = 5.8 pl/m2) (recommended = 4.2)*

## *Annex II. Layout of treatments in nurseries.*

Overview all nursery stage treatments

Table nursery

| | Variety | Raising System | | |
|---|---|---|---|---|
| | | Nursery | Container | Media |
| TA1B1 | Tit Segitiga | Table | Transparent plastic bag | manure+top-soil (1:1) |
| TA1B2 | Tit Segitiga | Table | Transparent plastic bag | manure+top-soil (1:1) +100mg/l N |
| TA1B3 | Tit Segitiga | Table | Small module tray | manure+top-soil (1:1) |
| TA1B4 | Tit Segitiga | Table | Large module tray | manure+top-soil (1:1) |
| TA1B5 | Tit Segitiga | Table | Transparent plastic bag | manure+top-soil (1:1) +Actara |
| TA1B6 | Tit Segitiga | Table | Transparent plastic bag | manure+top-soil (1:1) +Actara |
| TA2B1 | Hybrid | Table | Transparent plastic bag | manure+top-soil (1:1) |
| TA2B2 | Hybrid | Table | Transparent plastic bag | manure+top-soil (1:1) +100mg/l N |
| TA2B3 | Hybrid | Table | Small module tray | manure+top-soil (1:1) |
| TA2B4 | Hybrid | Table | Large module tray | manure+top-soil (1:1) |
| TA2B5 | Hybrid | Table | Transparent plastic bag | manure+top-soil (1:1) +Actara |

Soil nursery

| | Variety | Raising System | | |
|---|---|---|---|---|
| | | Nursery | Container | Media |
| SA1B1 | Tit Segitiga | Soil | Transparent plastic bag | manure+top-soil (1:1) |
| SA1B2 | Tit Segitiga | Soil | Transparent plastic bag | manure+top-soil (1:1) +100mg/l N |
| SA1B3 | Tit Segitiga | Soil | Small module tray | manure+top-soil (1:1) |
| SA1B4 | Tit Segitiga | Soil | Large module tray | manure+top-soil (1:1) |
| SA1B5 | Tit Segitiga | Soil | Transparent plastic bag | manure+top-soil (1:1) +Actara |
| SA1B6 | Tit Segitiga | Soil | Transparent plastic bag | manure+top-soil (1:1) +Actara |
| SA1B7 | Tit Segitiga | Soil | Broadcasted | |
| SA2B1 | Hybrid | Soil | Transparent plastic bag | manure+top-soil (1:1) |
| SA2B2 | Hybrid | Soil | Transparent plastic bag | manure+top-soil (1:1) +100mg/l N |
| SA2B3 | Hybrid | Soil | Small module tray | manure+top-soil (1:1) |
| SA2B4 | Hybrid | Soil | Large module tray | manure+top-soil (1:1) |
| SA2B5 | Hybrid | Soil | Transparent plastic bag | manure+top-soil (1:1) +Actara |
| SA2B7 | Hybrid | Soil | Broadcasted | |

Direct sowing in the field

| | Variety | Raising System |
|---|---|---|
| FA1B8 | Tit Segitiga | Direct seeding |
| FA2B8 | Gada | Direct seeding |

TABLE NURSERY

Replication 3: Nursery III

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | A2B1 | 30 | A2B3 | 31 | A1B3 | 32 | A1B6 | 33 | A2B5 | | | | |
| | | *L5* | | | | | *L6* | | | | | | |
| 23 | A1B4 | 24 | A1B2 | 25 | A1B5 | 26 | A1B1 | 27 | A2B2 | 28 | A2B4 | | |

III

Replication 2: Nursery II

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | A1B6 | 19 | A1B1 | 20 | A1B5 | 21 | A2B2 | 22 | A2B3 | | | | |
| | | *L3* | | | | | *L4* | | | | | | |
| 12 | A1B2 | 13 | A1B3 | 14 | A1B4 | 15 | A2B4 | 16 | A2B1 | 17 | A2B11 | | |

II

Replication 1: Nursery I

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | A2B5 | 8 | A1B1 | 9 | A1B5 | 10 | A1B3 | 11 | A1B6 | | | | |
| | | *L1* | | | | | *L2* | | | | | | |
| 1 | A2B2 | 2 | A2B4 | 3 | A1B4 | 4 | A2B1 | 5 | A1B3 | 6 | A1B2 | | |

