

HORTIN II Co Innovation Programme

Towards cost effective, high quality value chains

Improvement of shallot supply chains;
Research 2009

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Lubbert van den Brink
Rofik Sinung Basuki

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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.

In the Netherlands the Agricultural Economics Research Institute (**AEI**), Den Haag, the Agrotechnology and Food Sciences Group (**ASFG**), Wageningen, Applied Plant Research (**APR**), Lelystad, and WUR-Greenhouse Horticulture (**WUR-GH**), Bleiswijk, all partners in Wageningen University and Research centre, are involved in the programme.

Addresses:

Indonesian Centre for Horticultural Research and Development (ICHORD)

Address : Jl. Ragunan 29A, Pasarmingu, Jakarta 12520, Indonesia
Tel. : +62 21 7890990
Fax : +62 21 7805135
E-mail : pushor@rad.net.id or pushorti@yahoo.com
Internet : www.litbanghortikultura.go.id

Indonesian Vegetable Research Institute (IVEGRI)

Address : Jl. Tangkuban Perahu 517, Lembang-Bandung 40391, West Java, Indonesia
Tel. : +62 22 2786 245
Fax : +62 22 2786 416
E-mail : dir_ivegri@balitsa.org or balitsa@balitsa.org
Internet : www.balitsa.org

Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD)

Address : Kampus Penelitian Pertanian, Cimanggu, Bogor 16114, West Java, Indonesia
Tel. : + 62 251 321762
Fax : + 62 251 350920
E-mail : bb_pascapanen@litbang.deptan.go.id or bb_pascapanen@yahoo.com
Internet : www.pascapanen.litbang.deptan.go.id

Agricultural Economics Research Institute (AEI)

Address : Alexanderveld 5, Den Haag, The Netherlands
PO Box 29703, 2502 LS Den Haag, The Netherlands
Tel. : +31 70 335 83 30
Fax : +31 70 361 56 24
E-mail : informatie.lei@wur.nl
Internet : www.lei.wur.nl

Agrotechnology and Food Sciences Group (ASFG)

Address : Building 118, Bornsesteeg 59, Wageningen, The Netherlands
PO Box 17, 6700 AA, Wageningen, The Netherlands
Tel. : +31 317 480 084
Fax : +31 317 483 011
E-mail : info.asfg@wur.nl
Internet : www.asfg.wur.nl

Applied Plant Research (APR)

AGV Research Unit

Address : Edelhertweg 1, Lelystad, The Netherlands
PO Box 430, 8200 AK Lelystad, The Netherlands
Tel. : +31 320 29 11 11
Fax : +31 320 23 04 79
E-mail : infoagv.ppo@wur.nl
Internet : www.ppo.wur.nl

WUR-Greenhouse Horticulture (WUR-GH)

Address : Violierenweg 1, Bleiswijk, The Netherlands
: PO Box 20, 2665 ZG Bleiswijk, The Netherlands
Tel. : +31 317 48 56 06
Fax : +31 10 52 25 193
E-mail : glastuinbouw@wur.nl
Internet : www.glastuinbouw.wur.nl

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Programme Team

	Indonesia	The Netherlands
Programme management	Dr. Yusdar Hilman, Director ICHORD Telephone +62 21 7890990 Fax +62 21 7805135 E-mail: YHILMAN@INDO.NET.ID	Dr. Arij Everaarts, APR, General management Telephone +31 320 291 671 Fax +31 320 230 479 E-mail: ARIJ.EVERAARTS@WUR.NL Mrs. Myrtille Danse, AEI, Supply Chain Management
Sweet pepper pilot project	Dr. Nikardi Gunadi, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: NGUNADI@BDG.CENTRIN.NET.ID	Mrs. Marieke van der Staaij, Ruud Maaswinkel, WUR-Greenhouse Horticulture Telephone +31 317 485 537 Fax +31 105 225 193 E-mail: MARIEKE.VANDERSTAAIJ@WUR.NL RUUD.MAASWINKEL@WUR.NL
Shallot pilot project	Dr. Rofik Sinung Basuki, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: ROFIK@HOTMAIL.COM	Lubbert van den Brink, APR Telephone +31 320 291 353 Fax +31 320 230 479 E-mail: LUBBERT.VANDENBRINK@WUR.NL
Hot pepper pilot project	Dr. Witono Adiyoga, IVEGRI Telephone +62 22 2786 245 Fax +62 22 2786 416 E-mail: VICIANTI@YAHOO.CO.ID	Herman de Putter, APR Telephone +31 320 291 614 Fax: +31 320 230 479 E-mail: HERMAN.DEPUTTER@WUR.NL
Supply chain management	Dr. Witono Adiyoga, Dr. Nikardi Gunadi, Dr. Rofik Sinung Basuki, IVEGRI	Mrs. Myrtille Danse, Mrs. Rolien Wiersinga, Mrs. Olga van der Valk, AEI Telephone +31 70 3358 341 Fax +31 70 3615 624 E-mail: MYRTILLE.DANSE@WUR.NL ROLIEN.WIERSINGA@WUR.NL OLGA.VANDERVALK@WUR.NL
Quantitative Economic Analysis	Dr. Witono Adiyoga, IVEGRI	Marcel van der Voort, APR Telephone +31 320 291 312 Fax +31 320 230 479 E-mail: MARCEL.VANDERVOORT@WUR.NL
Fruit supply chains	Dr. Sri Yuliani, ICAPRD Telephone +62 251 321762 Fax +62 251 350920 E-mail: S.YULIANI@GMAIL.COM	Dr. Jeroen Knol, ASFG Telephone +31 317 480177 Fax +31 317 483011 E-mail: JEROEN.KNOL@WUR.NL

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Executive summary

In 2009 in Brebes research was done on different aspects of growing TSS: seed efficiency, optimal plant density, optimal nitrogen fertilization, early transplanting of TSS in the dry season, effect of seedling age and nitrogen fertilization in the nursery on production of TSS and the effect of insect nets.

The following conclusions could be drawn from the experiments done in 2009:

- Storability of the Hybrid is much better than storability of Tuk tuk. The only commercially available TSS-variety, Tuk tuk, has shown too many rotten bulbs. Introduction of the new Hybrid with a better storability is giving better perspectives for TSS.
- In 2009 transplanting TSS at the start of the dry season was giving relatively low yields. If transplanting was postponed to second half of May yield was increased (with ca 100% or more). These poor results of early transplanting are probably caused also by the rainy wetter at the start of dry season. But also in general soil structure at the start of dry season will always be less favourable for obtaining high yields.
- In the plant density experiment of 2009 the optimal plant density of Tuktuk was much higher than the optimal plant density of the Hybrid. The yield of Tuktuk grown at 75 plants /m² was very low. Tuktuk planted at 125 plants per m² was giving more or less the same yield as Bima and Ilokos. Optimal plant density of Tuktuk was ca. 150 – 175 plants per m². The hybrid was producing rather well with 75 plants per m². With increasing plant density the yield of the Hybrid is increasing also, but less fast as with Tuktuk. It will depend on the increase of nursery costs and costs of transplanting more seedlings if this increase in yield of the Hybrid is profitable for the farmer. With expensive nurseries, for example the nursery used in 2008 with trays filled with mixtures with stable manure and shelters, the optimal plant density of the Hybrid in the experiment of 2009 was ca. 75 plants per m².
- In the nitrogen fertilization experiment of 2009 the yield of Tuktuk was not giving a positive reaction on a higher nitrogen fertilization. The yield of the hybrid was increasing with higher levels of nitrogen. Yield of the Hybrid at 300 kg N/ha was significantly higher than yield at 120 kg N/ha (29%). The costs of nitrogen are relative low. So it is profitable for a farmer to give 300 kg N/ha in stead of 120 kg N/ha. Yield of the Hybrid grown with 300 kg N/ha was 128% higher than the mean yield of Bima and Ilokos.
- With respect to storability in reaction on increasing nitrogen fertilization, measured three months after harvest, there was in 2009 a clear difference between Tuktuk and the Hybrid. With Tuktuk the percentage of healthy bulbs was going down very fast with increasing nitrogen levels, while with the Hybrid the percentage of healthy bulbs was still at a high level also for the bulbs produced at the highest nitrogen level.
- In the all experiments transplanted in the second half of May the Hybrid and Tuktuk were much more productive than the seed bulb variety Bima: the Hybrid was yielding 52% more than Bima in the plant density experiment (grown at 150 plants/m²) and 74% in the fertilization experiment (grown with 180 kg N/ha); Tuktuk was yielding 17% more than Bima in the plant density experiment (grown at 150 plants/m²) and 31% in the fertilization experiment (grown with 180 kg N/ha);
- In all experiments the Hybrid was giving a higher yield than Tuktuk and the grading was much more in accordance with demands on the local market (more smaller bulbs). The Hybrid was also more resistant to antracnose than Tuktuk.
- Compared to the standard methods for sowing nurseries untill now in Brebes seed efficiency could be improved in the first place by closing the furrows with soil in stead of burned rice husks. Another important improvement is sowing at 1 cm in stead of 0,5 cm. Another aspect was: sufficient watering.
- Seed efficiency on beds was always lower than seed efficiency in trays. The highest seed efficiency (2 weeks after sowing) on beds reached in 2009 in nurseries with closing the furrow with soil and sowing at 1 – 1,5 cm: 54%, in trays 81%. The lowest seed efficiency reached on these nurseries was 25% both for trays and for beds. The difference is probably caused by the poorer soil conditions on beds.
- There are big differences between nurseries in loss of seedlings after emergence. Sometimes losses are only 5 -10%, but most of the time losses are bigger, up to 50%. These differences could not be explained.
- Treating the seed with Ridomil was damaging the seed and was giving a lower seed efficiency. In one nursery there was a tendency that loss of seedlings was reduced by Ridomil.
- Treating the seed with Tracer was not giving an improvement of seed efficiency.

