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Production of Botanical Seeds and Shallot Boobs with Vernalization and Giberrylin (GA3) Treatment in Highland Areas

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ABSTRACT

Vernalization and Gibberellin (GA3) solution can be applied to simultaneously increased shallot production and TSS (True Shallot Seed) in the highlands. The research aimed to obtain shallot varieties that are able to naturally flower more and have high growth and production. This research was carried out in the form of split plot experimental design. The main plots consisted of five shallot varieties selected from the adaptation test, which resulted from planting in the lowlands and highlands, namely the Bima Brebes variety (V1), Manjung variety (V2), Bauji variety (V3), Bangkok Jeneponto variety (V4), Mentes variety (V5). The sub-plots consisted of 4 stratifications of vernalization temperature, namely: room temperature (F1), 4°C (F2), 8°C (F3) and 12°C (F4). The sub-sub-plots consist ed of 4 concentrations of gibberellins GA3 in aquades, namely: 0 ppm (H1), 50 ppm (H2), 75 ppm (H3), and 100 ppm (H4). Each treatment was repeated three times, so as to obtain as many as: 5 x 4 x 4 x 3 = 240 experimental plots. Results showed that shallot varieties have different responses to vernalization and gibberellin GA3 treatment. No stratum of vernalization temperature and certain GA3 concentrations were found that consistently supported certain observational parameters on the growth and production of five shallot varieties. Manjung and Bauji varieties were observed as having great potential to produce more flowers and botanical seeds in highlands.

1. INTRODUCTION

Shallot or red onion (*Allium sativum* L.) is a horticultural plant that is used in everyday life as a cooking spice and medicine by Indonesian people (Pratiwi *et al*., 2020). Seeds as planting material play an important role in supporting the success of planting expansion (Prayudi *et al*., 2017). There are 2 types of shallot seeds, namely boobs and botanical seeds or TSS (True Shallot Seed) (Rahayu *et al*., 2019). The weakness of boobs is dormancy which can be overcome by vernalization treatment (Wang *et al*., 2020). The advantages of

TSS is that it can increase the production of shallot boobs by up to 2 times as compared to those of using boob seeds. In addition, TTS is free from disease and viruses, and has a longer shelf life than boobs (Djali & Rachmat 2013).

The use of high quality boob seeds is the first step in increasing production (Pangestuti & Sulistyaningsing, 2011). The obstacle to using planting material in the form of seed boobs is the long seed dormancy period of 2 to 3 months (Waluyo & Sinaga, 2017). The dormancy period of shallot boobs will hamper the smooth production and cultivation processes because the seeds have the potential to be late or unable to grow, which will also have an impact on planting time (Ohanenye *et al*. 2019). Therefore, it is necessary to apply technology, one of which is the vernalization treatment at low temperatures (Wibowo & Purnamaningsih, 2018).

According to Widiawati (2014) the problem of low flowering and seed formation of shallots can be overcome by selecting the right location, tuber size, seed tuber vernalization treatment, growth regulators (ZPT), planting time, fertilization, and using pollination methods. Wiguna *et al*. (2017) state that varieties Bima Brebes, Maja Cipanas, and Kuning as well as Trisula and Biru Lancor which are planted in several highlands, generally have flowering rates of up to 90–100%, while in the lowlands, flowering rates are generally still low (<30%) (Putrasamedja & Suwandi, 1996).

The existence of these treatments is expected to accelerate the process of cell division which plays a role in breaking dormancy or inhibition of plant growth by increasing the activity of endogenous gibberellins so that plants can grow normally (Rosliani *et al*., 2017; Abubakar *et al*., 2016). Based on research of Indah (2016), dormancy breaking can be carried out at a temperature of 5°C. Therefore, based on the background that has been stated, the current research aims to obtain onion varieties that are able to flower naturally more and have higher growth and production.

2. MATERIALS AND METHODS

2.1. Time and Place

This experiment took place from October 2017 to January 2018, in the District of Rompio Pao in the highlands (altitude of 1000 m asl), Gowa Regency, South Sulawesi, which is located at 12°38.16' East Longitude to 5°33.6' East Longitude .

