HORTIN II Co Innovation Programme

Towards cost effective, high quality value chains

Influence of raising system, tray use and variety on seedling raising and yield of hot pepper

HORTIN-II Research Report nr. 7

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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.

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Executive summary

From September 2007 till January 2008 an experiment was carried out with hot pepper transplants at Kersana Brebes, Central Java. Transplants were raised in simple nursery constructions. Effect of media, container and variety on transplant quality were tested and use of transplants was compared to direct sowing with respect to yield.
Tested varieties were the local open pollinated variety Tit Segitiga and Tanjung 2 and the hybrid variety Astina. Mixtures of rice husk, manure and top soil were tested as media for raising transplants. Tested containers in the experiment were individual plastic bags and modular trays with 128 cells.
Nursery results indicated that plant quality of seedlings is better compared to direct sowing with respect to thrips and virus infections. Performance of seedlings is better in plastic bags than in trays. The substrate mixture of manure with top soil resulted in better growth of seedlings compared to raising in mixture of rice husk + manure + top soil. None of the seedling raising transplants resulted in higher yields as compared to direct sowing. With seedling raising lower amounts of seeds are required as compared to direct sowing. In general, Astina showed a higher percentage of usable seedlings and lowest virus incidence as compared to the other varieties. Yield levels of Tit Segitiga were higher as compared to Tanjung 2 and Astina.
However, field results were greatly influenced due to the presence of pests and diseases. Concluded can that although raising of transplants in a nursery resulted in a better quality seedling, this improved quality did not result in higher yields. Raised transplant were not more resistant against pests and diseases present in the field compared to direct sowing. When field conditions are optimal the use of transplants may result in higher yields.

1 Introduction

Hot pepper is an important and essential component in Indonesian diet. It is mainly consumed in fresh semi crushed form, locally known as “sambal”. Hot pepper could also be categorized as an important commercial crop, since it is grown year-round. Despite the importance of hot pepper and its product in the Indonesian diet and their role in generating income for farmers and other stakeholders in the food chain, the industry is still facing bottlenecks that need further attention to be solved. In general, some bottlenecks identified during the inception workshop are: (a) Unavailability of a less costly and low input-demanding improved open pollinated varieties that have high yield potential and desired attributes, (b) Low quality of hot pepper for processing that leads to higher dependence to imported raw materials, (c) Relatively low productivity and high production cost that lead to export prices of hot pepper remained higher than the import prices (becoming uncompetitive in the international market), (d) Considering insects and diseases as the number one constraint in hot pepper production, no appropriate, safe, and low-risk control method available yet, that can assure farmers to stop the excessive use of pesticides, (e) Lack of post-harvest and processing activities at the farm-level that reduce farmer capacity of holding output for a longer period. Hence, it reduces farmers share in the retail price of hot pepper and weaken their bargaining power, and (f) Lack of collaboration along the market chain, among different stakeholders, that hinders the effort to increase efficiency in the market chain and to enhance the value of the products and services generated along a market chain. Moreover, stakeholder group-discussion during the workshop has agreed to narrow down the bottlenecks and suggested low yield of hot pepper as the root problem. Even though some high-yielding varieties, mostly hybrids (20-30 t/h) are already available in the market, their use in some production centers is still low. In the mean time, farmers’ preference to use their own saved-seed and the practice of direct seeding may also aggravate the problem, because they frequently use low quality planting material. Based on this identification process, experiments are carried out with the objectives of improving hot pepper planting material through nursery seedling raising and introducing alternatives hot pepper varieties and promising lines that have high yield potential and desired attributes.

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 PT 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 doing he observations.

2 Materials and methods

The experiment was conducted at the Kersana Village, Kersana Sub-district, Brebes District, Central Java from September 2007 until January 2008. Brebes is located on the northern coast of Java adjacent to the Java Sea at 7° S and 109° E (Fig. 1). The climate can be classified as a humid tropical lowland climate with clear distinguished dry and wet seasons. The 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. Samples were taken from the field of the top layer of 0 – 30 cm depth. Sampling was done by taking 5 sub samples along the diagonal of the three blocks.

Soil pH-H_2O indicates a slight acid to neutral soil (Table 1). Phosphate content of the soil is present at an excessive level while potassium is present at an adequate medium level. Calcium and magnesium content of the soil 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