-
- Drenching with Previcure had no positive effect on seed efficiency.
 - It could not be proved that there was a difference in survival of seedlings after transplanting and in production between transplanting 6-weeks old seedlings or 5-weeks old seedlings.
 - It could not be proved that there was a difference in survival of seedlings after transplanting and in production between giving 0 kg N/ha and 75 kg N/ha in the nursery.
 - Production of TSS Tuktuk grown under an insect net (without spraying insecticides) was not different from TSS Tuktuk without an insect net. However in 2009 Spodoptera was only present at a low level.

1 Introduction

In 2009 research on production of True Seed Shallots in Brebes is continued. At the end of 2008 it was decided to focus research on the following topics:

- Early sowing and transplanting of TSS. The aim was to investigate if it is possible to transplant TSS at the same time as the first planting of seed bulbs after paddy (ca. 15 April). Bulbs harvested from such a crop could be used as seed bulbs for a second crop. This second crop could be compared with a crop grown from traditional seed bulbs. In this research it can be investigated if seed bulbs harvested from TSS are giving a higher yield than traditional seed bulbs. On three moments a nursery was sown (11 March, 25 March and 15 April). On two locations an experiment with planting seed bulbs from TSS was done, in Brebes by IVEGRI/APR and in Purwakarta by EWSI.
- Optimal nitrogen fertilization of TSS. The aim was to find the optimal N-fertilization of Tuktuk and the Hybrid. In 2008 there was a lot of discussion about the level of nitrogen fertilization. There were indications that high nitrogen levels are giving much rot in the harvested bulbs. In 2009 a nitrogen fertilization experiment has been done with the varieties Tuktuk and the Hybrid. The varieties were tested at 120 – 180 – 240 and 300 kg N/ha. Samples of the harvested bulbs were stored by EWSI during six months to investigate the losses caused by rot, etc.
- Optimal plant density. The plant density is a very important factor for productivity of TSS and also for production costs. A lower plant density means a smaller nursery. Between varieties there are differences in number of bulbs produced per transplant: Tuktuk is producing normally only one bulb per transplant while the new Hybrid is producing more than one bulb per transplant. In 2009 an experiment was done to investigate the optimal plant density of Tuktuk and the Hybrid in relation to yield and costs (nursery and transplanting costs). The plant densities were: 75- 125- 175- 225 plants per m²
- Improving seed efficiency. In 2007 and 2008 seed efficiency was very variable. It could range from 15% till 80%. In 2009 some experiments were done in which the influence of sowing depth, ways of covering the seed, intensity of watering, seed treatment with fungicides, seed treatment with insecticides and drenching with fungicides was investigated.
- Optimal nitrogen fertilization of nursery and age of seedlings. At the start of the project it was assumed that transplanting could be done with six weeks old seedlings. However this was based on experiments done in the highland. During the project it appeared that five weeks old seedlings were giving also good results. So the optimal age of the seedling at transplanting time was questionable. Another question was: are seedlings grown under poor conditions giving a better TSS crop than seedlings grown under rich conditions. In 2009 a nursery experiment was done with two levels of N-fertilization (0 and 75 kg N/ha) and the seedlings were transplanted at two ages (5 and 6 weeks).
- TSS under insect nets. Information was available that TSS was grown also under insect nets. This would give protection against insects (Spodoptera, etc). By using insect nets the use of insecticides could be reduced. In this way shallots could be harvested with less residues. In 2009 a small experiment was done with insect nets.
- Storage experiment. Bulbs harvested in the TSS experiments of 2008 were stored in Brebes and the quality of these bulbs was measured at different moments.

It was decided to stop research on direct sowing. The problems with weed control and seed establishment were too big to expect good results with direct sowing.

At the end of 2009 results were presented to farmers and agronomists.

The seed was obtained from EWSI. Seed was used from the varieties Tuktuk and the Hybrid. EWSI has also treated some seed of Tuktuk with pesticides: 200 gram treated with the fungicide Ridomil and 200 gram treated with Tracer. The 1000-kernel weight and the germination of the seed was tested. The results are given in table 1.

Table 1. Thousand kernel weight and the germination of the seed used in 2009.

	1000-kernel weight	% Germination (400 seeds tested)
Tuktuk untreated	3.47	90
Hybrid untreated	3.83	69
Tuktuk treated with Ridomil	*	36
Tuktuk treated with Tracer	*	71

*: not measured



Picture 1. Overview of the activities in the field on 29 april 2009: transplanting of seedling in the early sowing experiment, sowing of the seed efficiency experiment and preparation of the beds for the fertilization experiment..

2 Storage experiment with bulbs harvested from TSS in 2008

2.1 Materials and methods

Samples of Tuktuk, the new Hybrid and Tanduyung harvested in transplanting experiment 1 of 2008 were stored under farmers conditions in Arifin's house. The bulbs of Tuktuk were harvested 12 august 2008, the bulbs of the Hybrid on August 2008. The bulbs of the control (Tanduyung) were harvested 30 July 2008. The samples were stored in a barn on a ceiling with natural ventilation. Sometimes a fire was made in the barn to dry the shallots. On 1 January and 1 April 2009 the bulbs were split in three groups: healthy, rotten and sprouted.

2.2 Results and discussion

In table 2 the results are given. The results are in accordance with the impression that compared to Tuktuk the new Hybrid is an improvement in storability. Especially at the beginning of April 2009 the percentage of healthy bulbs was higher with the Hybrid than with Tuktuk or with Tanduyung. The number of stored bulbs was small. This means these results are only giving an indication.

Table 2. Number of healthy, rotten and sprouted bulbs on 1 January and 1 April.

	Number of healthy bulbs	Number of rotten bulbs	Number of sprouted bulbs	% healthy bulbs
1 January				
Tuktuk	130	45	6	72
Hybrid	172	47	0	79
Tanduyung	249	56	0	82
1 April				
Tuktuk	21	216	6	7
Hybrid	73	142	3	33
Tanduyung	16	202	0	9

3 Early sowing and transplanting experiment

The aim of the early sowing and transplanting experiment was to investigate if it is possible to transplant TSS at the beginning of the dry season (ca. 15 April) and to compare the yield of TSS transplanted at different moments (15 April and 29 April in this experiment and 20 May and 27 May in respectively the plant density experiment and the fertilization experiment). Also the seed-bulb variety Bima was included as a reference to investigate if TSS is giving a higher yield than traditional seed bulb crops.

It was also investigated if the harvested bulbs of TSS could be used as seed bulbs for a second shallot crop. An experiment with planting TSS seed bulbs was done in Brebes and also by EWSI in Purwakarta.

3.1 Materials and methods

Two nurseries were sown in trays and on a seedbed: one 11 March, one 25 March. Per tray 1 gram of seed of Tuktuk (= 288 seeds; 259 viable seeds) or 1.4 gram of seed of the Hybrid (= 366 seeds; 253 viable seeds) was sown. The normal procedure for the nursery was followed: the trays were filled with a nursery mixture, consisting of home garden soil, sandy soil and stable manure (volume= 1:1:1). SP 36 and carbofuran were spread over the surface (50 grams of each per m²). Watering was done the day before sowing. The seed was sown in 0,5 cm deep furrows. The furrow was closed with rice husks. A blue plastic sheet was put on the trays for 5 days. After 5 days a shelter was put over the nursery and it was removed one week before transplanting. Two times per day water was given with a bruze.



Picture 2. The nurseries of the early sowing experiment and the beds with the transplanted plots, transplanting date 15 April 2009

The preparation of the seedbed was as follows: the top-layer of the soil was mixed up with stable manure (125 kg per bed of 16,5 m²). Before sowing 5 grams Carbufuran, 50 grams KCl en 50 grams SP36 was mixed per m². Seed of Tuktuk was sown in rows (15 cm from each other); per row 0,5 gram; sowing depth 0.5 cm and the furrow was closed with rice husks. The Hybrid was not sown on beds. A blue plastic sheet was put on the bed for 5 days. After 5 days a shelter was put over the nursery and it was removed one week before transplanting. Two times per day water was given with a bruze. Spraying of the nursery (trays and beds) was done against diseases (Score and Amistar Top).

On 13 April the seedlings of the nursery sown 11 March were transplanted. Tuktuk was transplanted on 3 plots and the Hybrid on 1 plot. The fertilization was as follows: before transplanting 111 kg P2O5 was given as SP36. Two weeks after transplanting 75 kg N/ha and 75 kg K/ha (KCl) was given. Half of the N was given as Urea and the other half as ZA. This was repeated two times: at four and at six weeks after transplanting. This means in total 225 kg N/ha and 225 KCl.

