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Pre-sowing Treatment Enhanced Germination and Vigour of True Shallot (Allium cepa var. aggregatum) Seeds

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Abstract— *The objective of this research was to sudy the effects of pre-sowing treatments to enhance germination, growth and transplanting of true shallot seeds. The experiment was conducted in the glasshouse at Tangtu village, Badung regency from August until November 2017. Germination experiment was carried out in petridishes, while that for seedling vigour and growth experiment was done in plastic pots containing sand and top soil mixture. Both experiments were designed as complete randomized design with eight concentrations of KNO_3 (1, 1.5 and 2 M) and GA_3 (100, 150 and 200 ppm). Those treatments were replicated four times. Seeds were soaked for 24 hours in each concentration of solution prior to planting in petridishes as well as in pots. Results of the experiment showed that GA_3 significantly increased germination percentage, speed of germination (57-63% germinated seeds at 1 dap), index of seedling vigour,* **II.** *speed of seedling emergence (34,39% day^{-1}) and percentage of seedlings having one true leaf (52%) at 9 dap. The effects of KNO_3 on those variables were not significantly different from those of GA_3 except on speed of seedling emergence. KNO_3 2M and GA_3 (100, 150 , 200 ppm) resulted in 12 days earlier in transplanting seedlings than control.*

Keywords— Germination, pre-sowing, true shallot seeds, vigour.

I. INTRODUCTION

The True shallot seeds (TSS) are increasingly used by farmers in Indonesia. The benefits of TSS are free from pathogen, smaller number of planting materials, easier transporting and storaging, producing healthier crops and bigger bulbs (van den Brink and Basuki, 2011). The use of TSS is economically beneficial as well, due to doubling the yields compared to seed bulb crops. The problem in using TSS is that seeds have to be grown in the nursery for 20-25 days and after that have to be transplanted into the field, therefore needs longer time to produce bulbs compared to seed bulb (bulb-propagated) crops, therefore needs longer time to produce bulbs compared to seed bulb crops. To reduce the time in the nursery efforts have to be done to increase the germination of the seeds and faster estabishement of seedlings. The use of priming and pre-sowing methods have been succeeded to improve the speed of germination, increase germination percentage and reduced the amount of abnormal seedlings of onion (*Allium cepa cv. aggregatum L.*) (Caseiro *et al*., 2004, Tajbakhsh *et al*., 2004, Sevarani and Umarani, 2011, Jagosz, 2015). Seed priming treatments were also reported to be able to increase germination capacity of parsley (*Petroselinum crispum* L.) (Dursun and Ekinel, 2010), tomato (*Lycopersicum esculentum* L.) (Mirabi and Hasanabadi, 2012; Lara *et al*., 2014), carrot (*Daucus carota* L.) (Sevarani and Umarani, 2011) and is a suitable method of shortening the time for early crops (Barlow and Haigh, 1987).

The role of KNO_3 in promoting germination of tomato seeds was also reported by Lara *et al*. (2014) and in increasing speed of seed germination and establishment of *Ramonda serbica* and *Ramonda nathaliae* by Gashi (2012). Gibberellin has roles in control and promote seed germination. GA_3 enhances biochemical reaction of hydrolase (particularly α amylase) enzyme synthesis in endosperm of cereal grains. Gibberellic acid stimulates seed germination through α amylase synthesis (Finch-Savage and Leubner, 2006). Effects of GA_3 at concentration of 1000 ppm combined with 0.3% KNO_3 were reported to result in the highest final germination percentage on *Ramonda serbica*, while the concentration of 500 ppm GA_3 gave higher germination percentage on *R. nathalie* (Gashi *et al*., 2012).

Seed priming by soaking the seeds in KNO_3 solution prior to planting is expected to increase germination and seedling establishment of true shallot seeds compared to those of seed bulb crops. If the seedlings are growing faster and stronger enough to be transplanted from the nursery into the field, the seedling growth could catch up with the growth of seed bulb crops. This research has an objective to study the effect pre-sowing treatments of KNO_3 and GA_3 concentrations on seed germination and seedling establishments of true seed shallots.