2.2. Materials and Equipment

The materials used in this experiment were 50 kg of shallot boobs for each variety, both upland and lowland. The seed tubers used were the product of the first trial selected varieties. MOL-M2 liquid organic fertilizer and granular organic fertilizer brand Tawon (16-16-16), and gibberellin (GA3). The tools used in this study were tractors for tilling the planting area, hoes for making beds, scythes for weeding, machetes as cutting tools, digital scales (Camry Model EHA401, 0.01-100 g), tape meter, GPS, thermometer, plastic drum, flushing tools (“gembos”), bags, streamin cloth, stationery, camera (Canon EOS 60D), refrigerators (Polytron).

2.3. Design of Experimental

The research was carried out in the form of split plots based on a randomized block design (RAK) pattern (Putri *et al*., 2018). The main plot of the five shallot varieties selected from the previous trial, which were planted in the lowlands and uplands. The five varieties are: (1) Bima Brebes (V1), (2) Manjung (V2), (3) Bauji (V3), (4) Bangkok Jeneponto (V4), and (5) Mentes (V5).

The sub plots consisted of 4 vernalization temperature, namely: (1) Temperature 4° C (F1), (2) 8°C (F2), (3) 12°C (F3), and (4) Room temperature >12°C (F4). Whereas, the sub-sub-plots consisted of 4 giberelin (GA3) concentration in aquades, namely: (1) 0 ppm (H1), (2) 50 ppm (H2), (3) 75 ppm (H3), and (4) 100 ppm (H4). Each treatment was repeated three times, so that we prepared 5 x 4 x 4 x 3 = 240 experimental plots for each study location and 80 treatment combinations were tried to assess the effect of treatment.

2.4. Research Procedures

The seed boobs to be planted were relatively uniform by selecting seed boobs having weigh of an average of 5 – 10 g. The selected boobs were treated with vernalization for 25 days at four temperature strata, namely, 1) room temperature, 2) 4^{o}C , 3) 8^{o}C, and 4) 12 ^{o}C. Vernalization was carried out using a refrigerator (show case). The vernalized seed boobs were soaked in distilled water, and then into GA3 solution with concentrations of 0 ppm (aquadest), 50 ppm, 75 ppm and 100 ppm for 25 minutes, and then drained for planting. Fertilizer application to shallot plants was given 3 times, namely basic fertilizer, supplementary fertilizer 1 and supplementary fertilizer 2. Basic fertilizer application was carried out 1 to 2 days before planting and after the shallot plants were 2 weeks old (10-15 days after planting).

At the beginning of growth until the shallot plants were 3 weeks old, watering was performed regularly in the morning and afternoon (Rizal & Inggi, 2020). Apart from that, the need for irrigation water is generally very necessary, especially during the critical period, namely during formation of the boobs (Basrum *et al*., 2020). Insufficient irrigation water will reduce the production of shallot boobs (Pujiastuti, 2017).

Plant maintenance was carried out by replacing the damaged dead seeds. Plant replacement can be done 7-10 days after planting (Andriyani, 2020). Meanwhile, weeding was done by removing and clearing weeds on the planting land so that the soil structure and cleanliness of the land are maintained to maintain optimal plant growth (Sahidin *et al*., 2019).

2.4. Observation and Measurement

Parameters observed were plant height, number of tillers, number of leaves, flowering clumps, flowering varieties, seed production, and seed weight. Observations were made for ± 84 days which lasted from October 2017 to January 2018. Measurements and observation were carried out every week during the study period. The number of leaves was presented as an average of the total and weekly number of leaves.

2.5. Analysis

The research data were analyzed by means of ANOVA for all observed variables. If there was a significant effect, to determine the best treatment then proceed with Duncan's multiple range test (DMRT) to determine the magnitude of the average difference between treatments (Setiawan, 2011).

3. RESULTS AND DISCUSSION

3.1. Plant Height

Figure 1 shows the average plant height based on varieties. The results from the analysis of variance (ANOVA) on plant height of five shallot varieties in the highlands showed that the shallot variety had a very significant effect on plant height. This is in accordance with the results of another study (Rihadi *et al*., 2021). While, the treatment

of vernalization temperature stratum and gibberellin hormone (GA3) concentration had no significant effect on plant height parameter. (Hafids *et al*., 2018) reported that GA3 hormone can stimulate stem growth, increase enlargement and cell multiplication in plants, so that plants can reach maximum height. However, it was not appear in our study.

