Production of True Seed Shallots in Indonesia

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Abstract

Shallot production in Indonesia is based on crops grown from seed bulbs. The introduction of True Seed Shallot (TSS) could be an option to improve competiveness of Indonesian shallot production. In the period 2007 till 2010 a research project was conducted to improve growing techniques of TSS. Seed emergence in the nursery was improved if the seed was sown in furrows 0.5-1.5 cm deep and by closing the furrow after sowing with soil instead of burned rice husks. Compared to traditional seed bulb crops productivity of TSS was much higher, up to twice as high in some experiments, while the growing period of TSS was two to three weeks longer. A recently developed cultivar, 'Sanren', which is an improvement in productivity, earliness, quality for the local market and which can be grown at a lower plant density than the older cultivar 'Tuktuk', has increased feasibility of TSS in Indonesia. Optimal plant density of 'Tuktuk' was 175 plants per m^2; optimal plant density of 'Sanren' was about 75-100 plants per m^2, depending on the costs of seedlings. Optimal nitrogen fertilization of 'Tuktuk' was 180 kg N/ha; optimal nitrogen fertilization of 'Sanren' was 240 kg N/ha. However, additional research is needed to investigate the effect of nitrogen on quality of the harvested bulbs.

INTRODUCTION

In Indonesia, shallot (*Allium cepa* L. *Aggregatum* group) is an important crop. The area of shallot is estimated to be 90,000 ha. Most shallots grown in Indonesia are used for the local market. The competitiveness of Indonesian shallots decreased in the last decade, and imports increased sharply. In the period 2002-2008 import of ware shallot increased from 33,000 to 127,000 tonnes.

Traditional shallot production is based on crops grown from seed bulbs. In order to improve competiveness of Indonesian shallot production, production using true seed shallots (TSS) has been developed. The advantages of TSS over those grown from bulbs are:

- Transmission of viruses and other seed borne diseases is reduced;
- Costs of planting material are lower and storage of seed bulbs is not needed;
- TSS undergo active cultivars development while bulb shallots do not.

The first experiments with TSS in Indonesia were done in 1989 and 1990, but at that time the advantages of TSS were not clear (Permadi, 1993; Grubben, 1993). Yield of TSS was low, as production systems were not well developed. In the period 2007-2010 a TSS production system development project was implemented under the framework of the Horticultural Research Co-operation Programme between Indonesia and The Netherlands (HORTIN-II). The aim was to investigate feasibility of TSS in Indonesia and to improve TSS nursery and transplanting techniques.

MATERIALS AND METHODS

Research was done on-farm in Brebes, one of the most important low-land (ca. 8 m a.s.l.) shallot production regions in Java. Soil was alluvial, pH 6.7 at the surface. Experiments were conducted in April to October (dry season) in 2008 and 2009, directly after paddy rice. Shallots were grown on beds separated by ditches filled with water. Two

TSS cultivars were used: 'Tuktuk', a cultivar which has been grown by farmers on a restricted scale since 2007 and a new cultivar, 'Sanren'.

Research on Nursery Techniques

1. Seed Raising Mixtures. In 2008 an experiment was conducted with different seed raising mixtures for trays. Mixtures were composed of soil and organic material available in the region. Trays were 36×28 cm and were filled with 7.5 cm of seed raising mix. The experiment was sown on 15 April in four replications, one tray per replication, each with 355 seeds. There were ten treatments:

- paddy field soil;
- home garden soil;
- sandy soil;
- mixture paddy field soil + sandy soil (1:1);
- mixture home garden soil + sandy soil (1:1);
- mixture paddy field soil + sandy soil + stable manure (1:1:1);
- mixture home garden soil + sandy soil + stable manure (1:1:1);
- mixture paddy field soil + sandy soil + burned rice husks (1:1:1);
- mixture home garden soil + sandy soil + burned rice husks (1:1:1);
- mixture Andisol soil + stable sanure (1:1).