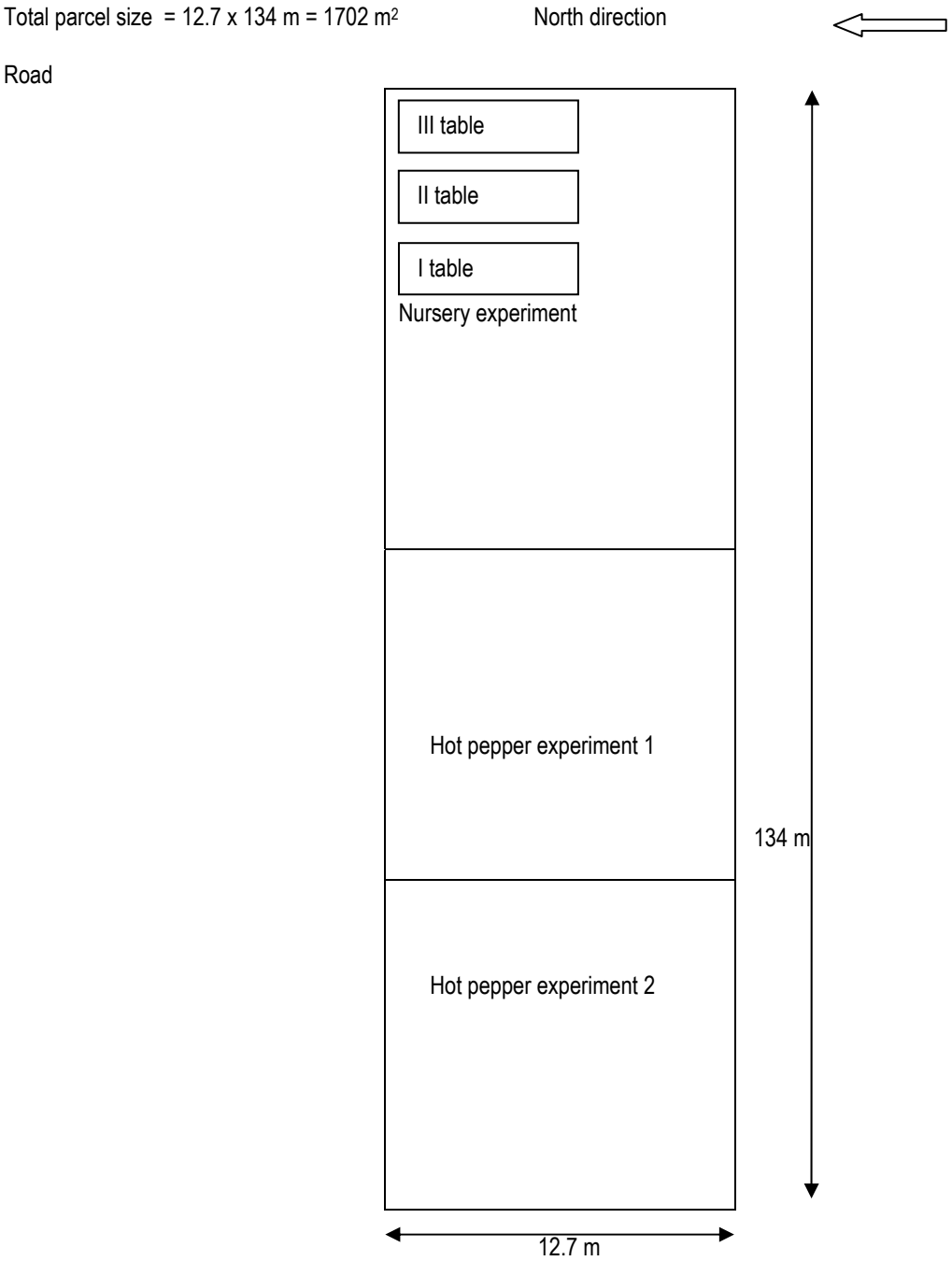


Figure 2. Layout of the experimental site

2.1 Nursery

Hot pepper seedlings were raised in a simple net house bamboo construction (Figure 3, 4 and 5). Three nursery net houses were built not only for conducting nursery experiment, but also for supplying seedlings for field experiment.

- One net house was designed to accommodate a maximum of 32 trays of 128 seedlings each. Hence, a nursery can accommodate a total of 4096 seedlings.
- Some wooden crates (55 x 35 cm) were also made available to place seedlings that use transparent plastic bags as container.
- Minimum required length of the nursery table is 16 x 35 cm = 5.60 m
- Minimum required width of the nursery table is 2 x 55 cm = 1.10 m
- Taking into account the spacing between wooden crates or trays, the size of a nursery table is approximately 1.5 x 7.0 m

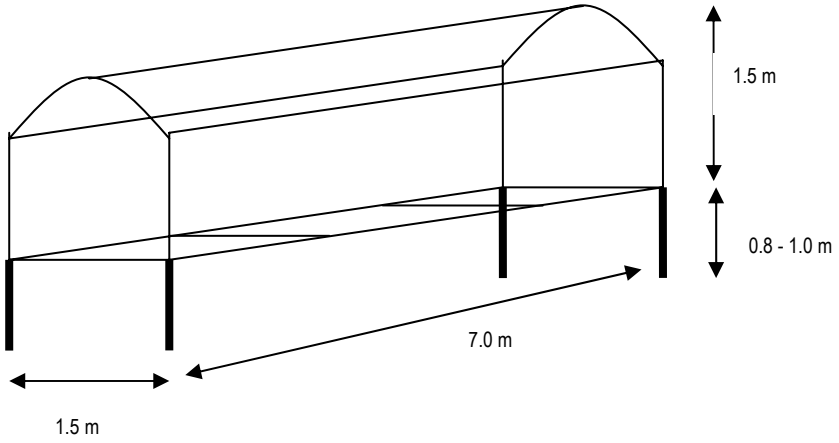


Figure3. Schematic view of a nursery.

Figure 4. Inside details of the nursery construction.

Figure 5. Outside details of the nursery construction.