In the production field several times spraying has been done against diseases and pest (Score and Amistar Top).

3.2 Results and discussion

In table 3 the percentage of emergence of the nursery sown 11 March is given. Also the percentage of antracnose observed 4 days before transplanting is given. The level of emergence of Tuktuk in the trays was on a medium level. This level was lower with the Hybrid, but the germination ability in the germination test was already low (see table 1). In this nursery Tuktuk was attacked more by antracnose than the Hybrid. In the trays sown with 288 seeds of Tuktuk the attack of antracnose was more severe than in the trays sown with 144 seeds. So the attack of antracnose was depending on seedling density. The difference was rather clear: 15 trays sown with 288 seeds and 5 trays with 144 seeds were observed. The loss of seedlings during the third and fourth week after sowing is rather small.

Table 3. Nursery sown 11 March; percentage of emergence and percentage of antracnose

Date of sowing, sowing material, percentage of emergence and percentage of antracnose	% emerged plants				% attack by antracnose
	% of sown		% of viable		
	after 2 wk	after 4 wk	after 2 wk	after 4 wk	
Tuktuk 288 seeds/tray	48	41	54	45	22.5
Tuktuk 144 seeds/tray	54	53	60	59	7.5
Hybrid 366 seeds/tray	32	30	46	43	4
Hybrid 183 seeds/tray	33	29	47	42	5

In table 4 the percentage of emergence of the nursery sown on 25 March is given. Emergence was lower than emergence in the nursery sown on 11 March. In the nursery sown on 25 March no attack by antracnose was visible. The loss of seedlings during the third and fourth week after sowing was rather small.

Table 4. Nursery sown 25 March; percentage of emergence

	% emerged plants			
	% of sown		% of viable	
	after 2 wk	after 4 wk	after 2 wk	after 4 wk
Tuktuk 288 seeds/tray	33	32	37	35
Tuktuk 144 seeds/tray	30	28	33	31
Hybrid 366 seeds/tray	15	13	22	19
Hybrid 183 seeds/tray	18	16	26	24

The emergence of Tuktuk on beds was lower than on trays. The nursery sown with Tuktuk on 11 March was giving an emergence of 35% after 2 weeks and 21% after 4 weeks. The emergence sown with Tuktuk on 25 March was extremely low: 7% after 2 weeks and 1% after 4 weeks.



Picture 3. Early sowing and transplanting experiment: transplanted seedlings; transplanting date 15 April 2009.

Table 5 is giving the results of the observations of survival and diseases in the transplanted production field. Survival of seedlings was rather good. Antracnose was occurring, especially in Bima.

Table 5. Survival and attack of antracnose in transplanted field; early sowing experiment 2009

	Transplanted 13 April			Transplanted 29 April		
	% sur- vival	% of leaf attacked by antracnose		% sur- vival	% of leaf attacked by antracnose	
		29-apr	20 may		3 june	13 May
	Bima curut-store 33,3 bulbs/m2	100	37	47	100	0
Tuktuk 150 pl/m2	76	10	27	93	0	15
Hybrid 150 pl/m2 (1 rep)	82	2	0	99	0	20

In table 6 the harvest results of the experiment are given. Tuktuk transplanted 13 April was giving a very low yield: ca. 50% lower than Bima. Tuktuk transplanted 29 April was slightly better but the yield was more or less on the same level as the yield of Bima. The Hybrid was giving a higher yield than Bima, respectively 30% and 50% higher than Bima. The yield level was much lower than in 2008. This was caused by diseases, especially on Tuktuk. At the start of the dry season in 2009 there was more rain than normal.

Compared to 2008 TSS was harvested much later than Bima: 4 till 5 weeks later in stead of 2 till 3 weeks. The difference in grading between Tuktuk and the Hybrid was the same as in 2008: The Hybrid was producing more smaller bulbs than Tuktuk.

Table 6. Early sowing experiment 2009; transplanted 13 and 29 April. Earliness, yield and grading.

	Earliness days until harvest	Shallots with leaves		Shallots without leaves		Grading (weight%)			
		5 days	20 days	5 days	20 days	(5-15)	15-25)	25-35)	>35
		after	after	after	after	mm	mm	mm	mm
		Yield	Yield	Yield	Yield				
		ton/ha**	ton/ha**	ton/ha**	ton/ha**				
Transplanted 13 April									
Bima curut-store 33,3 bulbs/m2	60	7.71	5.86	5.79	5.35	28.2	64.3	7.5	0.0
Tuktuk 150 pl/m2	95	4.10	3.36	3.03	2.95	0.0	18.3	54.9	26.7
Hybrid 150 pl/m2 (1 rep)	95	10.08	9.07	8.50	8.06	0.0	36.6	61.0	2.4
Transplanted 29 April									
Bima curut-store 33,3 bulbs/m2	56	8.50	7.82	6.96	6.75	16.9	72.7	10.5	0.0
Tuktuk 150 pl/m2	86	7.54	6.58	5.54	5.78	0.0	18.9	54.3	26.8
Hybrid 150 pl/m2 (1 rep)	84	12.78	11.76	10.48	9.72	0.0	16.2	56.8	16.2

** : ha with 70% beds and 30% ditches

The results of TSS transplanted at different moments at the start of the dry season are making clear that it is rather difficult to obtain high yields with very early transplanting. In 2009 this could be explained to a large extend by the weather conditions which were not favourable (more rain than normal). Another aspect is the soil structure at the start of the dry season: immediately after paddy the soil structure is very poor.

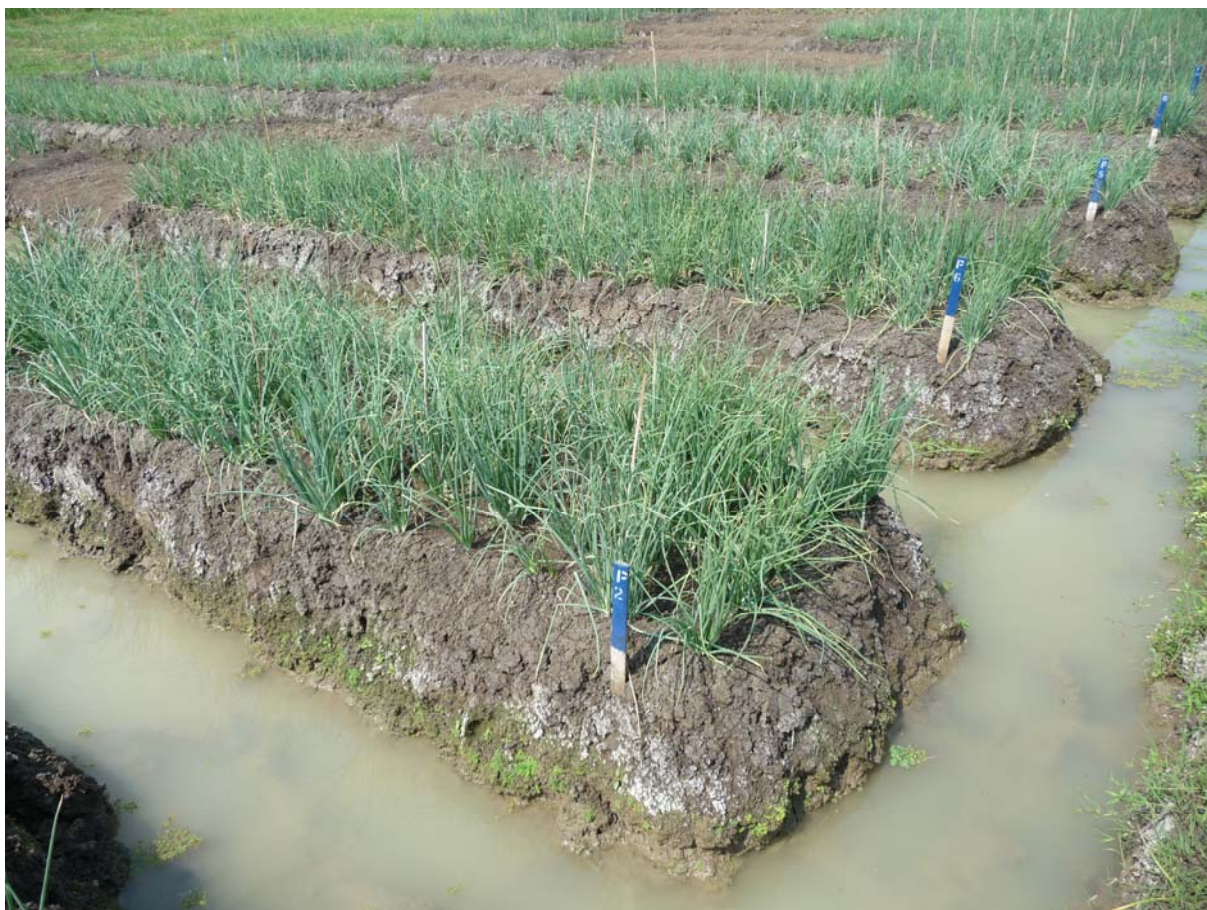
In figure 1 the yield of Tuktuk, the Hybrid and Bima in 2009 is given in relation to the different moments of transplanting (including the plant density experiment and the fertilization experiment).



