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Can We Produce True Seed of Shallot (TSS) from Small Size Shallot Sets?

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Abstract

The Indonesian government has been promoting the use of true seed of shallot (TSS) for shallot production due to its higher productivity and greatly reduced risk of disease transfer. This research was conducted at Leuwikopo experimental station, Department of Agronomy and Horticulture, Bogor Agricultural University, West Java, Indonesia, in 2015. The aim of the research was to study TSS production from small size shallot sets "Bima Brebes", an easy to flower shallot cultivar. The trial was arranged in a completely randomized block design with two factors; the size of shallot size, i.e. small (3 to 4 g) and medium (5 to 10 g) as the first factor, and BAP concentrations, i.e. 0.50. 100. 150 and 200 ppm as the second factor. The results showed that the vegetative growth of plants from the the two sizes of shallot sets. TSS production and TSS quality from small size (3-4 g) shallot set was also comparable to that of medium size shallot set, except for 1000-seeds weight in which medium size shallot set produced heavier 1000-seeds weight than that of small size shallot set. Therefore small size shallot set can potentially be useful for TSS production.

Keywords: BAP, capsule, flowering, seed weight, umbel

Introduction

The use of true seed of shallot (TSS) as planting materials for shallot production has been promoted by the government of Indonesia due to potentially higher productivity and it would minimize the problems associated with bulb-transmitted diseases. Using TSS as planting material significantly increases productivity and was reported to reach twice as much of the use of shallot set, thus increased the farmer's income up to 70 million rupiahs from a single planting season (Basuki, 2009). As a consequence the demand for TSS has been increasing. Despite government's effort to encourage the use of TSS as planting material, the seed supply has been inadequate.

Production of TSS in the highlands has been successful. Most easily to flower varieties such as "Maja", "Bauji", "Bima Brebes", "Trisula" and "Katineng", flowered and produced TSS readily in the highland provided that the shallot sets were vernalized at 10^{O}C for three to four weeks prior to planting and the plants were sprayed with 50 ppm benzylaminopurine (BAP) at 1, 3, and 5 weeks after planting (WAP), just before the first umbel appeared (Rosliani et al., 2012). Cultivation practice for TSS production in the lowland was very similar to that of highland; however, in the lowland TSS production was higher when BAP was applied at 2, 4, and 6 WAP due to later appearance of the first umbel (Kurniasari et al., 2017). The delayed BAP application resulted in higher percentage of flowering plants and higher number of flowers per umbel (Rosliani et al., 2013; Kurniasari et al., 2017). Incorporating honey bee (*Apis cerana*) hives or planting *Tagetes* sp. among the crop plants increased number of capsule per umbel (Palupi et al., 2015), and consequently higher TSS production. UV plastic sheet was put up to protect the plants from rain water and dewdrops before the plants started to flower. This cultivation procedure has been well adopted and practiced among TSS producers in Indonesia.

Small size shallot sets have been successfully used in production. In any case, medium to large size (>5 g) shallot sets always been used for the TSS production (Sumarni and Soetiarso et al., 1998; Rosliani et al., 2012; Rosliani et al., 2013; Hilman et al., 2014; Kurniasari et al., 2017) as was reported on onions by a number of studies that larger onion produced higher and better quality of TSS than smaller ones

(Ashrafuzzaman et al., 2009; Khokhar, 2009; Asaduzzaman et al., 2012; Ashagrie et al., 2014, and Mollah et al., 2015). Unfortunately, the availability of shallot sets of the required size is limited and is of higher price. This study aimed at developing a technique to speed up TSS production for potential uses as planting material for shallot production, and specifically to determine if small shallot sets (<4 g) can be used for TSS production.