2.2 Variety

The experiment used three varieties as follow:

- Open Pollinated variety (Tit Segitiga) – local variety (saved seed) dominantly used by farmers
- Open Pollinated variety (Tanjung 2) – purified and released by IVEGRI
- Hybrid variety (Astina F_1) – bred and commercially marketed by East West Seed Indonesia, (EWINDO), Purwakarta.

Figure 6. Open Pollinated variety (Tit Segitiga)

Figure 7. Hybrid variety (Astina F_1)

2.3 Seedling raising treatments

Learning from the results of previous experiment, in this experiment, only two media mixtures were tested (Table 2). Those were: (a) a mixture of manure and top soil (1:1); and (b) a mixture of burned rice-husk, manure and top soil (1:2:1). Burned rice-husk and manure were bought from outside sources, while top soil was collected from the field where the experiments were carried out.

Two types of container were used in this experiment. Those were a modular plastic tray with 128 modules per tray (approx. volume of 13 cm^3 per module) and a transparent plastic bag (approx. volume of 15 cm^3 per module (Fig. 8). The transparent plastic bags were punctured at the bottom for drainage. Some wooden-bamboo boxes were made to place seedlings in raised in transparent plastic bags.

Figure 8. Transparent plastic bags, modular plastic trays and wooden-bamboo box

Table 2. Treatments of the nursery – stage experiment.

	Variety	Raising System		
		Container	Media	
A1B1	Tit Segitiga	Plastic bag	manure+top-soil (1:1)	
A1B2	Tit Segitiga	Plastic bag	husk+manure+top-soil (1:2:1)	
A1B3	Tit Segitiga	Plastic tray	manure+top-soil (1:1)	
A1B4	Tit Segitiga	Plastic tray	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days
A1B5	Tit Segitiga	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A1B6	Tit Segitiga	Direct seeding		
A2B1	Astina	Plastic bag	manure+top-soil (1:1)	
A2B2	Astina	Plastic bag	husk+manure+top-soil (1:2:1)	
A2B3	Astina	Plastic tray	manure+top-soil (1:1)	
A2B4	Astina	Plastic tray	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days
A2B5	Astina	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A2B6	Astina	Direct seeding		
A3B1	Tanjung 2	Plastic bag	manure+top-soil (1:1)	
A3B2	Tanjung 2	Plastic bag	husk+manure+top-soil (1:2:1)	
A3B3	Tanjung 2	Plastic tray	manure+top-soil (1:1)	
A3B4	Tanjung 2	Plastic tray	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days
A3B5	Tanjung 2	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A3B6	Tanjung 2	Direct seeding		

From the nursery stage experiment, the best treatments per variety were selected for further testing in the field-stage experiment (Table 3). Only the two-best combinations from Tit Segitiga and Tanjung 2; and three-best combinations from Astina were selected as treatments in the field experiment besides the direct seeded treatments as standard or control. Those treatments were selected based on the highest number of usable seedling criterion, providing that the fresh weight of the seedlings was not too low.

Time of transplanting was set to be mainly dependent on seedling stage and not to the date. If after three to four weeks seedlings were not developed well enough, transplanting needed to be postponed. Also if transplants from one treatment were not good enough for transplanting this treatment should only be transplanted when seedlings were at the right stage. It was therefore possible that treatments were transplanted at different dates. In this experiment, however, seedlings from all selected treatments were relatively at the right stage at a same date. Hence, those seedlings from the different selected treatments were transplanted at the same date.

Table 3. Treatments of the field–stage experiment.

Code	Variety	Raising system		
		Container	Media	
A1	Tit Segitiga	Plastic bag	husk+manure+top-soil (1:2:1)	
A2	Tit Segitiga	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A3	Astina	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A4	Astina	Plastic tray	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days
A5	Astina	Plastic bag	husk+manure+top-soil (1:2:1)	
A6	Tanjung 2	Plastic bag	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times
A7	Tanjung 2	Plastic tray	manure+top-soil (1:1)	broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days
A8	Tit Segitiga	Direct sowing		
A9	Astina	Direct sowing		
A10	Tanjung 2	Direct sowing		

2.4 Cultivation

2.4.1 Intercropping

Hot pepper is commonly intercropped with shallot. Those two crops are grown on beds that are surrounded by ditches for irrigation and drainage purposes. Each plot of the experiment is occupying one-half of a bed with the size of 1.5 x 5.7 m. In common local practice, hot pepper seeds are directly planted about 7-10 days after shallot planting. In this experiment, hot pepper sowing took place at the same date as shallot planting. Hot pepper seedlings were transplanted 30 days after sowing. Table 4 shows the number of plants and planting distances used in the shallot-hot pepper intercropping system. A lay-out of the system, as adapted in this experiment, is shown in Annex 1.

Figure 6. Direct sowing

Figure 7. Seedlings transplanting

Table 4. 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	100	4	25	21	30/60

2.4.2 Cultivation practice

Adopting the local practice, shallot was planted preceding hot pepper. Hot pepper is usually directly sowed in the field after the shallot tuber seed shows some sprouts. The general information of the cultivation is shown in Table 5. Further cultural practices for both crops (weeding, fertilizing, pests and diseases controlling and harvesting) were carried out in accordance to local farmers' practices.