Figure 1. Yield (without leaves 5 days after harvest) in relation to date of transplanting in 2009.

Harvested bulbs were sent to EWSI for an experiment with planting seed bulbs of TSS. The main experience was that Tuktuk was losing very slowly dormancy. Another aspect was: the yield of the crop grown from seed bulbs of the hybrid was very heterogeneous. Before selling the product grading should be done. Data were not available completely at the moment of writing this report.

The experiment with planted seed bulbs in Brebes could not be harvested. The bulbs were stolen.



Picture 4. Experiment with planted seed bulbs of Tuktuk and the Hybrid in Brebes. Seed bulbs were harvested in the early sowing and transplanting experiment..

4 Plant density experiment

The aim of the plant density experiment was to investigate the optimal plant density of Tuktuk and the Hybrid in relation to yield and costs of the production. A lower plant density means a large reduction in production costs. May be it is more profitable for a farmer to grow a variety with a relative low number of plants per m² and an acceptable yield. Bima and Ilokos were also included in the experiment .

4.1 Materials and methods

On 15 April the nursery for the plant density experiment was sown. The normal procedure for the nursery was followed: the trays were filled with a nursery mixture, consisting of home garden soil, sandy soil and stable manure (volume= 1:1:1). SP 36 and carbofuran were spread over de surface (50 grams of each per m²). Watering was done the day before sowing. The seed was sown in 0,5 cm deep furrows. The furrow was closed with rice husks. A blue plastic sheet was put on the trays for 5 days. After 5 days a shelter was covering the nursery for 1 week until one week before transplanting. Two times per day water was given with a bruze. The emergence was measured: Tuktuk 2 weeks after sowing: 50%, 4 weeks after sowing 56% and 6 weeks after sowing 52%; Hybrid 2 weeks after sowing 35%, 4 weeks after sowing 41% and 6 weeks after sowing 37%; (based on 5 trays per variety). The lower emergence percentage of the Hybrid was caused by the lower germination ability (see table 1). In this nursery the decrease in number of seedlings during the third till sixth week was hardly occurring.

Spraying against diseases and pests in the nursery was done intensively (Score and Amistar Top).



Picture 5. Nursery for the plant density experiment; sowing date 15 April.

The seedlings were transplanted on 20 May. The experiment was done with four replicates and a plot size of 5 m x 1.5 m (net). The plant densities were realized as follows:

- 75 plants per m²: plant spacing 10 cm x 13,3 cm;
- 125 plants per m²: plant spacing 10cm x 8 cm;
- 175 plants per m²: plant spacing 7,5 cm x 7,6 cm;
- 225 plants per m²: plant spacing 7,5 cm x 5,9 cm;
- Bima and Ilokos: seed bulbs planted, plant spacing: 15cm x 20 cm.

The fertilization was as follows: before transplanting 125 kg P₂O₅ was given as SP36. Two weeks after transplanting 75 kg N/ha and 75 kg K/ha (KCl) was given. Half of the N was given as Urea and the other half as ZA. This was repeated two times: at four and at six weeks after transplanting. This means in total 225 kg N/ha, and 225 kg KCl

Spraying against diseases and pests in the nursery was done intensively (Score and Amistar Top).

The plant density experiment was harvested in July and August: Bima and Ilokos on 28 July, the Hybrid on 5 August and Tuktuk on 11 August.

4.2 Results and discussion

Table 7 is giving the results of the observation done during the growing season. In table 8 and figure 2 the yield results are presented.

Table 7. Plant density experiment 2009. Transplanted 20 May. Survival and attack by diseases

	% survival 10 June	% of leafs attacked by			
		Alternaria		Antracnose	Liriomyza
		24 June	8 July	8 July	8 July
Bima curut-store 33,3 b/m ²	99	41	41	0	1
Ilokos-imported 33,3 b/m ²	95	35	50	0	1
Tuktuk 75 plants/m ²	80	0	18	0	1
Tuktuk 125 plants/m ²	78	0	23	3	3
Tuktuk 175 plants/m ²	77	0	31	10	2
Tuktuk 225 plants/m ²	76	0	28	13	0
Hybrid 75 plants/m ²	90	0	15	9	1
Hybrid 125 plants/m ²	92	0	26	5	0
Hybrid 175 plants/m ²	88	0	23	6	0
Hybrid 225 plants/m ²	92	0	33	18	0
F probability (Anova)	<0.001	<0.001	<0.10	<0.10	n.s.
LSD 5%	0.0723	4.297	21.80	12.20	2.086

Table 8. Plant density experiment 2009; transplanted 20 May. Earliness, yield, number of harvested shallots and grading.

	Earliness days until harvest	Shallots with leaves		Shallots without leaves		Grading (weight%)				
		5 days after harvest	20 days after harvest	5 days after harvest	20 days after harvest	(5-15) mm	(15-25) mm	(25-35) mm	(35-45) mm	>45 mm
		Yield ton/ha**	Yield ton/ha**	Yield ton/ha**	Yield ton/ha**					
Bima curut-store 33,3 b/m ²	69	13.62	9.15	11.01	8.26	3.605	46.95	47.93	1.51	0.000
Ilokos-imported 33,3 b/m ²	69	14.23	9.29	11.75	8.56	3.202	49.36	45.39	2.05	0.000
Tuktuk 75 plants/m ²	83	9.38	6.13	6.86	5.63	0.000	4.67	38.70	52.77	3.860
Tuktuk 125 plants/m ²	83	13.81	9.45	10.71	8.74	0.000	5.27	35.78	54.42	4.526
Tuktuk 175 plants/m ²	83	19.39	12.71	15.19	11.75	0.000	5.40	33.91	55.95	4.744
Tuktuk 225 plants/m ²	83	19.90	15.04	16.45	12.16	0.000	4.62	42.97	47.79	4.621
Hybrid 75 plants/m ²	77	18.09	13.21	14.14	11.93	0.000	27.43	69.54	3.03	0.000
Hybrid 125 plants/m ²	77	20.31	15.59	15.86	13.59	0.000	27.40	71.84	0.76	0.000
Hybrid 175 plants/m ²	77	22.91	16.38	17.70	14.24	0.000	28.11	70.25	1.64	0.000
Hybrid 225 plants/m ²	77	22.93	15.85	17.93	14.71	0.000	24.07	75.00	0.93	0.000
F probability (Anova)		<0.001	<0.001	<0.001	2.304	<0.001	<0.001	<0.001	<0.001	<0.001
LSD 5%		3.651	2.399	2.729	<0.001	0.623	8.077	12.51	8.489	1.451

** : ha with 70% beds and 30% ditches

The yield of Bima and Ilokos was much higher in this experiment than in the early sowing experiment. Bima: 90% higher than the transplanted field of 13 April and 41% higher than the transplanted field of 29 April. Also the yield of Tuktuk was higher: ca. 250% higher than the transplanted field of 13 April and ca. 90% higher than the transplanted field of 29 April. The explanation for these higher yields could be the improving soil conditions at the beginning of the dry season. Also weather conditions could play a role.

Tuktuk was giving a much higher response to increasing plant density than the Hybrid. The yield of Tuktuk grown at 75 plants /m² was very low. Tuktuk planted at 125 plants per m² was giving more or less the same yield as Bima and Ilokos. If the plant density increases from 125 to 175 plants per m² the yield is increasing with 42%. The Hybrid was producing very well with 75 plants per m². With increasing plant density the yield is increasing also, but less fast as with Tuktuk. If this increase in yield is relevant for the farmer is depending on the increase in cost of production and transplanting of more seedlings. Based on a nursery with plastic trays and with a shelter and a seed efficiency of 60% as used in the economic calculation in 2008 (see Report nr.4) the costs of the nursery will increase with 17.860.000 Rp/ha if transplanting is done with 175 plants /m² in stead of 75 plants/m². With a price of 5000 Rp for harvested bulbs this is corresponding with ca. 3,6 ton harvested bulbs per ha. The yield increase is also ca. 3,6 ton per ha if the plant density of the Hybrid is increased from 75 plants/m² to 175 plants /m². With such a nursery it is not profitable for a farmer to increase the plant density. However with another type of nursery and other selling prices for the harvested bulbs it is possible that the calculation can lead to another conclusion. It is needed to do more economic calculations on this subject.