I

*L1* till *L6* = positions for measuring light intensity inside the nursery

I, II, III = positions for measuring light intensity outside the nursery

SOIL NURSERY

Replication 3: Nursery III

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | A2B7 | 35 | A2B2 | 36 | A1B3 | 37 | A1B6 | 38 | A2B4 | 39 | A1B7 | | |
| 27 | A1B4 | 28 | A1B2 | 29 | A2B5 | 30 | A1B1 | 31 | A2B1 | 32 | A2B3 | 33 | A1B5 |

*L5* *L6*

III

Replication 2: Nursery II

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | A1B6 | 22 | A2B5 | 23 | A1B5 | 24 | A2B1 | 25 | A2B9 | 26 | A1B1 | | |
| 14 | A2B7 | 15 | A1B3 | 16 | A2B4 | 17 | A2B3 | 18 | A1B7 | 19 | A2B4 | 20 | A1B2 |

*L3* *L4*

II

Replication 1: Nursery I

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | A2B4 | 9 | A1B1 | 10 | A1B5 | 11 | A1B2 | 12 | A2B7 | 13 | A1B6 | | |
| 1 | A2B1 | 2 | A2B3 | 3 | A1B4 | 4 | A2B5 | 5 | A1B3 | 6 | A1B2 | 7 | A1B7 |

*L1* *L2*

I

*L1* till *L6* = positions for measuring light intensity inside the nursery

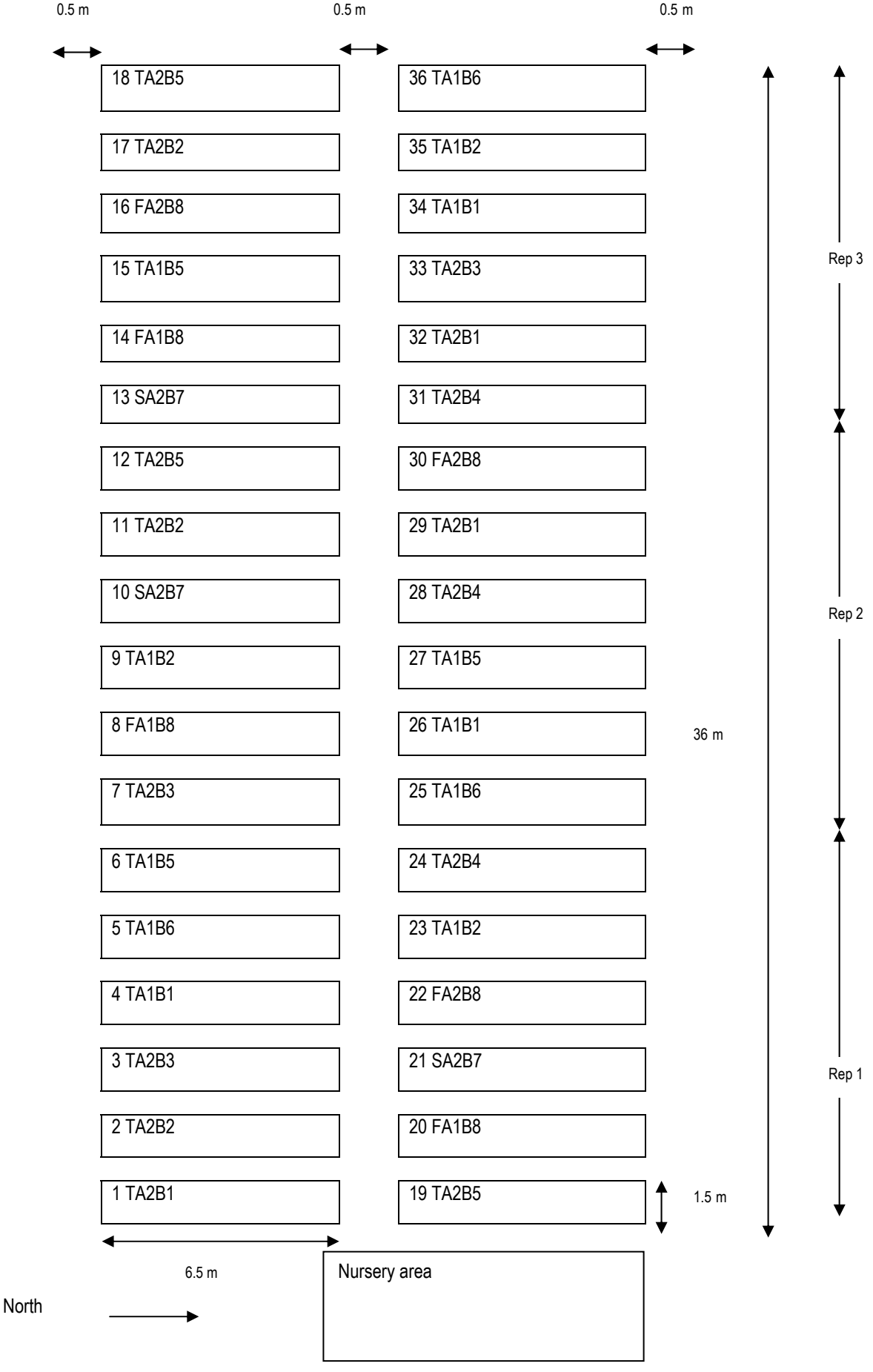
I, II, III = positions for measuring light intensity outside the nursery

