Application of potassium nitrate to increase flower and seeds formation on different shallots varieties

A Bakri¹, E Syam’un², Y Musa³, F Ulfa⁴
¹Muhammadiyah Sinjai University, Jl. Teuku Umar No.8, Kabupaten Sinjai, South Sulawesi.
²Hasanuddin University, Jl. Perintis Kemerdekaan Km. 10, Makassar, South Sulawesi.
e-mail: asriari146@gmail.com

Abstract. The use of True Shallot Seeds (TSS) as an alternative planting material to produce quality shallots (Allium cepa L.), is constrained by the low formed of flowers and seeds. This study investigates the effect of potassium nitrate (KNO₃) concentration on the flower and seeds formation of three shallots cultivars, and was conducted from September 2019 to January 2020 in District of West Sinjai, Sinjai Regency, South Sulawesi, at 1250 m above sea level. The experiments was set up as split plots design and provided with 3 replications. The main plot was shallots varieties (Sanren, Superpilip, and Tajuk) and the subplot was PN dosage (0, 7, 9, and 11 g per plant). Experimental results revealed that interaction of PN and shallots varieties gave a significant effect on the average number of flower buds, number of filled flower capsules, and seeds weight. Application of 11 g PN on Superpilip varieties was able to produce the highest average number of flower buds (63), number of filled flower capsules (66.62), and seed weight (4.4 grams). This finding concludes that application of 11 g potassium nitrate per plant induce flowering and increase seeds production of shallots, however the results will vary depend on the varieties.

Keywords: potassium nitrate; shallots; true seeds; flower.

1. Introduction
Shallots productivity in Indonesia is still relatively low, compared to the potential of productivity the commodity. Indonesian shallots productivity in 2019 is recorded at 9.93 tons h⁻¹[1], far from the optimal productivity that can reach 20 tons h⁻¹[2]. One of the causes is the use of poor quality planting material. Farmers generally use bulbs that come from previous plant seasons as seeds. The bulbs used for plant propagation are susceptible to damage due to storage, contracting pests and diseases, and eventually has a negative effect on crop productivity.

One of the potential technologies to be developed to overcome the problem of seed shallots in Indonesia is the use of True Shallot Seed (TSS) or botanical seeds. The use of TSS for shallot propagation has various advantages, including the relatively small seed requirements, lower supply costs, easier storage, longer shelf life of seeds, easier and cheaper distribution, and high productivity [3]. TSS also produces healthier plants, because they are free from disease pathogens, and produce better quality and larger tubers[4].
Despite the great potential for developing shallot commodities, the widespread use of TSS still faces numbers of obstacles. One of the obstacles is the low flowering and shallots seeds formation. The low percentage of flowering due to the climatic environment in Indonesia, especially the short length of the day (<12 hours) and the relatively high daily air temperature (> 18 °C) does not support flowering initiation, even when the flower occur, seeds production is very low[3]. Research on how low temperature induced the shallots flowering has been done abundantly [5], however this method were difficult to adopt by the farmer, especially in the rural area. Another approach needs to develop in order to help farmer to produce shallots seeds.

Potassium nitrate (KNO₃) is a basic element that needed to form various organic compounds such as amino acids, protein and nucleic acids, and plays an important role for plant lengthening, the formation of protoplasm, and new cells thus prolong the vegetative growth period to spur generative growth including the formation of flower buds[6]. Effect of KNO₃ on shallots growth has been investigate [7][8], however effect of KNO₃ on the formation of flowers and seeds production were not revealed yet. In this study we investigate the use of potassium nitrate (KNO₃) to stimulate flowering and seeds production in shallots. The application of KNO₃ in form of fertilizers will be easily to use by the farmer.

2. Methods

2.1. Study Site
This research was conducted in the District of West Sinjai, Sinjai Regency, South Sulawesi, at 1250 m above sea level. The research took place from September 2019 to January 2020.

2.2. Treatment and Research Design
This study uses the dose of KNO₃ fertilizer and the best dose of 250 ppm Benzyl Amino Purine (BAP) that has been obtained from the previous studies, this study was carried out in split plot design in a two factors factorial pattern. The first factor as the main plot is the three shallots varieties, namely Sanren Variety (V1), Superpilip Variety (V2), and Tajuk Variety (V3). The second factor as a subplot is the dose of KNO₃ fertilizer consisting of 0 grams per plant (K0), 7 grams per plant (K1), 9 grams per plant (K2), and 11 grams per plant (K3). There were 12 treatments with three replications, so there were 36 experiment units.

Each experimental unit consisted of a 1 x 5 m plot. Shallots seeds are planted with a spacing of 15 x 20 cm. In each plot there are a total of 133 plant populations. BAP application is given by dissolving BAP in water and then sprayed shallots plants at the age of 25 days after planting with the same dose in all treatments. KNO₃ application according to the treatment was given 30 days after planting by immersing it around the roots of the shallots plant.

2.3. Parameters
The parameters observed were the number of flower buds in each treatment plot, the number of filled flower capsules, and the weight of botanical seeds (grams).

2.4. Statistical analysis
Observational data was analysed using analysis of variance. If there is a significant interaction effect ($\alpha = 0.05$) on the observed variables, then it is continued with the average difference value test using the LSD test 5%.
3. Results

3.1. Number of flower buds
The results of this study showed the highest average number of flower buds obtained in Superpilip Varieties treated with KNO3 fertilizer at a dose of 11 grams per plant (V2K3), in this treatment the average number of flower buds formed in the treatment plot reached 63 (Table 1). The best results on this treatment are significantly different from the treatment of the same fertilizer dosage in other varieties.