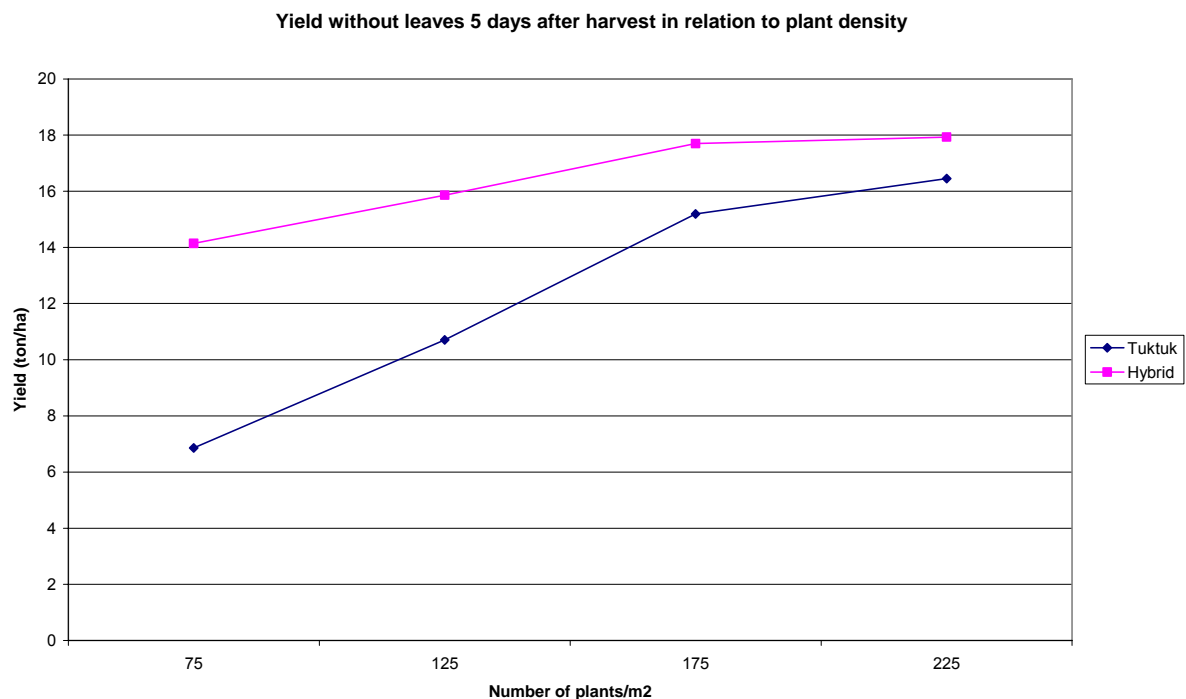


Figure 2. Yield without leaves in relation to plant density.



Picture 6. Harvest of the plant density experiment.

5 Nitrogen fertilization experiment

The aim of the nitrogen fertilization experiment was to find the optimal N-fertilization of Tuktuk and the Hybrid. In 2008 there was discussion about the level of nitrogen fertilization. There were indications that high nitrogen levels are giving much rot in the harvested bulbs. In 2009 a nitrogen fertilization experiment has been done with the varieties Tuktuk and the Hybrid. The varieties were tested at 120 – 180 – 240 and 300 kg/ha. Samples of the harvested bulbs were stored by EWSI during six months to investigate the losses caused by rot, etc. Bima and Ilokos were also included in the experiment.

5.1 Materials and methods

The nursery was sown on 24 April. The normal procedure for the nursery was followed: the trays were filled with a nursery mixture, consisting of home garden soil, sandy soil and stable manure (volume= 1:1:1). SP 36 and carbofuran were spread over the surface (50 grams of each per m²). Watering was done the day before sowing. The seed was sown in 0,5 cm deep furrows. The furrow was closed with rice husks. A blue plastic sheet was put on the trays for 5 days. Plastic sheet was removed 29 April. Temperature under the sheet was measured: 38 C, while the air temperature was 36 C. At the moment of removing the sheet emergence was estimated at 25 – 30%. It was suggested to remove the sheet earlier. Many seedlings were germinating in the rice husks. These seedlings were lost, because of lack of moisture.



Picture 7. Nursery of the fertilization experiment. Seedlings are lost because of germination in burned rice husks. The covering with nursery mixture was not enough to prevent loss of seedlings.

It was concluded that the furrows should be closed or should be closed better with soil after sowing. Emergence was measured: Tuktuk 3 weeks after sowing 21% and 5 weeks after sowing 15%; Hybrid 2 weeks after sowing

20% and 5 weeks after sowing 13% (based on 5 trays per variety). The main reason for these low percentages of emergence is the fact that many seedlings are lost because of germinating in the dry rice husks.

No shelter was used for protection of the nursery. Spraying against diseases and pest were done intensively.

The transplanting was done on 27 May. Plant density was 150 plants/m² (plant spacing: 10 cm x 6,7 cm). All treatments were planted in four replicates, except T240, T300, H120 and H240. These treatments were planted in three replicates, because of shortage of seedlings. Bima and Ilokos were planted at 33,3 bulbs/m² (plant spacing: 15 cm x 20 cm). Nitrogen fertilization of Bima and Ilokos was 180 kg N/ha.

The fertilization was as follows: before transplanting 125 kg P₂O₅ was given as SP36. Two weeks after transplanting N was given for the first time. In all treatments nitrogen was given in five times: 2 weeks, 3 weeks, 4 weeks, 5 weeks and 6 weeks after transplanting. Each time with 1/5 of the total amount of nitrogen. Nitrogen was given completely as ZA. KCl was given in four gifts: 3 weeks, 4 weeks, 5 weeks and 6 weeks after transplanting, 80 kg KCL each time.

Soil samples were taken per treatment (mixed sample of the four replicates; only plots with Tuktuk) seven weeks after transplanting. Samples were analysed on NO₃ and pH.

Diseases control was done as much as possible.

After harvest samples were send to EWSI. These samples were stored during six months. After 2, 4 and 6 months the percentage healthy bulbs and the weight loss is measured.

5.2 Results and discussion

Table 9 is giving the results of the observations done during growing season. Survival of seedlings two weeks after transplanting was quite good. Later on ca. 25% of the plants were lost, probably because of diseases. Attack of antracnose and Liriomyza was not visible. Some alternaria was occurring, especially in Ilokos. Spodoptera was present at a low level. Probably plant losses are caused by other diseases, pests or other factors.

Table 9. Fertilization experiment 2009. Survival of plants and % of leaves attacked by pests and diseases

	% survival		Number of plants/m2 at harvest	% of leaves attacked by							
	10 June at harvest			Alternaria		Liriomyza		Antracnose		Spodoptera	
				24 June	15 July	24 June	15 July	24 June	15 July	24 June	15 July
Bima curut-store 33,3 bulbs/m2	99.1	99.1	33.0	35	7.5	0	0	0	0	0	0
Ilokos-imported 33,3 bulbs/m2	97.5	97.6	32.5	30	56.3	0	0	0	0	0	0
Tuktuk 120 kg N; 150 pl/m2	80.6	70.3	105.5	0	11.3	0	0	0	0	0	0
Tuktuk 180 kg N; 150 pl/m2	87.6	72.5	108.7	0	11.3	0	0	0	0	0	0
Tuktuk 240 kg N; 150 pl/m2	85.8	63.1	94.6	0	12.0	0	0	0	0	0	0
Tuktuk 300 kg N; 150 pl/m2	81.4	67.2	100.8	0	13.7	0	0	0	0	0	0
Hybrid 120 kg N; 150 pl/m2	89.8	78.1	117.1	0	5.3	0	0	0	0	0	0
Hybrid 180 kg N; 150 pl/m2	86.6	79.2	118.8	0	8.8	0	0	0	0	0	0
Hybrid 240 kg N; 150 pl/m2	90.0	78.9	118.3	0	13.7	0	0	0	0	0	0
Hybrid 300 kg N; 150 pl/m2	90.5	80.5	120.7	0	5.0	0	0	0	0	0	0
F probability (Anova)	0.015	<0.001	<0.001	<0.001							
LSD 5%	9.43	12.67	19.01	10.4							

On 22 July soil samples were taken from the Tuktuk-plots. The pH was not high, but the level was just high enough for growing shallots. The nitrate concentration was very low in T240. The ranking between the other treatments was more or less according what could be expected. An explanation for the low nitrate concentration of T240 could not be found. May be it is a failure in the analysis. The difference with the other treatments is very big.

Soil analysis

sent to lab 22-jul-09
result received 7-aug-09

Code	pH		NO3	
	H2O	KCl	MV	
	pH meter		ppm	
T 120		5.9	5.2	1152.2
T 180		6	5.3	1436.5
T 240		6.1	5.3	653.2
T 300		5.7	4.9	1539.6



Picture 8. Nitrogen fertilization experiment in June, ca. 3 weeks after transplanting.

The harvest of Bima and Ilokos was done on 28 July and the harvest of Tuktuk and the Hybrid was done on 14 August. At the harvest the number of plants was counted on 10 representative rows of each plot. In the statistical analysis plant density was used as a covariable. This was done separately for Tuktuk and the Hybrid. This was done because of the different yield level of the varieties and because of the expectation that the varieties are different in reaction on plant density. For both varieties the effect of the covariable was significant ($F_{\text{prob}} < 0.001$). In table 10 the mean yield is given based on the analysis with the covariable plant density.

Table 10. Fertilization experiment 2009; transplanted 27 May. Earliness, yield, number of harvested shallots and grading.