## *Annex III. Layout of treatments in the field.*

Field stage treatments for sowing experiment from the table nursery with improved sowing technique.

| | | | Container | Media | Variety |
|---|---|---|---|---|---|
| 1 | TA1B1 | A1 | Plastic bag | Manure +Top Soil | Tit Segitiga |
| 2 | TA1B2 | A4 | Plastic bag | Manure + Top Soil+100mg/l N | Tit Segitiga |
| 3 | TA1B5 | A2 | Plastic bag | Manure +Top Soil + Actara | Tit Segitiga |
| 4 | TA1B6 | A3 | Plastic bag | Manure +Top Soil + Actara + border | Tit Segitiga |
| 5 | FA1B8 | A10 | - | Direct sowing field | Tit Segitiga |
| 6 | TA2B1 | A5 | Plastic bag | Manure +Top Soil | Gada |
| 7 | TA2B2 | A7 | Plastic bag | Manure +Top Soil + 100mg/l N | Gada |
| 8 | TA2B3 | A11 | Tray 128 | Manure + Top Soil | Gada |
| 9 | TA2B4 | A8 | Tray 70 | Manure +Top Soil | Gada |
| 10 | TA2B5 | A6 | Plastic bag | Manure +Top Soil + Actara | Gada |
| 11 | SA2B7 | A12 | Box broadcast | Top soil | Gada |
| 12 | FA2B8 | A9 | - | Direct sowing field | Gada |

Field experiment lay-out:



*Annex IV. Temperature and rainfall during the experiment.*

| | Inside temperature | | | | Outside temperature | | Rainfall |
|---|---|---|---|---|---|---|---|
| | Table | | Soil | | | | |
| Date | Min T | Max T | Min T | Max T | Min T | Max T | |
| 20-2-2008 | 20 | 36 | 20 | 37 | 20 | 37 | 0 |
| 21-2-2008 | 21 | 35 | 20 | 36 | 21 | 36 | 0 |
| 22-2-2008 | 20 | 34 | 21 | 35 | 20 | 35 | 0 |
| 23-2-2008 | 20 | 35 | 22 | 35 | 20 | 37 | 56 |
| 24-2-2008 | 20 | 35 | 20 | 35 | 20 | 37 | 19 |
| 25-2-2008 | 21 | 34 | 21 | 36 | 21 | 35 | 7 |
| 26-2-2008 | 20 | 35 | 23 | 38 | 20 | 37 | 0 |
| 27-2-2008 | 20 | 38 | 20 | 38 | 20 | 36 | 0 |
| 28-2-2008 | 20 | 34 | 21 | 35 | 20 | 37 | 0 |
| 29-2-2008 | 20 | 35 | 21 | 36 | 20 | 36 | 38 |
| 1-3-2008 | 20 | 36 | 20 | 36 | 20 | 35 | 0 |
| 2-3-2008 | 21 | 36 | 21 | 36 | 19 | 35 | 0 |
| 3-3-2008 | 20 | 38 | 20 | 35 | 20 | 36 | 57 |
| 4-3-2008 | 21 | 36 | 20 | 35 | 19 | 35 | 36 |
| 5-3-2008 | 20 | 36 | 20 | 36 | 20 | 34 | 7 |
| 6-3-2008 | 21 | 35 | 20 | 35 | 20 | 35 | 5 |
| 7-3-2008 | 19 | 35 | 20 | 35 | 19 | 35 | 0 |
| 8-3-2008 | 20 | 36 | 20 | 35 | 20 | 34 | 0 |
| 9-3-2008 | 21 | 35 | 20 | 35 | 20 | 35 | 0 |
| 10-3-2008 | 20 | 36 | 20 | 35 | 20 | 35 | 0 |
| 11-3-2008 | 20 | 36 | 20 | 36 | 20 | 35 | 0 |
| 12-3-2008 | 21 | 36 | 21 | 36 | 20 | 35 | 0 |
| 13-3-2008 | 20 | 38 | 20 | 35 | 19 | 35 | 0 |
| 14-3-2008 | 21 | 37 | 21 | 38 | 20 | 36 | 29 |
| 15-3-2008 | 22 | 37 | 21 | 39 | 20 | 36 | 0 |
| 16-3-2008 | 20 | 39 | 20 | 39 | 20 | 38 | 0 |
| 17-3-2008 | 21 | 37 | 21 | 37 | 20 | 36 | 32 |
| 18-3-2008 | 20 | 39 | 20 | 39 | 29 | 39 | 0 |
| 19-3-2008 | 21 | 39 | 21 | 39 | 20 | 38 | 3 |
| 20-3-2008 | 19 | 39 | 19 | 39 | 29 | 37 | 24 |
| 21-3-2008 | 20 | 40 | 20 | 39 | 19 | 36 | 12 |
| 22-3-2008 | 21 | 39 | 21 | 39 | 20 | 38 | 8 |
| 23-3-2008 | 19 | 37 | 19 | 38 | 19 | 35 | 37 |
| 24-3-2008 | 19 | 40 | 19 | 40 | 19 | 38 | 54 |
| 25-3-2008 | 20 | 39 | 20 | 39 | 19 | 38 | 0 |
| 26-3-2008 | 20 | 39 | 20 | 39 | 20 | 36 | 62 |
| 27-3-2008 | 21 | 40 | 21 | 40 | 20 | 38 | 0 |
| 28-3-2008 | 19 | 39 | 21 | 40 | 19 | 39 | 21 |
| 29-3-2008 | 21 | 39 | 22 | 41 | 21 | 39 | 0 |
| 30-3-2008 | 21 | 39 | 21 | 40 | 21 | 39 | 0 |
| 31-3-2008 | | | | | 21 | 39 | 0 |