Material and Methods

The study was conducted at Leuwikopo experimental station, Department of Agronomy and Horticulture, Bogor Agricultural University, West Java Indonesia, ±240 m asl, during June to November 2015, coincided with the dry season. Cultivar "Bima Brebes", an easy to flower cultivar, was used for this study. The experiment was arranged in a completely randomized block design (CRBD) with two factors and replicated three times. The first factor was the size of shallot sets: small (3-4 g), and medium (5-10 g) as control (Sumarni and Hidayat, 2005). The second factor was BAP concentrations of 0, 50, 100, 150, and 200 ppm applied at the rate of 100 ml per polybag containing three plants each, at 2, 4 and 6 week after planting (WAP).

The shallot sets were vernalized at 8-10^{o}C for four weeks prior to planting. The media was a mixture of pasteurized soil : goat manure : charcoal husk (3 : 2 : 1 v/v). Three shallot sets were planted in each polybag (Figure 1A) with ten polybags per replicate. The polybags were then placed in raised beds in 30 x 40 cm distance with plastic cover to avoid heavy rain. *Tagetes* sp were planted among the shallot plants to attract insect pollinators (Figure 1B).

Scoring was conducted on plant height,number of leaf per and per set, percentage of flowering plants, number of umbel per plant, florets per umbel, capsule production and 1000-seed weight. Data was analysed using ANOVA and further tested using Duncan Multiple Range Test (DMRT) at α = 5% to compare set of means.

Results and Discussion

Concentration of BAP and size of shallot sets independently affect the number of leaves per cluster, but not the plant height and the number of leaves per set. Most of the medium size shallot sets had already formed a cluster of several sets (Figure 2). The number of sets per cluster increased after planting

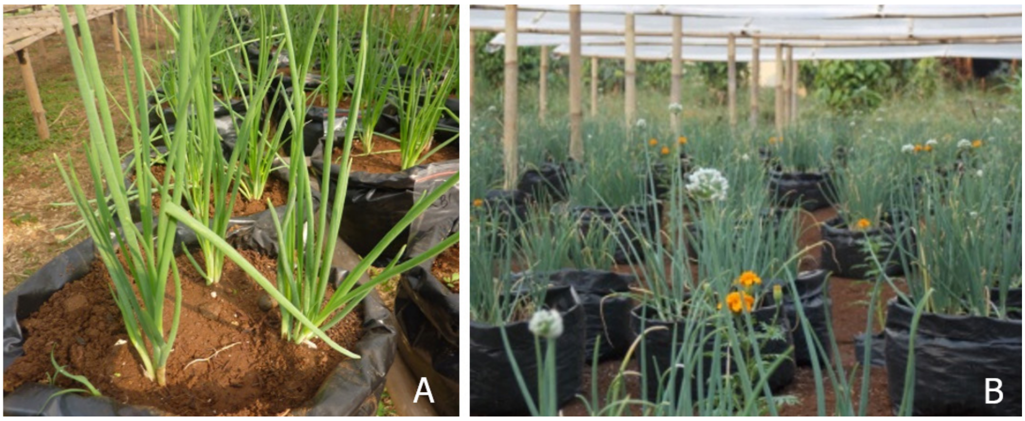

Figure 1. Experimental setting showing three shallot plants per polybag (A); flowering shallot plants grown under UV plastic sheet (B)

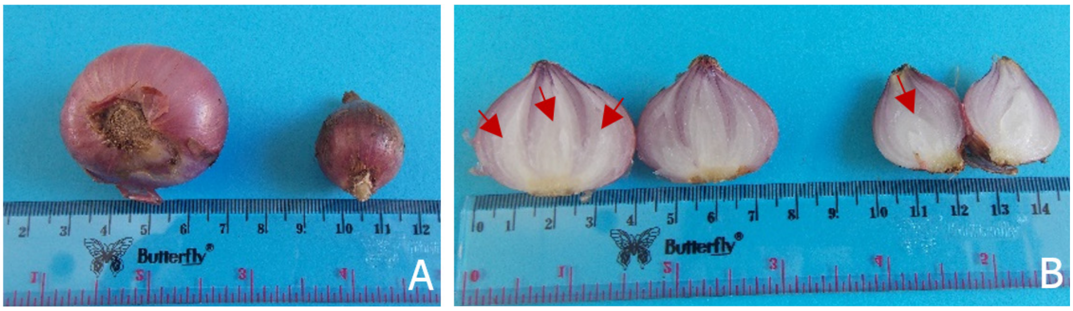

Figure 2. Medium (left) and small (right) sizes of shallot sets (A); shallot sets (A); the medium size had formed a cluster of three sets (red arrows) whereas the small size only had one (B).