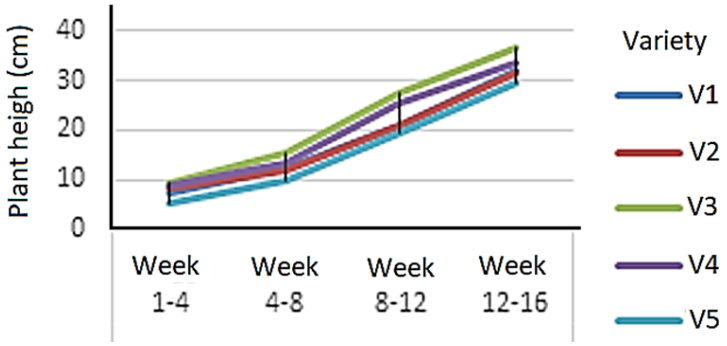

Figure 1. The development of plant height presented as weekly average

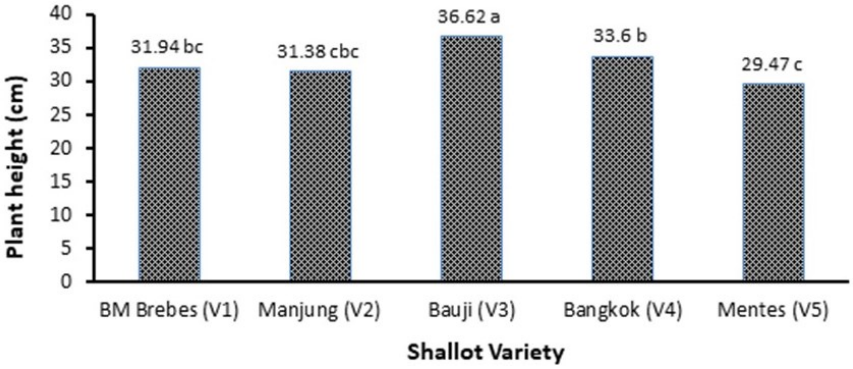

Figure 2. Average plant height of shallots cultivated in highland. (Note: numbers followed by the same lowercase is not significantly different in DMRT test at 5% significant level)

The Bauji variety has the highest plant height and is very significantly different from other varieties. The Bangkok Jeneponto variety was significantly different from the Mentes variety, but not significantly different from the Bima Brebes and Manjung varieties, as well as the Bima Brebes variety not significantly different from Mentes (Figure 2). This is due to the growing environmental conditions that are suitable for the Bauji shallot variety but are less supportive for other shallot varieties (Nurahim & Alfina 2020). According to (Yasin *et al*., 2020), the expected superior varieties of shallots should be varieties that are adaptive with high productivity, early harvest, resistant to pests and diseases, able to grow in their growing environment or agroecology, and have tuber quality according to consumer preferences (Suhartono *et al*., 2022).

Shallot plant height in this study was similar to that reported by Yoanma *et al*. (2022) for the control treatment with an average plant height of 37 cm. But it was lower when compared to shallot plants in the treatment with NPK fertilizer and coconut shell biochar which reached a plant height of up to 49 cm (Yoanma *et al*., 2022).

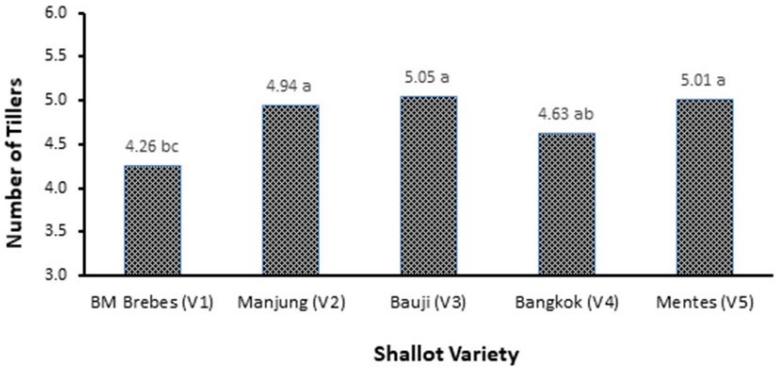

Figure 3. The number of tillers formed by five shallot varieties in the highlands (Note: numbers followed by the same lowercase is not significantly different in DMRT test at 5% significant level)

3.2. Number of Tillers

Figure 3 shows the number of tillers of the five shallot varieties tested. ANOVA test on the average number of tillers showed that treatment of vernalization temperature strata and gibberellin hormone concentration (GA_3) had no significant effect on the number of tillers formed. Five shallot varieties planted in the highlands, however, showed that the variety had a very significant effect on the number of tillers formed. The Bauji variety produced an average number of tillers and was very significantly different from the Bima Brebes variety, but not significantly different from the Bangkok Jeneponto, Mentes and Manjung varieties.