Table 1. The average number of flower buds per treatment plot

| Shallot Varieties | V1 | V2 | V3 | NP-LSD (α=0.05) |
|-------------------|----|----|----|-----------------|
| Control (K0)      | 10.13<sub>y</sub> | 52.32<sub>x</sub> | 12.56<sub>y</sub> |                |
| 7 gram (K1)       | 10.27<sub>y</sub> | 43.22<sub>x</sub> | 10.57<sub>y</sub> | 14.67           |
| 9 gram (K2)       | 11.88<sub>y</sub> | 40.00<sub>x</sub> | 23.28<sub>y</sub> |                |
| 11 gram (K3)      | 11.00<sub>y</sub> | 63.00<sub>x</sub> | 11.81<sub>y</sub> |                |
| NP-LSD (α=0.05)   | 20.83 |    |    |                 |

Note: Numbers that are still followed by the same letters in rows (a, b, c) and columns (x, y, z) mean that they are not significantly different in the LSD<sub>α=0,05</sub> test.

3.2. The number of filled flower capsules
The results of statistical analysis showed that the treatment of KNO3 dosages and shallots varieties as well as the interaction of both had very significant effects on the parameters of the number of filled flower capsules. The highest average number of filled flower capsules was obtained in the Superpilip Variety treatment with a dose of KNO3 11 grams per plant (V2K3), with an average of 66.62 (Table 2).

Table 2. The average number of filled flower capsules in each treatment plot

| Shallot Varieties | V1 | V2 | V3 | NP-LSD (α=0.05) |
|-------------------|----|----|----|-----------------|
| Control (K0)      | 16.87<sub>x</sub> | 44.21<sub>y</sub> | 12.82<sub>y</sub> |                |
| 7 gram (K1)       | 20.42<sub>x</sub> | 54.49<sub>y</sub> | 18.95<sub>y</sub> | 10.17           |
| 9 gram (K2)       | 22.17<sub>y</sub> | 39.88<sub>x</sub> | 37.13<sub>x</sub> |                |
| 11 gram (K3)      | 21.16<sub>y</sub> | 66.62<sub>x</sub> | 20.31<sub>y</sub> |                |
| NP-LSD (α=0.05)   | 16.45 |    |    |                 |

Note: Numbers that are still followed by the same letters in rows (a, b, c) and columns (x, y, z) mean that they are not significantly different in the LSD<sub>α=0,05</sub> test.

3.3. The Average seed weight per treatment plot (gram)
The results of statistical analysis showed that the treatment of varieties and doses of KNO3 as well as the interaction of both had very significant effects on the average weight of the seeds per treatment plot. Average seed weight per plot of the best treatment was obtained in the Superpilip Variety treatment with KNO3 dose 11 grams per plant (V2K3), with an average of 4.40 grams (Table 3).
Table 3. Average seed weight for each treatment plot (gram)

| Treatment KNO3 | Shallot Varieties | NP-LSD ($\alpha=0.05$) |
|----------------|------------------|------------------------|
|                | V1               | V2                     | V3               |
| control (K0)   | 1.17<sup>b</sup> | 3.77<sup>a</sup>       | 1.27<sup>b</sup> |
| 7 gram (K1)    | 1.47<sup>b</sup> | 1.67<sup>b</sup>       | 1.37<sup>b</sup> |
| 9 gram (K2)    | 1.70<sup>b</sup> | 1.53<sup>bc</sup>      | 1.87<sup>b</sup> |
| 11 gram (K3)   | 3.80<sup>a</sup> | 4.40<sup>a</sup>       | 1.17<sup>b</sup> |

Note: Numbers that are still followed by the same letters in rows (a, b, c) and columns (x, y, z) mean that they are not significantly different in the LSD<sub>$\alpha=0.05$</sub> test.

4. Discussion

The results of this study showed that potassium nitrate (KNO3), and its interaction with the variety factor have a positive influence on the formation of flowers and seeds of shallots. In all varieties, KNO3 treatment consistently showed better results in flower bud formation, the number of filled flower capsules, and the weight of onion seeds compared with control. The highest results on the number of flowers buds and the number of filled flower capsules were found on Superpilip varieties with 11 g KNO3, and these results were significantly different compare with other treatment. These results showed that there was an interaction between varieties and KNO3 dose, and 11 g KNO3 per plant is the best dose to induced flowering and seeds production on shallots. The positive impact of KNO3 to induce flowering were also reported by researchers [9] in flowering mangoes outside the flowering season. KNO3 is also reported to induce flowering in longan [10], and litchi [11].

Potassium nitrate (KNO3) contains two important nutrients needed by plants, namely potassium and nitrogen. Potassium is an element that plays a role in activating large amounts of enzymes needed for metabolic processes such as respiration and photosynthesis [6]. The ability of KNO3 to induce flowering is thought to be related to the role of k + ions in increasing the translocation of sucrose from leaves to buds, increasing sucrose synthesis and transportation in leaf mesophyll apoplast, increased phloem loading and direct influence of increased osmotic pressure. Application of KNO3 is thought to trigger translocation of more assimilation into flower buds resulting in rupturing the dormancy of these flower buds [6].

5. Conclusions

This study showed that the application 11 g potassium nitrate per plant on Superpilip varieties gave the highest flower buds formation (63), filled flower capsules (66.62), and the seeds weight (4.40), thus this combination of treatment can be use to produce TSS.

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