Table 5. General information on the cultivation.

Hot pepper sowing	:	5 September 2007
Hot pepper transplanting	:	4 October, 2007
Shallot transplanting	:	4 September, 2007
Used seeds for nursery	:	252 seeds/treatment at plastic bag container and 256 seeds/treatment at plastic tray container
Direct sowing	:	5 seeds per hole (total 500 seeds per plot/treatment)
Plant density	:	Tit Segitiga, Astina F_1 and Tanjung 2 at 12.2 plants per m^2

2.5 Observations

2.5.1 Climate

Temperature recordings were obtained from the weather station located at Tegal, about 20 km east of the experimental field. Rainfall data were gathered from Brebes Agricultural Office weather station.

2.5.2 Nutrient content

A sample from all media (1 kg per media) used in this experiment was submitted for laboratory analysis on the content of nitrogen, potassium, phosphate, calcium and pH level.

2.5.3 Light intensity

During the nursery-stage experiment, light intensity was measured with a handheld Lux-meter (LX93 from Nieuwkoop), both inside and outside the nurseries. Inside each nursery, light intensity was measured at two spots, while outside each nursery it was measured at one spot. The percentage of available light inside the nursery was calculated based on these readings.

2.5.4 Nursery observations

Seedling emergence of each treatment was observed 10 and 20 days after sowing. Percentage of normal and abnormal seedlings was calculated. At transplanting stage, some counts were carried out for the number of usable and unusable transplants and their percentages were also calculated. The number of plants with virus symptoms and infected by thrips were observed. Before transplanted, 15 usable seedlings were selected and cut those off at soil level. Moreover, some data were collected regarding the total fresh weight of 15 upper soil plant parts only; seedling height per plant from cutt off point to tip of the plant when fully stretched out; and the number of fully developed leaves per plant. After drying at 70^{o}C for 24 hours, the total weight of the 15 plants together was weighed. The percentage of dry weight was calculated as well.

2.5.5 Harvest observations

Fruits were harvested when mature, and harvesting took every two to five days 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.

2.6 Statistical information

The experiment was carried out as a factorial design 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

In September at the start of the experiment no rainfall was recorded (Fig. 8). Maximum temperature was ranging between 30 and 35°C from sowing till the start of the first harvest in December. In December the temperature was around 30°C while maximum temperature increased from 22 to 25°C. In November the wet season started and in total an amount of 580 mm was recorded during the experiment.

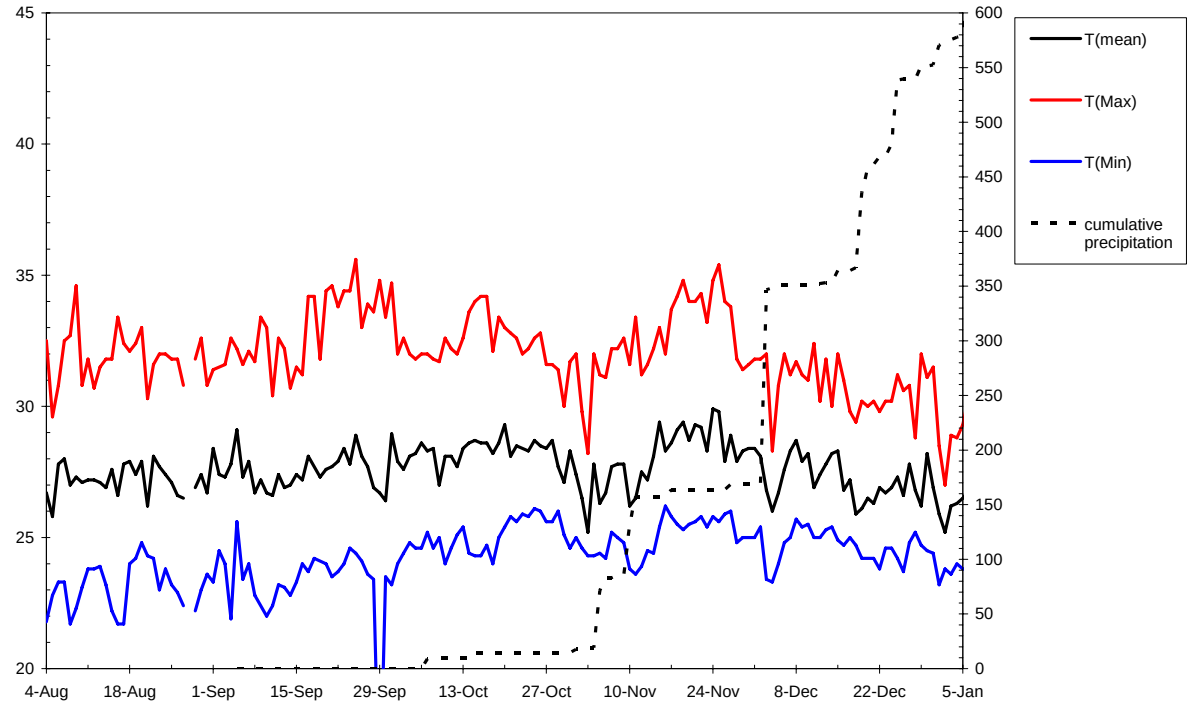


Figure 8. Rainfall and maximum and minimum temperature.