| | Inside temperature | | | | Outside temperature | | Rainfall |
|---|---|---|---|---|---|---|---|
| | Table | | Soil | | | | |
| Date | Min T | Max T | Min T | Max T | Min T | Max T | |
| 1-4-2008 | | | | | 21 | 39 | 49 |
| 2-4-2008 | | | | | 19 | 37 | 4 |
| 3-4-2008 | | | | | 19 | 40 | 0 |
| 4-4-2008 | | | | | 20 | 39 | 28 |
| 5-4-2008 | | | | | 20 | 39 | 16 |
| 6-4-2008 | | | | | 21 | 40 | 24 |
| 7-4-2008 | | | | | 19 | 39 | 10 |
| 8-4-2008 | | | | | 21 | 39 | 0 |
| 9-4-2008 | | | | | 21 | 39 | 0 |
| 10-4-2008 | | | | | 19 | 35 | 0 |
| 11-4-2008 | | | | | 19 | 38 | 7 |
| 12-4-2008 | | | | | 19 | 38 | 0 |
| 13-4-2008 | | | | | 20 | 36 | 16 |
| 14-4-2008 | | | | | 20 | 38 | 5 |
| 15-4-2008 | | | | | 19 | 39 | 0 |
| 16-4-2008 | | | | | 21 | 39 | 18 |
| 17-4-2008 | | | | | 21 | 39 | 0 |
| 18-4-2008 | | | | | 20 | 37 | 0 |
| 19-4-2008 | | | | | 21 | 38 | 0 |
| 20-4-2008 | | | | | 21 | 40 | 0 |
| 21-4-2008 | | | | | 22 | 39 | 13 |
| 22-4-2008 | | | | | 22 | 40 | 24 |
| 23-4-2008 | | | | | 21 | 40 | 8 |
| 24-4-2008 | | | | | 20 | 40 | 5 |
| 25-4-2008 | | | | | 21 | 40 | 67 |
| 26-4-2008 | | | | | 22 | 39 | 0 |
| 27-4-2008 | | | | | 21 | 39 | 3 |
| 28-4-2008 | | | | | 20 | 40 | 0 |
| 29-4-2008 | | | | | 22 | 41 | 0 |
| 30-4-2008 | | | | | 22 | 40 | 0 |
| 1-5-2008 | | | | | 21 | 41 | 0 |
| 2-5-2008 | | | | | 22 | 43 | 0 |
| 3-5-2008 | | | | | 22 | 44 | 0 |
| 4-5-2008 | | | | | 22 | 43 | 13 |
| 5-5-2008 | | | | | 22 | 42 | 0 |
| 6-5-2008 | | | | | 21 | 42 | 4 |
| 7-5-2008 | | | | | 21 | 43 | 0 |
| 8-5-2008 | | | | | 22 | 44 | 0 |
| 9-5-2008 | | | | | 22 | 41 | 0 |
| 10-5-2008 | | | | | 22 | 44 | 0 |
| 11-5-2008 | | | | | 21 | 43 | 0 |
| 12-5-2008 | | | | | 21 | 42 | 0 |
| 13-5-2008 | | | | | 21 | 43 | 0 |
| 14-5-2008 | | | | | 22 | 44 | 0 |
| 15-5-2008 | | | | | 21 | 42 | 0 |