Table 1. Plant height and number of leaves and sets per cluster at 6 WAP in response to BAP application and size of shallot set

BAP concentration (ppm)	Plant height (cm)	No. of leaves per cluster	No. of leaves per set
0	31.43	21.2 b	5.8
50	31.12	22.6 ab	5.6
100	32.26	25.0 a	6.3
150	31.40	21.8 b	5.5
200	31.98	23.4 ab	5.8
Average	31.63	-	5.8
Size of shallot sets			
Small (3-4 g)	31.20	20.5 b	5.2 b
Medium (5-10 g)	32.08	25.1 a	6.4 a
BAP x Size of sets	ns	ns	ns

Note : ns = not significantly different; values followed by the same letters within the same column are not significantly different according to DMRT at α = 5%.

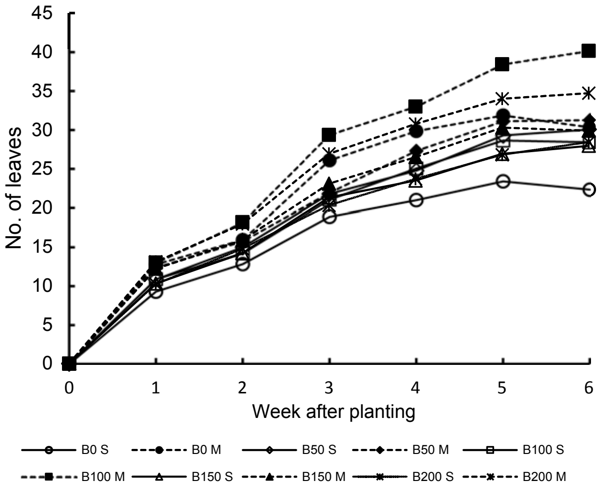

Figure 3. Number of leaves per cluster during vegetative growth as response to size of shallot set and BAP concentrations. B = benzylaminopurine; S and M are small and medium sets of shallots, respectively.

and ranged four to seven sets. Therefore, the higher number of leaves per cluster of plants treated with BAP at 100 ppm (Table 1) was likely because the plants produced greater number of shallot set per cluster. The greater the number of sets per cluster the greater the number of leaves per plant, which also the basis of the medium size shallot set had more number of leaves per cluster than the small size set. The plants from medium size shallot set tend to produce more sets per cluster (Table 1), thus greater number of leaves (Figure 3).

There was no interaction between BAP concentration and the size of shallot set in affecting the percentage of flowering plants of cultivar "Bima Brebes". However, BAP concentration as low as 50 ppm almost doubled the percentage of flowering plants, but did not affect the number of umbel per plant, number of floret per umbel and percentage of capsule set per umbel (Table 2). The flowering of untreated plants with BAP indicated the effect of vernalization that induced flower initiation, and application of BAP strengthened the process. BAP belongs to cytokinin, a plant-specific hormone that plays a central role during the cell cycle and influences numerous developmental processes, specifically the plant meristem activity and morphogenesis. Cytokinin maintains shoot apical meristem and root vascular development (Osugi and Sakakibara, 2015). The BAP might have affected the cell division in the apical meristem and reinforced the flower initiation that had been induced during vernalization, hence increased the percentage of flowering plant, as also reported by Rosliani et al. (2012 and 2013). Krontal et al. (1998) reported that flower initiation occurs after formation of at least six true leaves at the axillary meristem of each set, simultaneously with floral initiation at the apical meristem. The number of leaves per set was similar for all treatment, averaged 5.5-6.3 leaves per set. The number of leaves of small size shallot set was