3.2 Light levels

On September 21 , the available light inside the nursery constructions was on average 73% of the light intensity recorded outdoors.

3.3 Nutrient content of media and soil

In this experiment the most used media was the combination of top soil with manure (TS+M) (Table 6). The pH of this media is alkaline with a pH-H_2O of 7.2,while 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. For standard potting soils it is recommended to add on average of 0.2 kg nitrogen per m^3 potting soil, ranging from 0.12 till 0.45 kg, with fertilizers such as potassium nitrate, calcium nitrate or ammonium nitrate (Argo, 1998). With those recommendations about 200 mg per litre is applied and when assuming that 1 litre media weighs approximately 400 gram, this amount s into 50 mg per 100 gram, which is 10% lower then the total N content measured in the used substrate in this experiment. However, not known is how much of the total N content in the used substrate is ready available nitrate and ammonium.

Table 6. 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

Table 7 indicates no significant effects of variety (Tit Segitiga, Astina and Tanjung 2) on four seedling emergence parameters, except the percentage of usable seedlings. Astina shows the highest percentage of usable seedlings and is statistically or significantly different to Tanjung 2, but not significantly different to Tit Segitiga. Astina also shows the highest plant height and is significantly different to Tanjung 2, but not significantly different to Tit Segitiga. The lowest percentage of seedlings infected by virus is indicated by Astina, even though it is not significantly different to Tanjung 2.

Table 7. Effects of variety on seedling emergence, Brebes 2007.

Variety	Percentage of normal emergence after 14 days	Percentage of totalemergence after 14 days	Percentage of normal emergence at transplanting	Percentage of total emergence at transplanting	Percentage of usable seedlings
Tit Segitiga	40.0	47.4	55.9	67.8	42.6
Astina	43.9	50.0	61.1	70.2	51.9
Tanjung 2	33.3	39.7	49.9	66.7	35.8
Mean	*39.1*	*45.7*	*55.6*	*68.3*	*43.4*
p=	0.09	0.20	0.10	0.70	0.02
lsd	9.7	11.7	7.7	8.2	11.0

Table 8. Effects of variety on seedling growth, Brebes 2007.

Variety	Fresh weight (g)	Plant height (cm)	Dry weight (g)	Number of leaves per plant	Seedlings with thrips infection (%)	Seedlings with virus symptoms (%)
Tit Segitiga	5.9	7.2	0.8	6.5	2.3	2.9
Astina	6.1	7.8	0.7	6.7	2.4	1.3
Tanjung 2	5.4	6.3	0.8	6.8	1.9	2.2
Mean	*5.8*	*7.1*	*0.8*	*6.7*	*2.2*	*2.1*
p=	0.3	<0.001	0.3	0.2	0.4	0.02
lsd	0.9	0.7	0.2	0.3	0.7	1.1

Seedling raising systems B2 and B5 always show statistically better effect on emergence as compared to direct sowing. Further observation indicates that there is no significant difference among B1, B2, B4 and B5 seedling raising systems in affecting emergence. However, compared to B3, those four seedling raising systems show better effect on emergence. Some findings indicated from testing the effects of seedling raising systems on emergence are (a) better suitability of plastic bag container as compared to plastic tray container; (b) manure + top-soil media is dominantly better than husk + manure + top-soil media; and (c) some seedling raising systems show better performance than direct planting.

Table 9. Effects of seedling raising systems on emergence, Brebes 2007.

	Seedling raising systems	Normal seedlings after 14 days (%)	Total emergence after 14 days (%)	Normal seedlings at transplanting (%)	Total emergence at transplanting (%)	Usable seedlings (%)
B1	Plastic bag; manure + top soil	42.5	49.3	62.6	74.3	48.9
B2	Plastic bag; husk + manure +top soil	57.1	69.3	69.9	83.2	55.2
B3	Plastic tray; manure + top soil	6.8	9.8	18.8	50.1	14.8
B4	Plastic tray; manure + top soil (broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days).			58.5	65.2	50.5
B5	Plastic bag; manure + top soil (broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times).			71.0	78.3	59.4
B6	Direct sowing/planting	50.0	54.4	53.0	58.5	31.6
Mean		*39.1*	*45.7*	*55.6*	*68.3*	*43.4*
p=		<0.001	<0.001	<0.001	<0.001	<0.001
lsd		11.2	13.2	10.8	11.6	15.6

In terms of fresh weight, B1 and B2 systems perform better than B3, B4 and B5, but they are not significantly different to direct planting. Direct planting is even showing statistically better performance than B3, B4 and B5 seedling raising systems. There is no significant difference in plant height between B1, B2, B5 seedling raising systems and direct planting. However, the B1, B2, B5 seedling raising systems and direct planting produce higher plant height than B3 and B4 systems. Meanwhile, there is no significant difference in terms of dry weight among B1, B4, B5 and B6 systems, however B6 performs better than B2 and B3 systems. Similar indication is also happened for the number of leaves per plant. All seedling raising systems (B1-B5) are significantly showing lower thrips infection as compared to direct planting. Except B5, the other seedling raising systems (B1-B4) indicate statistically significant lower virus infection than direct planting.