2. Sowing Depth and Furrow Fill. In 2009 experiments were done with different sowing depths and different methods of filling the furrow after sowing, both in trays and on a seedbed in the field. Treatments consisted of eight different combinations of sowing depth and ways to fill the furrows:

- 0.25 cm, burned rice husks;
- 0.5 cm, burned rice husks;
- 1.0 cm, burned rice husks;
- 1.5 cm, burned rice husks;
- 0.25 cm, soil;
- 0.5 cm, soil;
- 1.0 cm, soil;
- 1.5 cm, soil.

The experiment in trays was sown on 29 April with four replications, one tray (36×28 cm) per replication with 144 seeds. The trays were filled with a mixture of home garden soil, sandy soil and stable manure (volume = 1:1:1). The seedbed in the field was prepared by mixing this mixture into the soil (27.5 L/m^2). Before sowing the soil was treated with carbofuran (50 g/m^2). The experiment on the seed bed was sown on 29 April with four replications. Each plot size was 1.75 m^2 sown with 1035 seeds, not treated with fungicides or insecticides. Germination of the seed in laboratory tests was 90%.

Research on Productivity and Transplanting Techniques

1. Productivity of TSS Cultivars. In 2008 an experiment was conducted to investigate the productivity of TSS in comparison with traditional shallots grown from seed bulbs. TSS cultivars were 'Tuktuk' and 'Sanren'. Seed bulb cultivars were 'Bima curut' and 'Tanduyung'. Treatments were:

- 'Tuktuk', six weeks old seedlings, 100 plants/m^2;
- 'Tuktuk', six weeks old seedlings, 150 plants/m^2;
- 'Tuktuk', five weeks old seedlings, 150 plants/m^2;
- 'Sanren', six weeks old seedlings, 100 plants/m^2;
- 'Sanren', six weeks old seedlings, 150 plants/m^2;
- 'Bima curut', bulbs from store, 33 plants/m^2;
- 'Tanduyung', imported bulbs, 33 plants/m^2;
- 'Bima curut', farmer's kept bulbs, 33 plants/m^2.

Shallots were transplanted on 30 May 2008. The experiment was arranged in a randomized block design with three replications. Plot size was 7.5 m^2. The experiment was fertilized with inorganic fertilizer, in total 126 kg N, 104 kg P_2O_5 and 96 kg K_2O per

ha. Control of pests and diseases was according to local practice.
2. Plant Density of TSS Cultivars. On 20 May 2009 six-weeks-old seedlings of 'Tuktuk' and 'Sanren' were transplanted at four plant densities: 75, 125, 175 and 225 seedlings/m^2. The experiment was arranged in a randomized block design with four replications; plot size 7.5 m^2. The experiment was fertilized with inorganic fertilizer, in total 225 kg N, 125 kg P_2O_5 and 135 kg K_2O per ha.
3. Nitrogen Fertilisation. On 27 May 2009 six-week-old seedlings of 'Tuktuk' and 'Sanren' were transplanted (150 seedlings/m^2) and grown at four levels of nitrogen fertilization: 120, 180, 240 and 300 kg N/ha. Nitrogen was applied as ammonium sulphate in five equal gifts, two, three, four, five and six weeks after transplanting. The experiment was arranged in a randomized block design with three replications; plot size 7.5 m^2. The experiment was fertilized with 125 kg P_2O_5 and 192 kg K_2O/ha. In both experiments of 2009 the seed bulb cultivars 'Bima curut' and 'Ilokos' were included as references. Control of pests and diseases was according to local practice.