In general, the number of tillers of shallot in our study was low. Yoanma *et al*. (2022) reported that the number of shallot boobs of the Bima Brebes variety with the application of NPK fertilizer, trichocompost, and the addition of biochar reached 10-15. Differences in the growing environment can be the cause of the low number of tillers in our study.

3.3. Number of Leaves

ANOVA analysis of the average number of leaves formed from five shallot varieties planted in the highlands showed that the varietal treatment, vernalization temperature stratum, and gibberellin hormone concentration (GA_3) had a very significant effect on the average number of leaves formed. The Bauji variety had the highest number of leaves and was significantly different from the Manjung, Bima Brebes and Bangkok Jeneponto varieties, but not significantly different from the Mentes variety (Figure 4).

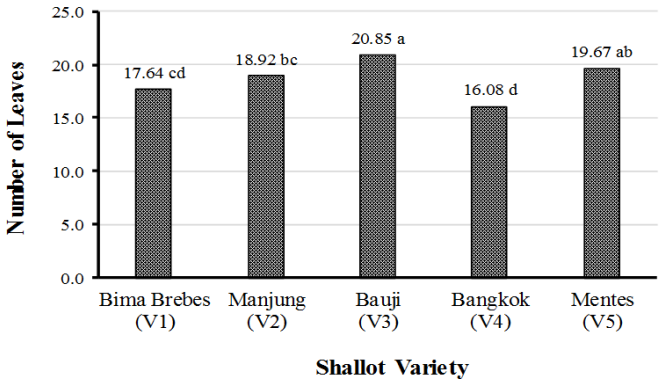

Figure 4. The average number of leaves formed on five shallot varieties planted in the highlands.

The results showed that vernalization at room temperature produced a better number of leaves than vernalization at lower temperatures (4°C, 8°C and 12°C). Vernalization at room temperature succeeded in triggering an increase in the number of shallots planted in the highlands. Vernalization temperature treatment not only stimulated flowering but was able to increase the number of leaves, even though it was not statistically significantly different. Figure 5 also shows that the lower the vernalization temperature, the lower the number of shallot leaves.

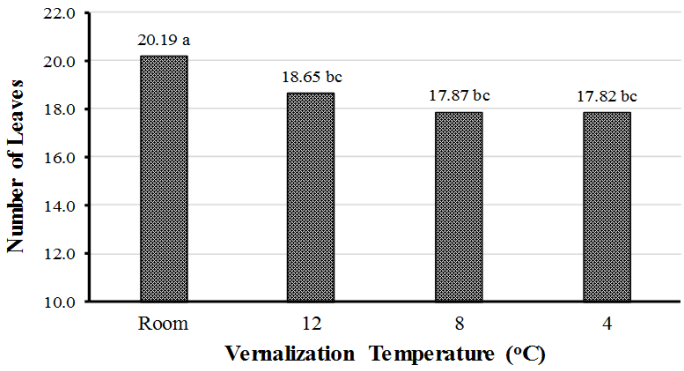

Figure 5. Effect of vernalization temperature on the average number of leaves of shallot planted in the highlands

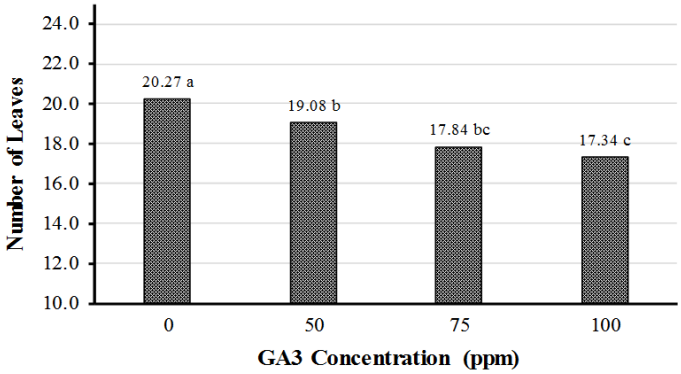

Figure 6. Effect of GA3 concentration on the average number of leaves of shallot planted in the highlands

The treatment of giving GA3 hormone to shallots in the highlands had a significant negative effect on the number of leaves, where the number of leaves became less, ranging from 17.34 to 19.08. Figure 6 shows that as the concentration of GA3 increases, the number of leaves formed decreases. So, if GA3 is given to onion plants in the highlands it will actually inhibit the increase in the number of leaves.