Table 10. Effects of seedling raising systems on seedling growth, Brebes 2007.

	Seedling raising systems	Fresh weight (g)	Plant height (cm)	Dry weight (g)	Number of leaves per plant	Seedlings with thrips infection (%)	Seedlings with virus symptoms (%)
B1	Plastic bag; manure + top soil	7.4	8.2	0.7	7.3	0.1	1.8
B2	Plastic bag; husk + manure +top soil	7.0	8.3	0.5	7.3	0.0	1.4
B3	Plastic tray; manure + top soil	2.3	4.6	0.6	4.8	0.0	1.1
B4	Plastic tray; manure + top soil (broadcasted first in a nursery bed; transplanted into plastic tray after 12-14 days).	4.6	6.5	0.9	6.2	0.3	0.9
B5	Plastic bag; manure + top soil (broadcasted first in a nursery bed; transplanted into transparent plastic bag after 12-14 days; drenched by Actara 2 times).	5.6	7.4	0.8	6.9	0.3	3.9
B6	Direct sowing/planting	8.0	7.8	1.0	7.7	12.3	3.6
Mean		*5.8*	*7.1*	*0.8*	*6.7*	*2.2*	*2.1*
p=		<0.001	<0.001	0.02	<0.001	<0.001	<0.001
lsd		1.3	1.0	0.3	0.5	1.0	1.5

The effect of variety x seedling raising systems interaction is only statistically significant for the percentage of total seedling at transplanting. Comparing to the direct planting, the interactions that are significantly different are Tit Segitiga x B2; Tanjung 2 x B1; Tanjung 2 x B2; and Tanjung 2 x B5 interaction.

Table 11. Effects of variety x seedling raising system interaction on emergence, Brebes 2007.

Variety	Seedling raising system	Normal seedlings after 14 days (%)	Total emergence after 14 days (%)	Normal seedlings at transplanting (%)	Total emergence at transplanting (%)	Usable seedlings (%)	Variety
Tit Segitiga	B1	36.5	42.5	60.1	71.0	46.4	Tit Segitiga
	B2	62.3	78.3	74.7	88.1	59.8	
	B3	8.5	11.5	37.5	66.5	29.6	
	B4			45.3	50.8	38.5	
	B5			63.6	71.7	48.9	
	B6	52.7	57.3	54.1	58.9	32.2	
Astina	B1	55.3	61.1	71.0	79.4	61.9	Astina
	B2	63.8	75.8	73.7	83.1	63.8	
	B3	0.9	2.5	0.0	21.5	0.0	
	B4			78.7	83.9	72.5	
	B5			81.5	85.3	75.3	
	B6	55.7	60.5	61.6	68.4	37.8	
Tanjung 2	B1	35.7	44.2	56.6	72.6	38.4	Tanjung 2
	B2	45.1	53.7	61.2	78.3	42.1	
	B3	10.9	15.5	18.8	62.2	15.0	
	B4			51.4	61.1	40.4	
	B5			67.9	77.9	54.1	
	B6	41.4	45.5	43.4	48.2	24.7	
Mean		*39.1*	*45.7*	*55.6*	*68.3*	*43.4*	*Mean*
	p=	0.2	0.2	0.9	<0.001	0.1	
	lsd				20.09		

The effect of variety x seedling raising systems interaction is only statistically significant for the number of leaves per plant. In comparison to direct planting, the variety x B1, B2 and B5 seedling raising systems interactions do not show any significant difference. In the mean time, the variety x B3 and B4 seedling raising systems interactions are consistently showing worse performance.

Table 12. Effects of variety x seedling raising system interaction on seedling growth, Brebes 2007.

Variety	Seedling raising system	Fresh weight (g)	Plant height (cm)	Dry weight (g)	Number of leaves per plant	Seedlings withthrips infection (%)	Seedlings with virus symptoms (%)
Tit Segitiga	B1	7.1	7.7	0.8	6.7	0.3	2.4
	B2	6.5	8.0	0.7	6.8	0.00	1.6
	B3	3.5	5.6	0.5	5.4	0.0	2.0
	B4	4.6	6.7	0.6	6.0	0.0	1.3
	B5	6.1	8.1	1.2	6.7	0.8	5.8
	B6	7.8	7.4	1.1	7.7	12.7	4.3
Astina	B1	8.5	9.7	0.5	7.6	0.0	0.8
	B2	7.6	9.4	0.45	7.4	0.0	0.5
	B3	1.2	4.2	0.6	4.1	0.1	0.1
	B4	5.5	7.7	0.9	6.6	0.9	0.0
	B5	5.8	7.9	0.6	7.3	0.0	2.4
	B6	8.2	8.1	0.9	7.6	13.1	3.9
Tanjung 2	B1	6.6	7.1	1.0	7.6	0.0	2.3
	B2	6.8	7.4	0.4	7.6	0.0	2.1
	B3	2.1	4.0	0.7	4.9	0.0	1.2
	B4	3.8	5.3	1.1	5.8	0.0	1.4
	B5	5.0	6.2	0.6	6.9	0.1	3.6
	B6	8.1	7.9	1.0	8.0	11.1	2.7
Mean		*5.8*	*7.1*	*0.8*	*6.69*	*2.18*	*2.13*
	p=	0.6	0.2	0.3	0.008	0.8	
	lsd			0.5	0.8		