	Earliness days until harvest	Shallots with leaves		Shallots without leaves		Grading (weight%)			
		5 days after harvest	20 days after harvest	5 days after harvest	20 days after harvest	(5-15) mm	(15-25) mm	(25-35) mm	>35 mm
		Yield	Yield	Yield	Yield				
		ton/ha**	ton/ha**	ton/ha**	ton/ha**				
Bima curut-store 33,3 bulbs/m ²	62	14.23	8.64	11.67	8.64	3.605	46.95	47.93	1.51
Ilokos-imported 33,3 bulbs/m ²	62	11.84	7.06	9.90	7.06	3.016	46.57	48.36	2.05
Tuktuk 120 kg N; 150 pl/m ²	79	17.04 ab	14.88 ab	13.82 a	13.70 ab	0.000	2.76	30.02	67.21
Tuktuk 180 kg N; 150 pl/m ²	79	18.27 b	16.81 b	15.29 a	14.84 b	0.000	2.31	40.74	56.96
Tuktuk 240 kg N; 150 pl/m ²	79	15.43 a	14.04 a	13.83 a	12.59 ab	0.000	6.23	31.26	62.51
Tuktuk 300 kg N; 150 pl/m ²	79	15.06 a	12.79 a	12.96 a	11.72 a	0.000	2.65	27.59	69.75
Hybrid 120 kg N; 150 pl/m ²	79	24.15 a	21.01 a	19.40 a	19.41 a	0.000	29.98	66.43	3.58
Hybrid 180 kg N; 150 pl/m ²	79	25.75 a	22.62 a	20.34 ab	21.47 a	0.000	23.62	71.10	5.28
Hybrid 240 kg N; 150 pl/m ²	79	28.15 ab	23.96 ab	22.90 ab	23.02 ab	0.000	21.05	76.10	2.85
Hybrid 300 kg N; 150 pl/m ²	79	31.07 b	27.27 b	25.05 b	25.70 a	0.000	26.33	67.75	5.92

** : ha with 70% beds and 30% ditches

Remark: yield values: difference is significant if one value has 'a' and another value has 'b' (only comparable within variety)

Also in this experiment the Hybrid is giving a higher yield than Tuktuk. The yield (5 days after harvest with leaves) of Tuktuk grown at 180 kg N/ha was 40% higher than the mean yield of Bima and Ilokos grown at the same level of nitrogen fertilization. The yield of the Hybrid was 98% higher than the mean yield of Bima and Ilokos. In this experiment yield of Tuktuk was not giving a positive reaction on a higher nitrogen fertilization. The tendency is even negative. The yield of the hybrid was increasing with higher levels of nitrogen. Yield of the hybrid at 300 kg N/ha was significantly higher than yield at 120 kg N/ha (29%). Costs of nitrogen are relative low (costs for giving 180 kg N extra are the same as financial yield of ca. 1,5% higher yield). This means it is profitable for the farmer to give 300 kg N/ha. Yield of the Hybrid grown with 300 kg N/ha is 128% higher than the mean yield of Bima and Ilokos

Yield without leaves 5 days after harvest in relation to N-fertilization

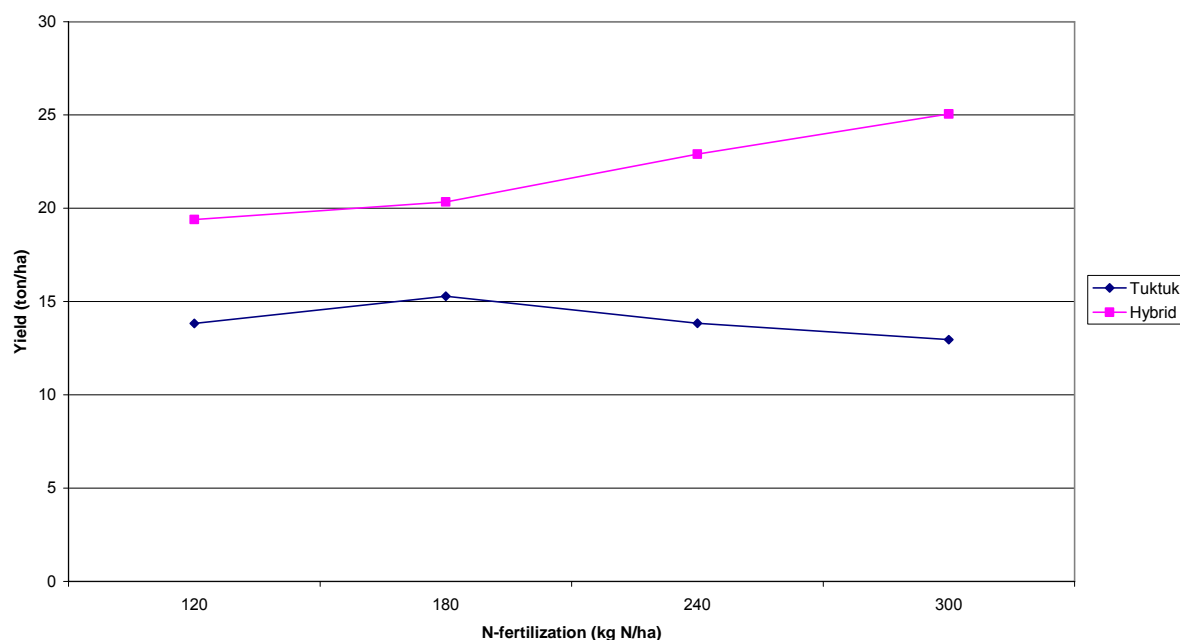


Figure 3. Yield without leaves 5 days after harvest in relation to nitrogen fertilization level.

In December the results of the storage experiment done by EWSI were only available after 3 months of storage. Exact data were not available at the moment of writing this report. A great difference is present between Tuktuk and the hybrid. With Tuktuk The percentage of healthy bulbs is going down very fast with increasing nitrogen levels, while with the Hybrid the percentage of healthy bulbs is still on a high level also for the bulbs produced at

the highest nitrogen level. In picture 9 this is illustrated: starting with the same number of bulbs after harvest it appears that Tuktuk grown at a higher nitrogen level has lost much more rotten bulbs after 3 months storage than the Hybrid.



Picture 9. Healthy bulbs after three months of storage. Upper row of boxes: Tuktuk grown with 120, 180, 240 and 300 kg N/ha (from left to right). Under row of boxes: Hybrid grown with 120, 180, 240 and 300 kg N/ha (from left to right). At the start of the storage period each box had more or less the same number of healthy bulbs (within a variety).

6 Seed efficiency experiments

Improving seed efficiency is a very important topic in the shallot project. In 2007 and 2008 seed efficiency was very variable. It could range from 15% till 80%. In 2009 experiments were done in which the influence of sowing depth, ways of covering the seed, intensity of watering, seed treatment with fungicides, seed treatment with insecticides and drenching with fungicides were investigated. EWSI has treated some seed of Tuktuk with the insecticide Tracer and also some seed with the insecticide Ridomil. The dosage was based on experiences obtained in other crops.

6.1 Materials and methods

Seed efficiency experiment 1 was sown on 29 April. The experiment was done in trays and on a seedbed. The trays were prepared in the same way as described for the plant density experiment. On 28 April SP36 and carbofuran were spread over the seedbed. The seedbed was build 1 month before. 1 week before the top layer was mixed up with 150 liter stable manure, 150 liter sand and 150 liter home-soil per 1 bed. It was difficult to make a good seedbed. In the experiments 8 treatments were included (see table 11). Both in trays and on the seedbed there were 4 replicates. In the experiment with trays size of the trays was 36 cm x 28 cm. Each replicate was one tray. Per tray 0,5 gram seed of Tuktuk (144 seeds) was sown. In the experiment on a seedbed plot size was: 9 rows of 1,30 cm, 15 cm from each other. In each row 0,4 gram seed of Tuktuk was sown (115 seeds per row). In each plot 4 rows were counted. The replicates were split into 2 groups:

- Experiment in trays: 2 replicates were done as usual: after sowing the furrow was not closed with soil, but with rice husks; in the other 2 replicates the furrow was covered by pushing lightly by hand the soil into the furrow.
- Experiment on the seedbed: 2 replicates were done as usual: after sowing the furrow was not closed with soil, but with rice husks; in the other 2 replicates the furrow was filled with dry soil applicated by means of a sieve. By hand the soil was moved into the furrow.

After sowing a plastic sheet was put over the trays and beds for 3 days. No shelter was used to protect the nursery.

One of the treatments was drenching with Previcure. Drenching was applied directly after sowing. Per m² 5 ml Previcure in 2 liter water was used.

Percentage of emergence was measured at four moments: 2, 4 and 6 weeks after sowing. Each time the same rows were counted.



Picture 10. Sowing and covering the seed with soil.

On 29 April an additional experiment was started to test if applying SP36 and carbofuran over the surface of the nursery before sowing, as has been done in seed efficiency experiment 1, could have a negative effect on emergence.