3.4. Flowering Clump

ANOVA analysis regarding the percentage of flowering clumps of shallots planted in the highlands showed that the main plot (variety) had a very significant effect, while the vernalization and gibberellin (GA3) treatment had no significant effect. Figure 7 presents the effect of variety on the number of flowering clumps. The percentage of flowering families for the Bauji variety reached 48.8%, which was highly significant compared to the Bangkok Jeneponto, Bima Brebes, Manjung and Mentes varieties. The Bangkok Jeneponto, Bima Brebes, Manjung and Mentes varieties were not significantly different. There is no positive correlation between the emergence of flowers and the

number of flowers of several varieties in the highlands. The more flowers that appear are not always followed by a large number of flowers. This is in accordance with the explanation (Kurniasari *et al*. 2018) showing that increased flowering is not always followed by high seed production.

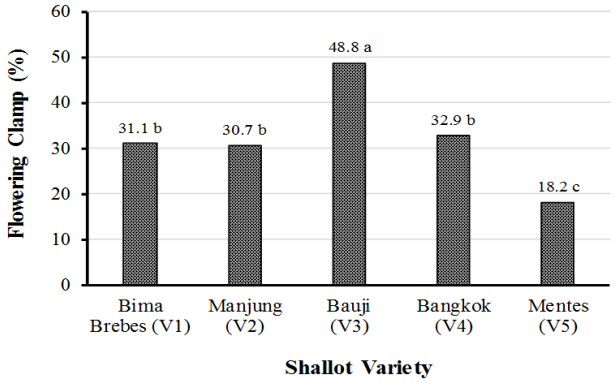

Figure 7. Percentage of flowering clumps of five shallot varieties planted in the highlands

3.5. Flowering Variety

ANOVA analysis of the percentage of flowering of five shallot varieties in the highlands showed that the main plot (variety) and subplot (vernalization) had a very significant effect on the flowering percentage of the five shallot varieties. The Bauji variety had the highest flowering of 59.48% and was very significantly different from the Bangkok Jeneponto, Bima Brebes, Mentes and Manjung varieties. There were no significant differences between Bangkok Jeneponto, Bima Brebes and Manjung varieties, but very significantly different from the Mentes variety (Figure 8).

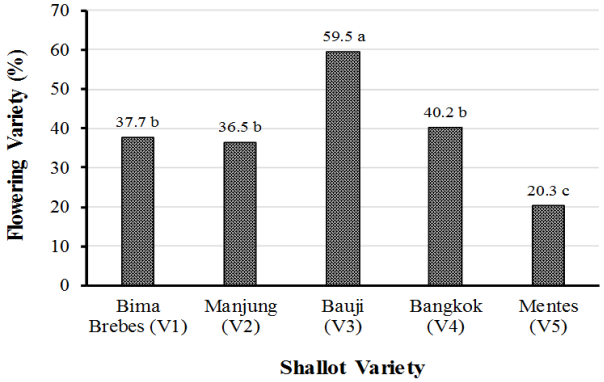

Figure 8. Percentage of flowering variety of five shallot planted in the highlands

3.6. Seed Production

ANOVA analysis of botanical seed yield (kg/ha) of five Shallot varieties in the highlands, showed that the main plot (variety) had a very significant effect, while the vernalization and gibberellin (GA_3) treatment had no significant effect. The Bauji variety produced the most botanical seeds, namely 73.51 kg/ha, significantly different from the Mentes and Bangkok Jeneponto varieties, but not significantly different from the Bima Berebes and Manjung varieties. Likewise, the Manjung variety was not significantly different from the Bima Brebes and Mentes varieties, but very significantly different from Bangkok Jeneponto (Figure 9).