3.5 Harvest results

A fairly late planting date has induced a heavy attack of pests and diseases. Routine and alternate pesticide spraying and non-chemical control (traps) were not able to reduce the severity of pest and disease damage. Because of poor crop condition, the experiment was terminated after three harvests. Inconclusive trends as shown in Table 13 and 14 suggest that (a) Tit Segitiga is generally performing better than Astina and Tanjung 2; and (b) seedling raising systems are not able to show better performance as compared to direct planting.

Table 13. Total and marketable prodcution per plant and total fruit number per plant based on 3 harvests.

	Treatment			Total production per plant (g)	Marketable production per plant (g)	Total fruit number per plant
	Variety	Container	Media			
A1:	Tit Segitiga	Plastic bag	Husk + manure + top-soil	0.22	0.19	0.05
A2:	Tit Segitiga	Plastic bag	Manure + top-soil; *broadcasted* + Actara	0.24	0.18	0.05
A8:	Tit Segitiga	Direct planting		0.25	0.21	0.05
Mean - Tit Segitiga				*0.24*	*0.19*	*0.05*
A3:	Astina	Plastic bag	Manure + top-soil; *broadcast* + Actara	0.19	0.14	0.04
A4:	Astina	Plastic tray	Manure + top-soil; *broadcasted*	0.19	0.13	0.04
A5:	Astina	Plastic bag	Husk + manure + top-soil	0.20	0.19	0.04
A9:	Astina	Direct planting		0.22	0.17	0.04
Mean - Astina				*0.20*	*0.158*	*0.04*
A6:	Tanjung 2	Plastic bag	Manure + top-soil; *broadcast* + Actara	0.15	0.11	0.04
A7:	Tanjung 2	Plastic bag	Husk + manure + top-soil	0.24	0.17	0.05
A10:	Tanjung 2	Direct planting		0.23	0.17	0.06
Mean - Tanjung 2				*0.21*	*0.15*	*0.05*

Table 14. Share of marketable production in total prodution, average fruit weigth of total and marketable prodcution based on 3 harvests.

	Treatment			Marketable fruit (%)	Average fruit weight (gr	Average marketable fruit weight (g)
	Variety	Container	Media			
A1:	Tit Segitiga	Plastic bag	Husk + manure + top-soil	59.9	3.2	3.2
A2:	Tit Segitiga	Plastic bag	Manure + top-soil; *broadcasted* + Actara	48.6	2.8	3.2
A7:	Tit Segitiga	Direct planting		65.8	4.8	4.6
Mean - Tit Segitiga				*58.1*	*3.6*	*3.6*
A3:	Astina	Plastic bag	Manure + top-soil; *broadcast* + Actara	41.7	2.8	2.9
A4:	Astina	Plastic tray	Manure + top-soil; *broadcasted*	41.1	3.5	3.8
A9:	Astina	Plastic bag	Husk + manure + top-soil	64.8	3.5	3.7
A8:	Astina	Direct planting		59.7	4.2	4.1
Mean - Astina				*51.8*	*3.5*	*3.6*
A5:	Tanjung 2	Plastic bag	Manure + top-soil; *broadcast* + Actara	38.6	2.7	2.0
A6:	Tanjung 2	Plastic bag	Husk + manure + top-soil	37.7	3.3	3.2
A10:	Tanjung 2	Direct planting		50.9	3.3	3.3
Mean - Tanjung 2				*42.4*	*3.1*	*2.9*