Twenty trays which were filled with nursery mixture and which has got already SP36 and carbofuran were treated as follows: the soil in each tray was mixed up and after this the seedbed in the tray was made. Four treatments were given:

- R. Sowing in a furrow of 0,5 cm without closing the soil, but only with rice husks (5 trays)
- S. Sowing in a furrow of 0,5 cm with closing the soil by means of adding dry soil and afterwards rice husks is applicated (5 trays)
- T. Sowing in a furrow of 1.0 cm without closing the soil, but only with rice husks (5 trays)
- Z. Sowing in a furrow of 1.0 cm with closing the soil by means of adding dry soil and afterwards rice husks is applicated (5 trays)

The additional seed efficiency experiment was treated in the same way as seed efficiency experiment 1.

On 15 July seed efficiency experiment 2 was sown, also in trays and on beds. In this experiment the effect of giving water after sowing was investigated. In experiment 1 water was not applied after sowing. Discussion was started if watering was needed. The aim of seed efficiency experiment 2 was to investigate the effect of watering after sowing and to repeat the most important treatments of seed efficiency experiment 1. Another aspect which was investigated in experiment 2 was the way of closing the furrow with soil: by using sieved soil or by moving the soil of the seedbed into the furrow.

Percentage of emergence was measured at one moment: 4 weeks after sowing.

Control of pest and diseases was done as optimal as possible.

6.2 Results and discussion

In tables 10 the results of seed efficiency experiment 1 on trays are presented.

Table 10. Seed efficiency experiment I in trays; Tuktuk 144 seeds per tray sown 29 april 2009

	Sowing depth (cm)	Emergence in %			
		After 2 weeks		After 6 weeks	
		Covering with ash	Covering with soil	Covering with ash	Covering with soil
Normal seed	0.5	33.0	67.0	23.3	45.5
Drenching Previcure	0.5	44.1	52.1	28.8	24.7
Treated Ridomil	0.5	22.6	29.2	16.3	23.3
Treated Tracer	0.5		47.9		31.3
Tr. Tracer + Dr. Previcure	0.5	30.2	41.0	14.6	19.8
Normal seed	1.0	40.6	74.7	29.2	52.1
Normal seed	1.5	44.4	80.9	33.0	39.6
Normal seed	0.25	22.9	44.1	11.1	23.6
Fprob (medium.object)		0.017		0.325	
LSD 5% (comparison within 'ash' or 'soil')		14.16	14.16	13.76	13.76
LSD 5% (comparison across 'ash' and 'soil')		15.20		18.42	

Results obtained in trays are showing that closing the furrow with soil is giving a big improvement of the seed efficiency (from 33% to 67% at a sowing depth of 0,5 cm). Also deeper sowing than 0,5 cm is giving a positive effect (+8 -14%). Sowing at a depth of 1 – 1,5 cm and closing the furrow with soil is giving the best seed efficiency. After emergence the decrease in number of seedlings is less at the sowing depth of 1 cm, but the differences between replicates is rather big. Ridomil is damaging the seed as already shown in the germination test (see table 1). Tracer is also damaging the seed a little bit, as shown in the germination test. Both Ridomil and Tracer are not improving the number of seedlings after 6 weeks. With Ridomil the decrease in number of seedling during six weeks was lower than with untreated seed. It is possible that Ridomil has a protection effect. However the total number of seedlings is very low. The decrease in number of seedlings is on the same level as with normal seed. Also Drenching with Previcure does not give an improvement in seed efficiency. Compared with the nurseries for the early sowing experiment and the plant density experiment the loss of seedlings during the period 2 weeks after sowing until 6 weeks after sowing is very big, up to 50%. It is not clear why this is occurring. Anthracnose could probably be a reason. Ridomil and Previcure did not gave lower percentages of seedling losses.

Table 11 is giving the results of seed efficiency experiment 1 on beds.

Table 11. Seed efficiency experiment 1 in beds; Tuktuk 1035 seeds sown per plot 29 april 2009

	Sowing depth (cm)	Emergence in %			
		After 2 weeks		After 6 weeks	
		Covering with ash	Covering with soil	Covering with ash	Covering with soil
Normal seed	0.5	26.8	32.5	21.6	23.9
Drenching Previcure	0.5	24.7	53.9	19.8	28.3
Treated Ridomil	0.5	17.6	15.6	17.8	18.8
Treated Tracer	0.5	28.4	28.9	19.8	21.7
Tr. Tracer + Dr. Prvicure	0.5	30.9	36.9	20.4	25.1
Normal seed	1.0	23.8	35.0	15.4	20.4
Normal seed	1.5	27.9	42.8	17.5	24.1
Normal seed	0.25	24.7	31.1	17.8	21.0
Fprob (medium.object)		0.350		0.989	
LSD 5% (comparison within 'ash' or 'soil')		17.68	17.68	12.89	12.89
LSD 5% (comparison across 'ash' and 'soil')		18.89		13.53	



Picture 11. Loss of seedlings in the seed efficiency experiment, probably because of antracnose.

Seed efficiency on beds was much lower than in trays. The structure of the soil on the beds was less optimal than in the trays. Also on beds closing the furrow with soil is giving an improvement of seed efficiency. Sowing deeper (1 cm and 1.5 cm) was giving an improvement in the initial number of seedlings (after two weeks), but after six weeks this difference had disappeared. Drenching with Previcure and closing the furrow with soil was giving the highest seed efficiency. However it is not clear if this effect was caused by the extra watering effect after sowing which was occurring in this treatment. The other treatments were not getting water after sowing. May be the seed efficiency could be improved by extra watering. The amount of water which was given is comparable with 2 mm rain.

Also on beds the same loss of seedlings was occurring as on trays.

In table 12 the results are given of the additional seed efficiency experiment.

Table 12. Seed efficiency experiment I (additional) in trays; Tuktuk 144 seeds/tray sown 29 april 2009

	Sowing depth (cm)	Emergence in %		
		After 2 weeks	After 4 weeks	After 6 weeks
closing with sieved soil	0.5	55.0	41.8	36.2
only closed with rice husk	0.5	24.9	19.7	17.6
closing with sieved soil	1.0	61.4	46.5	37.2
only closed with rice husk	1.0	41.4	33.1	23.3
Fprob		<0,001	0.002	0.002
LSD 5%		11.22	11.82	9.90



Picture 12. Counting the number of seedlings in nursery on seedbed in the field

The results obtained in the additional seed efficiency experiment are in line with the results obtained in the first seed efficiency experiment: Closing the furrow with soil is improving seed efficiency to a large extent. There is a tendency that sowing at a depth of 1 cm is giving a higher seed efficiency than sowing at 0,5 cm.

In table 13 the results of seed efficiency experiment 2 are given.

Table 13. Emergence on trays and in beds 4 week after sowing; seed efficiency experiment 2, sown 15 July

	Trays		On beds	
	Without extra water	With extra water	Without extra water	With extra water
Normal 0,5 cm moving soil into furrow	10	20	19	17
Normal 1.0 cm moving soil into furrow	28	35	24	25
Normal 1.0 cm sieved soil in furrow	21	25	22	27
Normal 1,5 cm moving soil into furrow	48	55	25	26
Normal 1.5 cm sieved soil in furrow	47	57	22	25
Tracer 1.0 cm moving soil into furrow	14	31	19	15
Tracer 1.0 cm sieved soil in furrow	14	13	19	17
Previcure 1.0 cm moving soil into furrow		10		22
Previcure 1.0 cm sieved soil in furrow		14		19
Tr. Prev. 1.0 cm moving into furrow		16		20
Tr. Prev. 1.0 cm sieved soil in furrow		18		20
Fprob	<0.001	<0.001	0.158	0.195
LSD 5%	12.8	13.4	6.0	9.9

Also in seed efficiency experiment 2 the seed efficiency on beds was lower than in trays. In trays seed efficiency was improved by sowing deeper. Sowing at a depth of 1,5 cm was giving the highest seed efficiency. Watering

after sowing was improving seed efficiency. This means that sufficient watering is also an important factor to improve seed efficiency.



Picture 13. Nursery on trays.

7 Age of seedlings and fertilization of nursery

At the start of the project it was assumed that transplanting could be done with six weeks old seedlings. However this was based on experiments done in the highland. During the project it appeared that five weeks old seedlings were giving also good results. So the optimal age of the seedling at transplanting time was questionable. Another question was: are seedlings grown under poor conditions giving a better TSS crop than seedlings grown under rich conditions. In 2009 a nursery experiment was done with 2 levels of N-fertilization (0 and 75 kg N/ha) and the seedlings were transplanted at two ages (5 and 6 weeks).

7.1 Materials and methods

On 13 May and on 20 May a nursery was sown to produce seedlings of different ages at the moment of transplanting. In both nurseries two treatments were included: 0 kg N/ha and 75 kg N/ha (ZA). Nitrogen was given 3 weeks after sowing. Seeds of Tuktuk were used and the nursery was done as described for the plant density experiment.

On 24 June the 5 and 6 weeks old seedlings were transplanted at 150 plants/m². The fertilization was as follows: before transplanting 125 kg P₂O₅ was given as SP36. Two weeks after transplanting 75 kg N/ha and 75 kg K/ha (KCl) was given. Half of the N was given as Urea and the other half as ZA. This was repeated two times: at four and at six weeks after transplanting. This means in total 225 kg N/ha, and 225 kg KCl. Diseases control was done as much as possible.