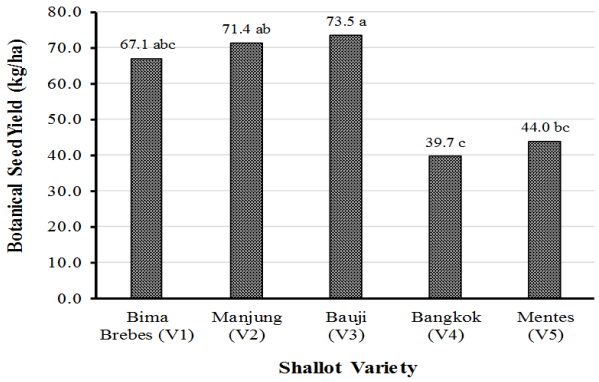

Figure 9. Botanical seed production (kg/ha) of five shallot varieties in the highlands

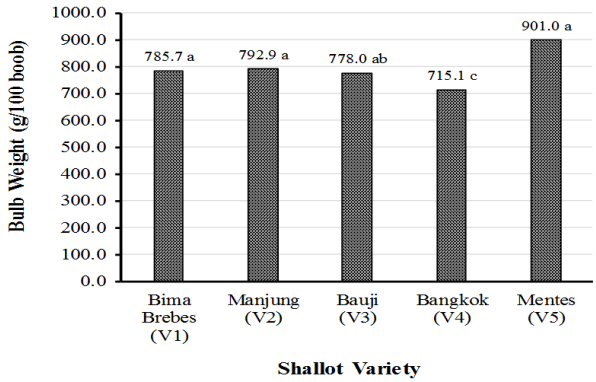

Figure 10. Boob weight (g/100 boobs) of five shallot varieties in the highlands

3.7. Boob Weight

Shallot varieties planted in the highlands had heavy tubers, but the differences between the five varieties were not significant (Figure 10). The Bauji variety is not significantly different from Mentes. The observed production parameter was tuber weight. Based on grain size Mentes, Manjung and Brebes are larger and above 700 gr to the highest 800 gr, while bangkok has small tubers of around 700 gr (Figure 10). In addition to the environment, tuber size is influenced by genetic factors. If various varieties are planted in the same land, the tuber size of each variety is also different (Firmansyah, 2018).

4. CONCLUSIONS

Shallot varieties have different responses to vernalization and gibberellin (GA3) treatment. There were no strata of vernalization temperature and certain GA3 concentrations that consistently supported certain observed parameters on the growth and production of five shallot varieties. The Manjung and Bauji varieties have great potential to produce more flowers and botanical seeds. The giberellin did not contribute significantly to flowering and seed formation of the five shallot varieties in the highlands. There is no interaction between GA3 concentration and vernalization temperature on the flowering and formation of botanical seeds. There were no stratum of vernalization temperature and certain GA3 concentrations that consistently supported certain observation parameters on the growth and production of five shallot varieties. The Manjung and Bauji varieties have great potential to produce more flowers and botanical seeds.

REFERENCES

Abubakar, I., Syam'un, E., Zakaria, Z., & Riyadi, M. (2016). Potential selection of flowering and tuber production in fourteen onion varieties (*Allium ascalonicum* L.) at lowland and upland. *International Journal Of Current Research In Biosciences And Plant Biology*, ***2***(7), 63-67.

Andriyani, B.L. (2020). Partisipasi perempuan tani pada kegiatan usahatani dan penyuluhan tanaman pangan di Kecamatan Sakra Barat Kabupaten Lombok Timur. *Agroteksos*, ***29***(2), 97-104. https://doi.org/10.29303/agroteksos.v29i2.445

Rustan, M.F., Mansur, M.F., & Basrum, B. (2020). Implementasi penyiraman otomatis tanaman bawang merah berbasis mikrokontroller. *Journal of Computer and Information System*, ***1***(2), 37-44. https://doi.org/10.31605/jcis.v1i2.613

Djali, M., & Rachmat, R. (2013). Perubahan karakteristik umbi bawang merah (*Allium ascalonicum* L) akibat proses curing selama penyimpanan. *Jurnal Penelitian Pascapanen Pertanian*, ***10***(1), 48-57.

Firmansyah, M.A. (2018). Pertumbuhan, produksi, dan kualitas bawang merah di tanah pasir kuarsa pedalaman luar musim. *Jurnal Agroekoteknologi FP USU*, ***6***(2), 271-278.