4 Conclusions

4.1 Nursery Experiment

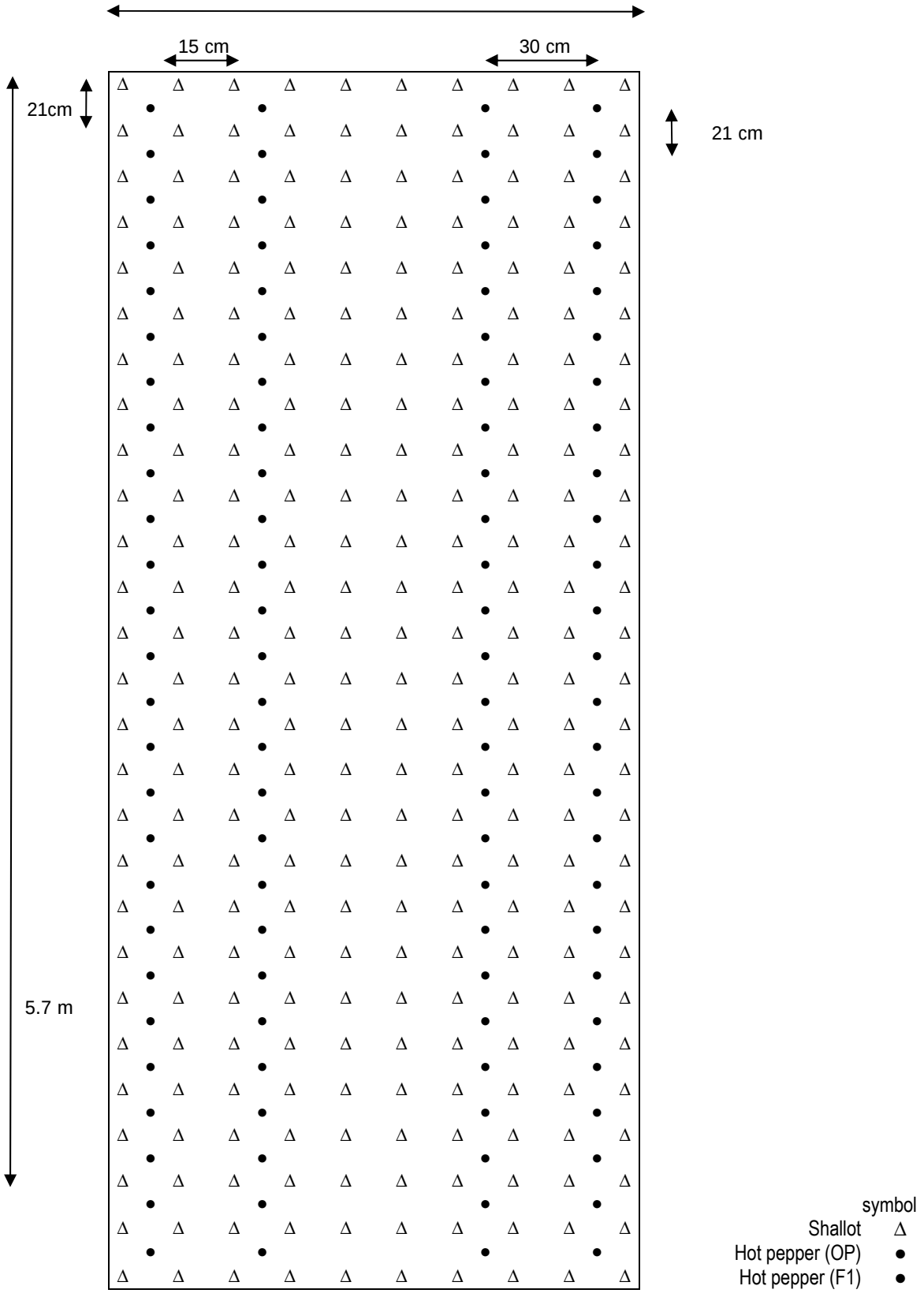
- Astina is performing better than Tanjung 2 in terms of the percentage of usable seedling and plant height, but it is not significantly different to Tit Segitiga. Seedlings from Astina variety also indicate the lowest percentage of virus incidence.
- Plastic bag container is more suitable than plastic tray for raising seedlings. Seedlings raised in manure + top-soil media are growing better than those raised in husk + manure + top-soil media. Some seedling raising systems, such as B2 and B5, show better performance than direct sowing.
- All seedling raising systems (B1-B5) are significantly showing lower thrips infection as compared to direct sowing. Except B5, the other seedling raising systems (B1-B4) indicate statistically significant lower virus infection than direct sowing.
- Tit Segitiga – B2 (plastic bag and husk + manure + top-soil) interaction; Tanjung 2 – B1 (plastic bag and manure + top-soil) interaction; B2; and B5 (plastic bag and manure + top-soil _ broadcasted + Actara) are statistically having better percentage of total seedling at transplanting as compared to direct sowing.

4.2 Field Experiment

- In general, Tit Segitiga is performing better than Astina and Tanjung 2
- The seedling raising systems are not able to show better performance as compared to direct sowing.

The nursery experiment has resulted in the best seedling raising technique and improved planting material quality. However, in the field experiment, those nursery improvements have not yet been able to show their superiority as compared to direct sowing system.

Annex I. Plant arrangement per plot.



Plant arrangement per plot (100 plants = 11.7 pl/m2)

Annex II. Layout of nursery treatments.

See for explanation of the treatment codes table 2.

Trays for experiment 2 were arranged as follow: ← North

Replication 3: Nursery III

39 A1B3	40 A3B4 L5	41 A3B5	42 A3B3	43 A3B2	44 A2B3 L6	45 A1B5	
31 A2B2	32 A2B5	33 A2B4	34 A1B4	35 A3B1	36 A1B2	37 A2B1	38 A1B1

III

Replication 2: Nursery II

24 A2B4	25 A2B2 L3	26 A3B4	27 A1B5	28 A3B3	29 A3B2 L4	30 A1B2	
16 A2B5	17 A3B1	18 A2B3	19 A1B3	20 A1B1	21 A2B1	22 A1B4	23 A3B5

II

Replication 1: Nursery I

9 A2B5	10 A2B4 L1	11 A3B1	12 A3B5	13 A1B2	14 A3B4 L2	15 A2B3	
1 A3B2	2 A1B3	3 A1B1	4 A1B5	5 A3B3	6 A1B4	7 A2B2	8 A2B1

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 experiment lay-out: (see for treatment codes table 3)