RESULTS AND DISCUSSION

Research on Nursery Techniques

1. Seed Raising Mixtures. Mixtures containing stable manure gave the highest percentages of seed emergence (Table 1). Stable manure improved probably soil structure while burned rice husks did not. Adding sandy soil or burned rice husks to paddy field soil or to home garden soil did not improve emergence. Paddy field soil was very sticky and difficult to handle in trays and at least 1/3 of the nursery mixture should be sandy soil.
2. Sowing Depth and Furrow Fill. In trays, the optimal sowing depth was 0.5-1.5 cm (Table 2). On the seedbed the effect of sowing depth was not significant. Filling the furrow after sowing with soil gave better emergence than filling the furrow with burned rice husks. In soil filled furrows seedling root growth was better than in furrows filled with burned rice husks. Seedlings were lost between two and six weeks after sowing. Loss of seedlings was probably caused by diseases and watering damage. Seeds were not treated with fungicides or insecticides. Although seedling emergence was higher in trays than on seedbeds, nurseries on a seedbed are preferred in Brebes. Costs of trays are relatively high and the availability of sandy soil and stable manure is restricted. In farmers nurseries in Brebes seedling emergence of about 40-50% was achieved on seedbeds, which means that ca.7.5 kg seed was needed for 1 ha TSS.

Research on Productivity and Transplanting Techniques

1. Productivity of TSS Cultivars. Table 3 presents the results of the experiment comparing TSS and seed bulb cultivars conducted in 2008. Survival of seedlings after transplanting was ca. 90%. Compared to seed bulb cultivars, the growing period of 'Tuktuk' was 25 days longer. 'Sanren' was one week earlier than 'Tuktuk'. Both TSS-cultivars were giving a higher yield than the seed bulb cultivars ('Tuktuk': 84%; 'Sanren': 126%). 'Sanren' was giving a significantly higher yield than 'Tuktuk' at both plant densities (23%). 'Tuktuk' was producing bigger bulbs than the other cultivars. Bulb size of 'Sanren' was slightly larger than 'Bima curut'. 'Sanren' is more accepted by the local market than 'Tuktuk' because of the smaller bulbs that are red.
2. Plant Density of TSS Cultivars. Figure 1 presents the results of the plant density experiment conducted in 2009. There was a clear difference between 'Tuktuk' and 'Sanren' in reaction on plant density differences. 'Tuktuk' grown at 75 and 125 plants per m^2 is giving a relatively low yield, while 'Sanren' is producing much better at these plant densities. Growing TSS at a lower plant density reduces production costs considerably. Transplanting 'Sanren' at lower plant densities could be profitable, especially if the cost per seedling is high. Under normal conditions this is not true for 'Tuktuk'. Also in this experiment, yield of TSS was significantly higher than yield of the seed bulb cultivars 'Bima curut' and 'Ilokos', except for 'Tuktuk' grown at 75 and 125 plants per m^2. The

difference was smaller than in 2008. This should be ascribed to the less optimal weather conditions in 2009 for shallot production. Also, on-farm shallot yield was relatively low in 2009. In the experiment the growing period of 'Tuktuk' was 14 days longer than the growing period of 'Bima curut' and 'Ilokos'. 'Sanren' was 6 days earlier than 'Tuktuk'.

3. Nitrogen Fertilisation. Table 4 presents the results of the nitrogen fertilization experiment conducted in 2009. Optimal nitrogen fertilization of 'Tuktuk' was 180 kg N/ha, while 'Sanren' was giving the highest yield at 300 kg N/ha. An indicative trial conducted with the harvested bulbs of the experiment showed that storability was probably decreasing with higher nitrogen. This was more pronounced with 'Tuktuk' than with 'Sanren', but 'Sanren' quality was also compromised probably too much at 300 kg N/ha. After a storage period of 75 days percentage of healthy bulbs was below 50% if nitrogen fertilization was higher than 180 kg N with 'Tuktuk' and higher than 240 kg N with 'Sanren', while this percentage was higher than 70% with lower gifts. Additional research is needed to investigate the effect of nitrogen on quality of the harvested bulbs.

CONCLUSIONS

It was found that when stable manure was added to seed raising mixtures, seedling emergence significantly improved. This may have been an effect on the physical characteristics of the seed raising mix, and more research should be conducted to elucidate the mechanism of this effect.