Picture 14. transplanting of the experiment "Age of seedlings and fertilization of nursery".

7.2 Results and discussion

In table 14 the results are given of the observation done in the production field during the growing season.

Table 14. Experiment age of seedlings and fertilization of nursery; transplanted 24 June. Survival and attack by diseases

	% survival		Number of plants/m2 15-aug	% of leaves attacked by			
	9 July	15-aug		Alternaria		Ulat	
				22 July	12-aug	22 July	12-aug
6 weeks old seedling with 0 kg N	74.0	64.4	96.5	0	0	0	0
6 weeks old seedlings with 75 kg N	81.0	67.9	101.9	0	0	0	0
5 weeks old seedling with 0 kg N	67.6	56.9	85.3	0	0	0	0
5 weeks old seedlings with 75 kg N	74.1	63.4	95.1	0	0	0	0
Fprob	0.21	0.38					
LSD 5%	13.28	14.38					

Survival in this experiment was lower than in the other experiments. The differences between treatments are not significant. There is a slight tendency that 5 weeks old seedlings were weaker.

On 18 September the experiment was harvested. In table 15 the results are given.

Table 15. Experiment age of seedlings and fertilization of nursery 2009; transplanted 24 June. Yield and grading.

	Shallots with leaves		Shallots without leaves	
	5 days after harvest Yield ton/ha**	20 days after harvest Yield ton/ha**	5 days after harvest Yield ton/ha**	20 days after harvest Yield ton/ha**
6 weeks old seedling with 0 kg N	11.08	10.03	9.23	9.59
6 weeks old seedlings with 75 kg N	12.26	10.79	10.21	9.97
5 weeks old seedling with 0 kg N	11.17	10.11	9.31	9.73
5 weeks old seedlings with 75 kg N	12.44	10.61	10.38	10.03
Fprob	0.445	0.798	0.522	0.947
LSD 5%	2.425	2.209	2.269	2.069

Compared with the fertilization experiment and the plant density experiment the yield is low. The differences between treatments in yield are small and not significant.

8 Effect of insect net

Information was available that TSS was grown also under insect nets. This would give protection against insects (Spodoptera, etc). By using insect nets the use of insecticides could be reduced. In this way shallots could be harvested with less residues. In 2009 a small experiment was done with insect nets.

8.1 Materials and methods

On 24 June a small experiment was transplanted to investigate the effect of insect nets. Seedlings of Tuktuk were used. The experiment was done in two replicates. Two treatment were included: with and without insect net. Transplanting density was 150 plants per m². Under the insect net no spraying with insecticides was done. The fertilization was as follows: before transplanting 125 kg P₂O₅ was given as SP36. Two weeks after transplanting 75 kg N/ha and 75 kg K/ha (KCl) was given. Half of the N was given as Urea and the other half as ZA. This was repeated two times: at four and at six weeks after transplanting. This means in total 225 kg N/ha, and 225 kg KCl

Diseases control was done as much as possible.

Characteristics of the net were: brand name = agro pro: type r12-c215trm²-73. 27% light intensity reduction, 37% IUV reduction, 73% wind speed reduction, 138 holes per cm², mesh/1" is 24x3, weight is 150 g/m².

8.2 Results and discussion

In table 16 the results are given of the observation done in the production field during the growing season. Survival of seedlings two weeks after transplanting was not high and also during the growing season many plants were lost. The reason is not clear. No difference could be seen between the two treatments. Spodoptera was only present at a very low level. This means the effect of insect net could not be expressed in this experiment.

Table 16. Experiment age of seedlings and fertilization of nursery; transplanted 24 June. Survival and attack by diseases

	% survival		Number of plants/m ² 15-aug	% of leaves attacked by <u>Liriomyza</u> 27 July
	9 July	15-aug		
With insect net	70.5	45.8	68.7	2.6
Without insect net	63.4	51.2	76.8	4.3
Fprob				
LSD 5%				

The experiment was harvested on 18 September. In table 17 the harvest results are given. There is no clear difference between with and without insect net. Because of the absence of Spodoptera the experiment could not provide usefull information about the effect of insect nets.

Table 17. Experiment with insect net 2009; transplanted 24 June. Yield and grading.

		Shallots with leaves		Shallots without leaves	
		5 days after harvest Yield ton/ha**	20 days after harvest Yield ton/ha**	5 days after harvest Yield ton/ha**	20 days after harvest Yield ton/ha**
	Number of plants/m2 15-aug				
With insect net	68.7	12.69	9.54	10.34	8.78
Without insect net	76.8	12.00	9.13	9.13	8.58
Fprob					
LSD 5%					



Picture 15. Experiment with TSS grown under insect nets.

9 Conclusion Research 2009

The following conclusions could be drawn from the experiments done in 2009:

- Storability of the Hybrid is much better than storability of Tuk tuk. The only commercially available TSS-variety, Tuk tuk, has shown too many rotten bulbs. Introduction of the new Hybrid with a better storability is giving better perspectives for TSS.
- In 2009 transplanting TSS at the start of the dry season was giving relatively low yields. If transplanting was postponed to second half of May yield was increased (with ca 100% or more). These poor results of early transplanting are probably caused also by the rainy wetter at the start of dry season. But also in general soil structure at the start of dry season will always be less favourable for obtaining high yields.
- In the plant density experiment of 2009 the optimal plant density of Tuktuk was much higher than the optimal plant density of the Hybrid. The yield of Tuktuk grown at 75 plants /m² was very low. Tuktuk planted at 125 plants per m² was giving more or less the same yield as Bima and Ilokos. Optimal plant density of Tuktuk was ca. 150 – 175 plants per m². The hybrid was producing rather well with 75 plants per m². With increasing plant density the yield of the Hybrid is increasing also, but less fast as with Tuktuk. It will depend on the increase of nursery costs and costs of transplanting more seedlings if this increase in yield of the Hybrid is profitable for the farmer. With expensive nurseries, for example the nursery used in 2008 with trays filled with mixtures with stable manure and shelters, the optimal plant density of the Hybrid in the experiment of 2009 was ca. 75 plants per m².
- In the nitrogen fertilization experiment of 2009 the yield of Tuktuk was not giving a positive reaction on a higher nitrogen fertilization. The yield of the hybrid was increasing with higher levels of nitrogen. Yield of the Hybrid at 300 kg N/ha was significantly higher than yield at 120 kg N/ha (29%). The costs of nitrogen are relative low. So it is profitable for a farmer to give 300 kg N/ha in stead of 120 kg N/ha. Yield of the Hybrid grown with 300 kg N/ha was 128% higher than the mean yield of Bima and Ilokos.
- With respect to storability in reaction on increasing nitrogen fertilization, measured three months after harvest, there was in 2009 a clear difference between Tuktuk and the Hybrid. With Tuktuk the percentage of healthy bulbs was going down very fast with increasing nitrogen levels, while with the Hybrid the percentage of healthy bulbs was still at a high level also for the bulbs produced at the highest nitrogen level.
- In the all experiments transplanted in the second half of May the Hybrid and Tuktuk were much more productive than the seed bulb variety Bima: the Hybrid was yielding 52% more than Bima in the plant density experiment (grown at 150 plants/m²) and 74% in the fertilization experiment (grown with 180 kg N/ha); Tuktuk was yielding 17% more than Bima in the plant density experiment (grown at 150 plants/m²) and 31% in the fertilization experiment (grown with 180 kg N/ha);
- In all experiments the Hybrid was giving a higher yield than Tuktuk and the grading was much more in accordance with demands on the local market (more smaller bulbs). The Hybrid was also more resistant to antracnose than Tuktuk.
- Compared to the standard methods for sowing nurseries untill now in Brebes seed efficiency could be improved in the first place by closing the furrows with soil in stead of burned rice husks. Another important improvement is sowing at 1 cm in stead of 0,5 cm. Another aspect was: sufficient watering.
- Seed efficiency on beds was always lower than seed efficiency in trays. The highest seed efficiency (2 weeks after sowing) on beds reached in 2009 in nurseries with closing the furrow with soil and sowing at 1 – 1,5 cm: 54%, in trays 81%. The lowest seed efficiency reached on these nurseries was 25% both for trays and for beds. The difference is probably caused by the poorer soil conditions on beds.
- There are big differences between nurseries in loss of seedlings after emergence. Sometimes losses are only 5 -10%, but most of the time losses are bigger, up to 50%. These differences could not be explained.
- Treating the seed with Ridomil was damaging the seed and was giving a lower seed efficiency. In one nursery there was a tendency that loss of seedlings was reduced by Ridomil.
- Treating the seed with Tracer was not giving an improvement of seed efficiency.
- Drenching with Previcure had no positive effect on seed efficiency.
- It could not be proved that there was a difference in survival of seedlings after transplanting and in production between transplanting 6-weeks old seedlings or 5-weeks old seedlings.

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- It could not be proved that there was a difference in survival of seedlings after transplanting and in production between giving 0 kg N/ha and 75 kg N/ha in the nursery.
 - Production of TSS Tuktuk grown under an insect net (without spraying insecticides) was not different from TSS Tuktuk without an insect net. However in 2009 Spodoptera was only present at a low level.