Table 2. Percentage of flowering plant, number of umbel per plant, number of floret per umbel, and percentage of capsule set per umbel in response to BAP concentrations

BAP concentration (ppm)	Flowering plant (%)	No. of umbel per plant	No. of floret per umbel	Capsule set per umbel (%)
0	20.6 b	1.3	88.1	46.0
50	38.3 a	1.2	81.5	52.4
100	41.0 a	1.4	74.9	58.6
150	31.6 ab	1.6	83.9	54.2
200	39.6 a	1.3	75.4	54.7
Average	-	1.3	80.8	53.2

Note : values followed by the same letters within the same column are not significantly different according to DMRT at α = 5%.

was slightly lower than that of medium size shallot set (Table 1). that of the medium size shallot set.

The percentage of flowering plants in this experiment was higher than reported by Rosliani et al. (2013). Application of BAP at 50 ppm had almost doubled the percentage of flowering plant from 20.6 to 38.3% higher than in the previous experiment, i.e. doubled from 11.7 to 28.9%. In the previous experiment cultivar “Bima Brebes” was planted in the lowland of Subang (100 m asl) with the same cultivation procedure except that BAP was applied at 1, 3 and 5 WAP instead of at 2, 4, and 6 WAP. The number of umbel per plant (1.3 umbels) and number of floret per umbel (80.8 florets) were comparable to the previous experiment of 1.3 and 89.0 respectively. Nevertheless, the percentage of capsule set in this experiment was higher than that of Rosliani et al. (2013) and was considered to be due to the biodiversity in the surrounding area which affect the abundance of pollinators and their activities. The Leuwikopo experimental station was planted with many species, and more diverse than that of Subang experimental station. The higher the biodiversity the higher the population and diversity of insect pollinators therefore increased capsule formation. Introducing bee colonies among the flowering plants proved to increased capsule set (Kurniasari et al., 2017). Hence, application of BAP would increase the percentage of flowering plants that would increase the chance of having greater yield.

Figure 4 shows the percentage of flowering plants and number of floret per umbel from the small size shallot sets were not significantly different from that of the medium size, indicating that the small size shallot set was equally potential for production of TSS. The lower number of leaves produced by small size shallot sets did not seem to affect the flowering. The same result on the number of capsule and TSS per umbel was more likely to depend on the activity of the insect pollinators rather than the size of shallot sets. This data also indicate that the activity of the insect pollinator was evenly distributed among plants and resulted in TSS yield per plant and per plot (30 plants) from small size shallot sets was not significantly different from those of the medium size shallot sets. The data confirmed that the small size shallot sets was as good as the medium size for TSS production and yielded seeds in a comparable quantity.

Application of BAP did not affect the TSS yield per umbel, per plant and per plot, although the higher concentration of BAP tended to increase TSS yield per plant and per plot (Table 3). The yield from BAP-

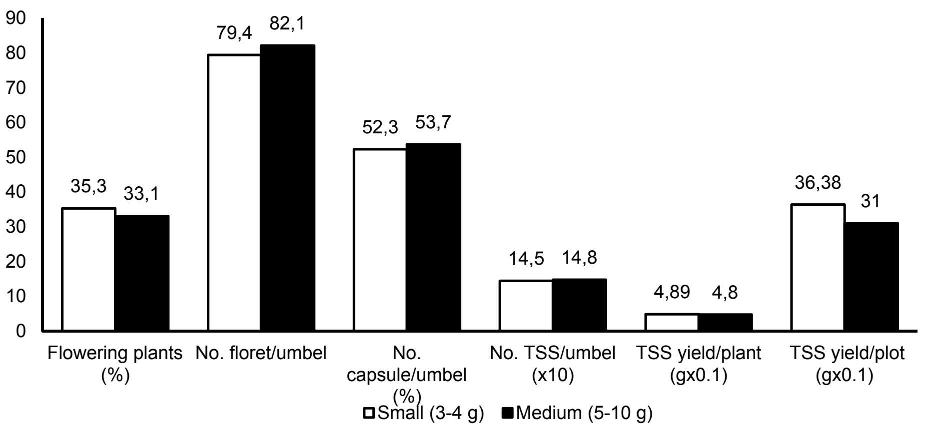

Figure 4. Flowering and true shallot seeds (TSS) yield from small and medium size shallot sets