| | Inside temperature | | | | Outside temperature | | Rainfall |
|---|---|---|---|---|---|---|---|
| | Table | | Soil | | | | |
| Date | Min T | Max T | Min T | Max T | Min T | Max T | |
| 16-5-2008 | | | | | 20 | 42 | 0 |
| 17-5-2008 | | | | | 20 | 43 | 0 |
| 18-5-2008 | | | | | 21 | 41 | 0 |
| 19-5-2008 | | | | | 22 | 43 | 0 |
| 20-5-2008 | | | | | 22 | 44 | 0 |
| 21-5-2008 | | | | | 22 | 43 | 0 |
| 22-5-2008 | | | | | 22 | 42 | 0 |
| 23-5-2008 | | | | | 21 | 42 | 0 |
| 24-5-2008 | | | | | 21 | 43 | 0 |
| 25-5-2008 | | | | | 21 | 43 | 0 |
| 26-5-2008 | | | | | 22 | 44 | 0 |
| 27-5-2008 | | | | | 22 | 44 | 0 |
| 28-5-2008 | | | | | 22 | 41 | 0 |
| 29-5-2008 | | | | | 22 | 44 | 0 |
| 30-5-2008 | | | | | 21 | 43 | 0 |
| 31-5-2008 | | | | | 21 | 42 | 0 |
| 1-6-2008 | | | | | | | 36 |
| 2-6-2008 | | | | | | | 0 |
| 3-6-2008 | | | | | 21 | 37 | 0 |
| 4-6-2008 | | | | | 26 | 42 | 0 |
| 5-6-2008 | | | | | 26 | 43 | 0 |
| 6-6-2008 | | | | | 24 | 45 | 0 |
| 7-6-2008 | | | | | 24 | 44 | 0 |
| 8-6-2008 | | | | | 23 | 45 | 0 |
| 9-6-2008 | | | | | 23 | 47 | 0 |
| 10-6-2008 | | | | | 21 | 48 | 0 |
| 11-6-2008 | | | | | 21 | 45 | 0 |
| 12-6-2008 | | | | | 20 | 40 | 0 |
| 13-6-2008 | | | | | 21 | 41 | 0 |
| 14-6-2008 | | | | | 22 | 43 | 0 |
| 15-6-2008 | | | | | 22 | 44 | 0 |
| 16-6-2008 | | | | | 22 | 43 | 0 |
| 17-6-2008 | | | | | 22 | 42 | 0 |
| 18-6-2008 | | | | | 21 | 43 | 7 |
| 19-6-2008 | | | | | 21 | 43 | 0 |
| 20-6-2008 | | | | | 22 | 44 | 0 |
| 21-6-2008 | | | | | 22 | 44 | 0 |
| 22-6-2008 | | | | | 22 | 41 | 0 |
| 23-6-2008 | | | | | 22 | 44 | 0 |
| 24-6-2008 | | | | | 22 | 41 | 0 |
| 25-6-2008 | | | | | 22 | 44 | 0 |
| 26-6-2008 | | | | | 21 | 43 | 0 |
| 27-6-2008 | | | | | 21 | 42 | 3 |
| 28-6-2008 | | | | | 22 | 43 | 0 |
| 29-6-2008 | | | | | 22 | 44 | 0 |
| 30-6-2008 | | | | | 22 | 43 | 0 |