Research on nursery techniques has shown that seedling emergence could be improved by sowing at 0.5-1.5 cm deep and by closing the furrow after sowing with soil, rather than with burned rice husks. Seedling emergence in trays was higher than on a seedbed in the field. However, because of the high costs of trays and the poor availability of stable manure and sandy soil, nurseries on a seedbed in the field are generally preferred by farmers in lowland regions such as Brebes.

Productivity of the TSS cultivars 'Tuktuk' and 'Sanren' was much higher than seed bulb cultivars. On average, yields were 70 and 113% higher than 'Bima curut', respectively. A disadvantage of TSS was the longer growing period. Compared with traditional seed bulb cultivars the growing period of 'Tuktuk' was 2-3 weeks longer, and 'Sanren' about 1 week. The harvested bulbs of 'Sanren' were smaller than those of 'Tuktuk' and the colour is more deeply red, making them more acceptable for local consumption than 'Tuktuk'.

The plant density experiment showed that 'Sanren' could be grown at a lower plant density than 'Tuktuk' and still achieve similar yields. Transplanting at a lower plant density reduces the production costs remarkably, especially if the costs per seedling are relatively high.

The nitrogen fertilization experiment showed that productivity of 'Sanren' was improved with increasing nitrogen fertilization up to 240 kg N per ha, while quality of the harvested bulbs was still on a good level. Optimal productivity of 'Tuktuk' was reached at 180 kg N/ha, while increasing the nitrogen fertilization to 240 kg N/ha resulted in a loss of quality of the harvested bulbs.

These results show that the introduction of TSS could be a realistic option to improve competiveness of Indonesian shallot production.

ACKNOWLEDGEMENTS

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Literature Cited

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Tables

Table 1. Effect of nursery mixture on seedling emergence, four weeks after sowing.

Soils and mixtures (volume based)	% seedling emergence
Paddy field soil	22
Home garden soil	27
Sandy soil	12
Mixture paddy field soil + sandy soil (1:1)	13
Mixture home garden soil + sandy soil (1:1)	13
Mixture paddy field soil + sandy soil + stable manure (1:1:1)	47
Mixture home garden soil + sandy soil + stable manure (1:1:1)	31
Mixture paddy field soil + sandy soil + burned rice husks (1:1:1)	17
Mixture home garden soil + sandy soil + burned rice husks (1:1:1)	16
Mixture Andisol soil + stable manure (1:1)	52
LSD 5%	9

Table 2. Effect of sowing depth and methods of filling the furrow after sowing on seed emergence two and six weeks after sowing.

Depth of sowing/filling furrow with soil or burned rice husks	% seedling emergence			
	On seedbed		In trays	
	2 weeks	6 weeks	2 weeks	6 weeks
0.25 cm, burned rice husks	25	18	23	11
0.5 cm, burned rice husks	27	22	33	23
1.0 cm, burned rice husks	24	15	41	29
1.5 cm, burned rice husks	28	18	44	33
0.25 cm, soil	31	21	44	24
0.5 cm, soil	33	24	67	46
1.0 cm, soil	35	20	75	52
1.5 cm, soil	43	24	81	40
LSD 5%	18	13	14	14

Table 3. Transplanting experiment in 2008. Earliness, yield and grading of TSS cultivars 'Tuktuk' and 'Sanren' grown at different plant densities and traditional seed bulb cultivars.

	Earliness (growing period in days)	Yield with leaves (t/ha)*	Grading (weight %)				
			5-15	15-25	25-35	35-45	>45
			mm				
Tuktuk 100 pl/m^2	82	30.9	0.0	1.1	16.7	82.0	0.2
Tuktuk 150 pl/m^2	81	36.2	0.0	1.0	16.3	82.7	0.0
Tuktuk 150 pl/m^2**	82	37.5	0.0	1.0	20.1	77.9	1.0
Sanren 100 pl/m^2	75	39.7	0.0	10.5	66.5	23.0	0.0
Sanren 150 pl/m^2	75	42.5	0.0	17.1	69.7	13.2	0.0
Bima curut (store)	57	14.3	3.3	32.5	56.1	8.0	0.0
Tanduyung (imported)	56	23.2	8.1	71.6	20.3	0.0	0.0
Bima curut (farmer)	57	17.1	0.7	24.0	58.0	17.3	0.0
LSD 5%		0.7	1.2	7.4	12.0	14.3	1.3

* ha with 70% beds and 30% ditches.
** Seedlings transplanted 5 weeks after sowing; other treatments: 6-week-old seedlings.