Tabel 3. Number of true shallot seeds (TSS) per umbel and TSS yield per plant and per plot in response to BAP concentration

BAP concentration (ppm)	No. TSS per umbel	TSS yield/plant (mg)	TSS yield/plot (mg)
0	137.7	488	2517
50	146.5	443	3685
100	154.2	456	3543
150	153.2	520	3268
200	136.3	516	3838
Average	145.6	484	3370

treated plants tended to be higher than control and could be due to higher number of leaves, thus higher production of assimilate to be accumulated as storage reserves.

Size of shallot sets did not affect seed quality but did the concentration of BAP. Application of higher concentration of BAP increased 1000-seed-weight and vigor index of TSS of "Bima Brebes" (Table 4). Based on the minimum standard of quality seed of 75% germination (Direktorat Bina Perbenihan, 2007), the TSS produced from BAP-treated plants was categorized as quality seed although statistically was not significantly different from untreated plants.

Weight of 1000-seeds, vigor index, germination and maximum growth potential of TSS from small size shallot sets were comparable to those from medium size shallot sets (Figure 5). The germination of TSS from the two sizes of shallot set met the minimum standard of quality seed. Therefore small size shallot sets was as good as the medium size bulbs for TSS production.

Conclusion

This study has demonstrated that small size shallot sets was suitable for true shallot seed production provided the shallot sets were vernalized at 8-10°C for four weeks prior to planting and was applied with benzylaminopurine at 50 ppm at 2, 4, 6 week after planting.

Table 4. The quality of true shallot seeds (TSS) as response to BAP concentration

BAP concentration (ppm)	1000-seed- weight (mg)	Vigor index (%)	Germination (%)	Maximum growth potential (%)
0	3556 b	65.5 bc	71.0	81.5
50	3519 b	58.8 c	78.0	83.0
100	3663 a	72.0 ab	78.5	84.0
150	3675 a	72.0 ab	76.5	81.5
200	3688 a	75.0 a	81.0	88.0
Average	-	-	77.0	83.6

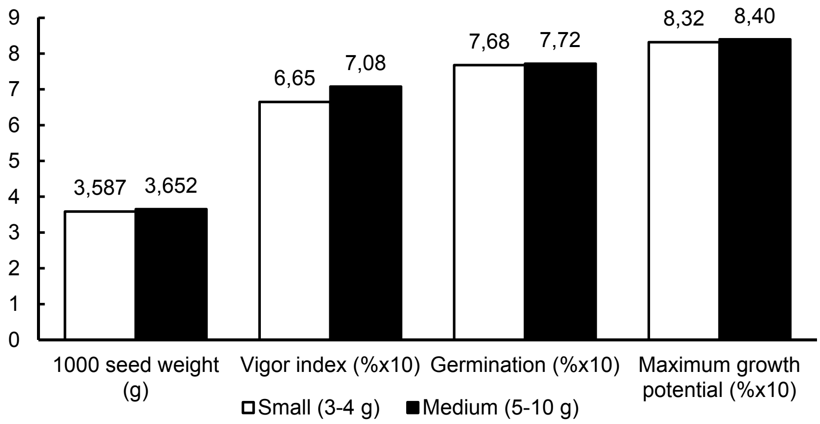

Figure 5. The quality of true shallot seeds (TSS) from small (3-4 g) and medium size (5-10 g) shallot sets.