Hafids, A., Dwi, N., Wildan, R., Arinda, F.P., Janna, A., & Fauzi, A. (2018). Daya perkecambahan biji trembesi (*Samanea saman*) yang direndam oleh hormon giberellin. In *Prosiding Seminar Nasional IV 2018: Peran Biologi dan Pendidikan Biologi dalam Revolusi Industri 4.0 dan Mendukung Pencapaian Sustainability Development Goals* (*SDG's*), 137-144.

Indah, I.M. (2016). Keragaan bawang merah (*Allium ascalonicum* L.) IPB di tiga lokasi. [*Undergraduate Theses*]. Institut Pertanian Bogor.

Khoyriyah, N., Ekowati, T., & Anwar, S. (2019). Strategi pengembangan umbi mini bawang merah true shallot seed di Kabupaten Grobogan. *Jurnal Ekonomi Pertanian dan Agribisnis*, ***3***(2), 278-293. https://doi.org/10.21776/ub.jepa.2019.003.02.6

Kurniasari, L., Palupi, E.R., Hilman, Y., & Rosliani, R. (2018). Peningkatan produksi benih botani bawang merah (*Allium cepa* Var. Ascalonicum) di dataran rendah Subang melalui aplikasi BAP dan introduksi *Apis cerana*. *Jurnal Hortikultura*, ***27***(2), 201-208. http://dx.doi.org/10.21082/jhort.v27n2.2017.p201-208

Nurahim, L., & Alfina, R. (2020). Pengoptimalan produksi bawang merah (*Allium ascalonicum* L.) dengan pemanfaatan pupuk kandang ayam. *Jurnal Hortuscolere*, ***1***(1), 7-13. https://doi.org/10.32530/jh.v1i01.69

Ohanenye, I.C., Alamar, M.C., Thompson, A.J., & Terry, L.A. (2019). Fructans redistribution prior to sprouting in stored onion boobs is a potential marker for dormancy break. *Postharvest Biology and Technology*, ***149***, 221-234. https://doi.org/10.1016/j.postharvbio.2018.12.002

Pangestuti, R., & Sulistyaningsih, E. (2011). Potensi penggunaan true seed shallot (TSS) sebagai sumber benih. Prosiding Semiloka Nasional "Dukungan Agro-Inovasi untuk Pemberdayaan Petani," Kerjasama UNDIP, BPTP Jateng, dan Pemprov Jateng, Semarang 14 Juli 2011, 258-266.

Pratiwi, E.E., Maharijaya, A., & Dinarti, D. (2020). Keragaman genetik bawang merah (*Allium cepa* Var. Aggregatum) berdasarkan marka morfologi dan molekuler. *Jurnal Hortikultura Indonesia*, 11(1), 51-60. https://doi.org/10.29244/jhi.11.1.51-60

Prayudi, B., Pangestuti, R., & Kusumasari, C. (2014). Produksi umbi mini bawang merah asal true shallot seed (TSS). In: *Inovasi Hortikultura Pengungkit Peningkatan*

Pendapatan Rakyat, IAAR Press, Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian, Jakarta, 35–44.

Pujiastuti, Y. (2017). Budidaya tanaman bawang merah di desa binaan Pemulutan Ulu. *Jurnal Pengabdian Sriwijaya*, 5(2), 446-454. https://doi.org/10.37061/jps.v5i2.5681

Putri, Y.D, Nasrah, S., & Nurtiti, S. (2018). Analisis kovariansi rancangan petak terbagi pada rancangan acak kelompok (RAK) dengan data hilang. *Jurnal Matematika Statistika & Komputasi*, ***14***(2), 114-120, https://doi.org/10.20956/jmsk.v14i2.3549

Rahayu *et al*., 2019. The feasibility and farmer perception of true shallot seed technology in Sigi District, Central Sulawesi, Indonesia. *Asian Journal of Agriculture*, ***3***(01),16-213. https://doi.org/10.13057/asianjagric/g03103

Rihadi, S.S.A., Soedomo, R.P., Sulandjari, K., & Laksono, R.A. (2021). Studi karakteristik agronomi bawang merah (*Allium ascalonicum* L.) varietas agrihorti-1 dan mentes dengan bawang daun kultivar lokal Kalimantan (*Allium fistulosum* L.) di dataran tinggi Jawa Barat. *Agrovital : Jurnal Ilmu Pertanian*, ***6***(1), 16-25. http://dx.doi.org/10.35329/agrovital.v6i1.2000