Table 4. Effect of nitrogen fertilization on yield of 'Tuktuk' and 'Sanren' in 2009.

	Yield with leaves (t/ha*)	
	Tuktuk	Sanren
120 kg N/ha; 150 plants per m^2	17.0	24.2
180 kg N/ha; 150 plants per m^2	18.3	25.8
240 kg N/ha; 150 plants per m^2	15.4	28.2
300 kg N/ha; 150 plants per m^2	15.1	31.1
LSD 5%	2.6	4.5

* ha with 70% beds and 30% ditches.
Remark: yield of seed bulb cultivars grown with 180 kg N/ha in this experiment: 'Bima curut': 14.2 t/ha; 'Ilokos': 11.8 t/ha.

Figures

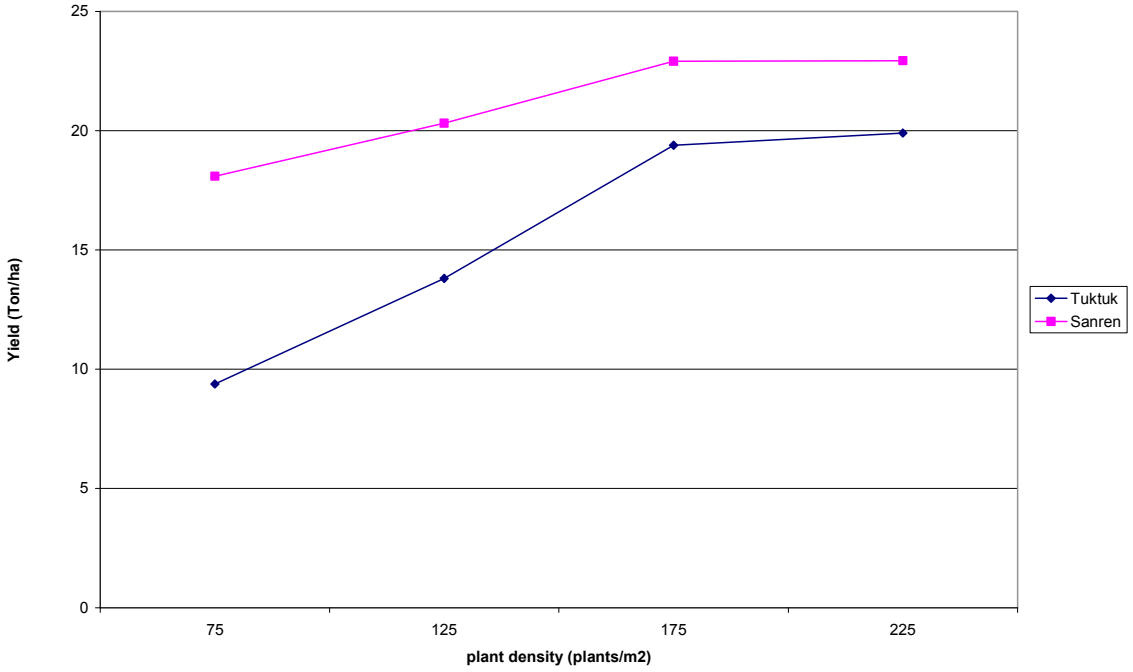

Fig. 1. Effect of plant density on yield of 'Tuktuk' and 'Sanren' in 2009; yield of 'Bima curut' (store) and 'Ilokos' (imported) was 13.6 and 14.2 t/ha, respectively; ha with 70% beds and 30% ditches; LSD 5% in this experiment = 3.65 t/ha.