| | Inside temperature | | | | Outside temperature | | Rainfall |
|---|---|---|---|---|---|---|---|
| | Table | | Soil | | | | |
| Date | Min T | Max T | Min T | Max T | Min T | Max T | |
| 1-7-2008 | | | | | 21 | 43 | 0 |
| 2-7-2008 | | | | | 22 | 44 | 0 |
| 3-7-2008 | | | | | 21 | 43 | 0 |
| 4-7-2008 | | | | | 22 | 45 | 0 |
| 5-7-2008 | | | | | 22 | 44 | 0 |
| 6-7-2008 | | | | | 22 | 45 | 0 |
| 7-7-2008 | | | | | 22 | 45 | 0 |
| 8-7-2008 | | | | | 21 | 42 | 0 |
| 9-7-2008 | | | | | 22 | 44 | 0 |
| 10-7-2008 | | | | | 22 | 44 | 0 |
| 11-7-2008 | | | | | 22 | 44 | 0 |
| 12-7-2008 | | | | | 21 | 43 | 0 |
| 13-7-2008 | | | | | 22 | 44 | 0 |
| 14-7-2008 | | | | | 22 | 42 | 0 |
| 15-7-2008 | | | | | 22 | 44 | 0 |
| 16-7-2008 | | | | | 22 | 43 | 0 |
| 17-7-2008 | | | | | 22 | 44 | 0 |
| 18-7-2008 | | | | | 22 | 43 | 0 |
| 19-7-2008 | | | | | 22 | 42 | 0 |
| 20-7-2008 | | | | | 21 | 42 | 0 |
| 21-7-2008 | | | | | 21 | 43 | 0 |
| 22-7-2008 | | | | | 21 | 43 | 0 |
| 23-7-2008 | | | | | 22 | 44 | 0 |
| 24-7-2008 | | | | | 22 | 44 | 0 |
| 25-7-2008 | | | | | 22 | 41 | 0 |
| 26-7-2008 | | | | | 22 | 44 | 0 |
| 27-7-2008 | | | | | 21 | 43 | 0 |
| 28-7-2008 | | | | | 21 | 42 | 0 |
| 29-7-2008 | | | | | 22 | 41 | 0 |
| 30-7-2008 | | | | | 22 | 44 | 0 |
| 31-7-2008 | | | | | 21 | 43 | 0 |
| 1-8-2008 | | | | | 22 | 43 | 0 |
| 2-8-2008 | | | | | 22 | 44 | 0 |
| 3-8-2008 | | | | | 22 | 43 | 0 |
| 4-8-2008 | | | | | 22 | 42 | 0 |
| 5-8-2008 | | | | | 21 | 42 | 0 |
| 6-8-2008 | | | | | 21 | 43 | 0 |
| 7-8-2008 | | | | | 21 | 43 | 0 |
| 8-8-2008 | | | | | 22 | 44 | 0 |
| 9-8-2008 | | | | | 22 | 44 | 0 |
| 10-8-2008 | | | | | 22 | 41 | 14 |
| 11-8-2008 | | | | | 22 | 44 | 0 |
| 12-8-2008 | | | | | 21 | 43 | 0 |
| 13-8-2008 | | | | | 21 | 42 | 0 |
| 14-8-2008 | | | | | 21 | 43 | 0 |
| 15-8-2008 | | | | | 22 | 43 | 0 |

| | Inside temperature | | | | Outside temperature | | Rainfall |
|---|---|---|---|---|---|---|---|
| | Table | | Soil | | | | |
| Date | Min T | Max T | Min T | Max T | Min T | Max T | |
| 16-8-2008 | | | | | 22 | 42 | 0 |
| 17-8-2008 | | | | | 22 | 43 | 0 |
| 18-8-2008 | | | | | 22 | 44 | 0 |
| 19-8-2008 | | | | | 20 | 42 | 0 |
| 20-8-2008 | | | | | 22 | 43 | 0 |
| 21-8-2008 | | | | | 22 | 42 | 0 |
| 22-8-2008 | | | | | 21 | 42 | 0 |
| 23-8-2008 | | | | | 21 | 42 | 0 |
| 24-8-2008 | | | | | 21 | 42 | 0 |
| 25-8-2008 | | | | | 20 | 40 | 0 |
| 26-8-2008 | | | | | 21 | 40 | 0 |
| 27-8-2008 | | | | | 21 | 41 | 3 |
| 28-8-2008 | | | | | 20 | 41 | 6 |
| 29-8-2008 | | | | | 21 | 40 | 22 |
| 30-8-2008 | | | | | 22 | 41 | 2 |
| 31-8-2008 | | | | | 20 | 41 | 0 |
| 1-9-2008 | | | | | 20 | 42 | 6 |
| 2-9-2008 | | | | | 21 | 42 | 0 |
| 3-9-2008 | | | | | 21 | 42 | 0 |
| 4-9-2008 | | | | | 22 | 44 | 0 |