Rizal, R., & Inggi, R. (2020). Perancangan alat pengontrol ketinggian air dan penyiraman tanaman secara otomatis berbasis arduino pada media tanam hidroponik. *Simkom*, ***5***(2), 28-34

Rosliani, R., Suwandi, S., & Sumarni, N. (2005). Pengaruh waktu tanam dan zat pengatur tumbuh mepiquat klorida terhadap pembungaan dan pembijian bawang merah (TSS). *Jurnal Hortikultura*, ***15***(3), 192-198.

Sahidin, S., Wahyuni, W., Kamaluddin, M., & Suaib, S. (2019). Tanaman obat keluarga (TOGA) dan pemanfaatannya sebagai penunjang kesehatan masyarakat di Desa Sindangkasih. *Pharmauho: Jurnal Farmasi, Sains, dan Kesehatan*, 4(2), 43-45. http://dx.doi.org/10.33772/pharmauho.v4i2.6276.

Putrasamedja, S., & Suwandi, S. (1996). Bawang Merah Di Indonesia. Balai Penelitian Tanaman Sayuran, Pusat Penelitian dan Pengembangan Hortikultura, Badan Penelitian dan Pengembangan Pertanian, Bandung. 15 pp.

Setiawan, A. (2011). *Uji Lanjut Duncan*. https://www.smartstat.info/materi/rancangan-percobaan/perbandingan-rata-rata/uji-lanjut-duncan.html

Suhartono, S., Faizati, A.R., Wijaya, K.T., Fitriana, A.F., Gholidho, A.F., Afina, Z., Hasna, L.F., Gussyanti, L., Santoso, S., Istiqomah, N., & Harsanti, D.W. (2022). Penyuluhan pertanian teknik budidaya bawang merah pada ibu-ibu pembinaan kesejahteraan keluarga (PKK) Desa Kalibeji. *Dedikasi: Community Service Reports*, ***4***(1), 39-48. https://doi.org/10.20961/dedikasi.v4i1.55558

Waluyo, N., & Sinaga, R. (2015). Bawang merah yang dirilis oleh Balai Penelitian Tanaman Sayuran. *Iptek Tanaman Sayuran*, ***005***, 1–5.

Wang, Z., Ma, R., Zhao, M., Wang, F., Zang, N., & Si, H. (2020). NO and ABA interaction regulates tuber dormancy and sprouting in potato. *Frontiers in Plant Science*, ***08*** (April), 00311. https://doi.org/10.3389/fpls.2020.00311

Wibowo, T.R., & Purnamaningsih, S.L. (2018). Pengaruh lama vernalisasi umbi terhadap pembungaan dan hasil biji pada tiga varietas bawang merah (*Allium ascalonicum* L.), ***6***(7), 1570–1577.

Widiawati, F. (2014). Perubahan Mutu Bawang Merah (*Allium ascalonicum* L.) Pada Penyimpanan Suhu Rendah. [*Undergraduate Theses*]. Institut Pertanian Bogor.

Wiguna, G., Hidayat, I.M., & Azmi, C. (2016). Perbaikan teknologi produksi benih bawang merah melalui pengaturan pemupukan, densitas, dan varietas. *Jurnal*

Hortikultura, ***23***(2), 137–42. http://dx.doi.org/10.21082/jhort.v23n2.2013.p137-142

Yasin, M., Pramudyani, L., Noor, A., & Qomariah, R. (2020). Keragaan tanaman bawang merah (*Allium ascalonicum* L.) pada berbagai dosis pupuk KCL di lahan rawa lebak. *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian*, ***22***(3), 275-284. http://dx.doi.org/10.21082/jpptp.v22n3.2019.p291-300

Yoanma, A.D., Haryanto, A., Oktafri, O., & Triyono, S. (2022). Effect of coconut shell biochar application on the effectivity of NPK fertilizer in red onion (*Allium ascalonicum* L.) cultivation. *Jurnal Teknik Pertanian*, ***11***(1), 1-14. http://dx.doi.org/10.23960/jtep-l.v11i1.1-14