References

Asaduzzaman, M. Hasan, M., and Moniruzzaman, M. (2012). Quality seed production of onion (*Allium cepa* L.) an integrated approach of bulb size and plant spacing. *Journal of Agricultural Research* **50**, 119-128.

Ashagrie, T. Belew, D. Alamerew, S., and Getachew, Y. (2014). Effects of planting time and mother bulb size on onion (*Allium cepa* L.) seed yield and quality at Kobo Woreda, Northern Ethiopia. *Journal of Agricultural Research* **9**, 231-241.

Ashrafuzzaman, M., Millat, MN., Ismail, M.R., Uddin, M.K., Shahidulliah, S.M., and Meon, S. (2009). Paclobutrazol and bulb size effect on onion seed production. *Journal of Agriculture and Biology* **11**, 245-250.

Basuki. (2009). Analisis kelayakan teknis dan ekonomis teknologi budidaya bawang merah dengan biji botani dan benih umbi tradisional. *Jurnal Hortikultura* **29**, 214-227.

Direktorat Bina Perbenihan (2007), "Pedoman Sertifikasi dan Pengawasan Peredaran Mutu Benih", Direktorat Bina Perbenihan, Direktorat Jenderal Tanaman Pangan dan Hortikultura, Jakarta.

Hilman, Y., Rosliani, R., and Palupi, E.R. (2014). Pengaruh ketingian tempat terhadap pembungaan, produksi, dan mutu benih botani bawang merah. *Jurnal Hortikultura* **24**, 154-161.

Krontal, Y., Kamenetsky, R., and Rabinowitch, H.D. (1998). Lateral development and florogenesis of tropical shallot – a comparison with bulb onion. Internat. *Jurnal of Plant Science* **59**, 57-64.

Kurniasari, L., Palupi, E.R., Hilman, Y., and Rosliani R. (2017). Peningkatan produksi benih botani bawang merah (*Allium cepa* var. ascalonicum) di dataran rendah subang melalui aplikasi bap dan introduksi *Apis cerana. Jurnal Hortikultura* **27**, 201-208.

Mollah, M.R.A., Ali, M.A., Ahmad, M., Hassan, M.K., and Alam, M.J. (2015). Effect of bulb size on the yield and quality of true seeds of onion. *European Journal of Biotechnology and Bioscience* **3**, 23-27.

Osugi, A, and Sakakibara, H. (2015). Q&A: How do plants respond to cytokinins and what is their importance?. *BioMed Central Biology* **13,**102.

Palupi, E.R., Rosliani, R., and Hilman, Y. (2015). Peningkatan produksi dan mutu benih botani bawang merah (*True Shallot Seed*) dengan introduksi serangga penyerbuk. *Jurnal Hortikultura* **25**, 26-36.

Rosliani, R., Palupi, E.R., and Hilman, Y. (2012). Penggunaan benzilaminopurin dan boron untuk meningkatkan produksi dan mutu benih *true shallot seed* bawang merah (*Allium cepa* var. ascalonicum) di dataran tinggi. *Jurnal Hortikultura* **22**, 242-250.

Rosliani, R, Palupi, E.R., and Hilman, Y. (2013). Penggunaan benzilaminopurin dan boron terhadap pembungaan, viabilitas serbuk sari, produksi, dan mutu benih bawang merah di dataran rendah. *Jurnal Hortikultura* **23**, 339-349.

Sumarni, N., and Hidayat, A. (2005). "Panduan Teknis Budidaya Bawang Merah". BALITSA, Bandung.

Sumarni, N., and Soetiarso. (1998). Pengaruh waktu tanam dan ukuran umbi bibit terhadap pertumbuhan, produksi dan biaya produksi biji bawang merah. *Jurnal Hortikultura* **8**, 1085-1094.

Sumiati, E., and Sumarni, N. (2006). Pengaruh kultivar dan ukuran umbi bibit bawang Bombay introduksi terhadap pertumbuhan, pembungaan dan peoduksi benih. *Jurnal Hortikultura* **16**, 12-20.