II. MATERIALS AND METHODS

The experiment was conducted in the glasshouse in the village of Tangtu, Badung regency from 29 August 2017 until 21 September 2017. The commercial seeds of shallot cv. Tuk-Tuk (produced by PT. East West Indonesia, Cap Panah Merah) used in this experiment The KNO_3 solutions were prepared at the concentrations of respectively 1, 1.5 and 2 M, while those of GA_3 were respectively 100, 150 and 200 ppm. Distilled water was used as control. An amount of 50 seeds were subjected to priming by soaking them in 25 ml of each solution concentration for 24 hours prior to planting. The treatments were arranged in a randomized complete design with four replicates making 28 units for each experiment.

Half amount of seeds were then cultured in petri dishes on a single sheet of Whatman No.1 filter paper, moistened with distilled water, kept on a glasshouse bench in 25±1ºC room temperature. Another 25 seeds for each treatment were planted in a plastic pot of a pot of 12 cm diameter having 600 g of mixture of sand and fertile potting soils. Pots were watered to field capacity and leave for 24 h before planting and a volume of 50 ml water was given to all pots every day.

Seed germination was monitored and counted everyday, and a seed was considered to be germinated when the radicle was 2 cm long (Soltani *et al*, 2015).

Data were recoded daily on germination percentage (GP) of normal seedlings (protrusion of radicles of 2 cm long in the petridishes for 7 days (Heydecker and Coolbear, 1977; Gashi *et al*., 2012; Jagosz, 2015), calculated using the following formulas:

$$GP\ (\%) = \frac{\text{number of germinated seeds}}{\text{number of total seeds}} \times 100\% \qquad (1)$$

where *D* is the number of days counted from the beginning of germination, and *G* is the number of seeds which germinated on day *D* (Moradi *et al*., 2008; Jagosz, 2015).

The development of seed germination (% germinated seeds day^{-1}) was also calculated in petridishes (2)

Seedling vigour index (SVI), the speed of seedling emergence (SSE), and percentage of seedlings having true leaves (at least one true leaf has been developed) (PSTL) were recorded in pot experiment. Seedling vigour index (Hossain *et al.*, 2006; Zanjan and Asli, 2012) was calculated as:

$$SVI = \frac{\text{Seedling length (cm)} \times PSE\ (\%)}{100} \qquad (3)$$

The criteria of PSE was similar to that of GP. Seedling length was randomly measured on five seedlings from the root to the hypocotyl and cotyledon at 9 DAP (De Souza *et al*., 2014). The speed of seedling emergence (SSE) was calculated using formula according to Islam *et al*. (2003):

$$SSE = \frac{\text{number of seedlings emerged at 1 DAP}}{\text{number of seedlings emerged at 9 DAP}} \times 100 \qquad (4)$$

Percentage of seedlings having true leaves ((at least one true leaf has been developed) (PSTL). (5)

The pot experiment was terminated 21 DAP at which seedlings were harvested and parameters were evaluated. Data collected from the experiments were analyzed statistically with ANOVA using CoStat and MstatC computer softwares and means were compared based on 5% Least Significant Different test.

III. RESULTS AND DISCUSSION

GA_3 solution significantly ($p<0.05$) affected individually all variables measured in this research as indicated by germination percentage (GP), development of seed germination (in petridish experiment), seedling vigour index (SVI), speed of seedling emergence (SSE) and percentage of seedlings having true leaves (PSTL) (pot experiment). The first true leaf on some seedlings was appeared 9 DAP.

3.1 Germination Percentage (GP), and The Development of Seed Germination

Soaking the seeds in GA_3 and KNO_3 concentrations, except KNO_3 2 M, resulted in significantly ($p<0.05$) higher germination percentage compared to the other treatments (Fig.1). The treatments of GA_3 (100 ppm, 150 ppm and 200 ppm) and KNO_3 1 M increased germination percentage of TSS 25.1% higher than control. KNO_3 concentration of 1.5 and 2.0 M did not significantly increased seed germination percentage. The use of KNO3 infact has important role in increasing germination of shallots as nitrate provided exogenously acts as a signal molecule favouring germination (Alboresi *et al*., 2005). The nitrate could be absorbed during soaking, being used in the metabolism of the embryo, through the activity of enzyme nitrate reductase (NR). This enzyme activity in the production of nitrite/nitric oxide couls act in promoting a faster germination (Lara *et al*., 2014).

Gibberellins, as growth hormones, have a role to enhance germination besides other functions such as stimulate cell elongation, flowering and fruiting. GA_3 promotes a biochemical reaction i.e. the synthesis of *hydrolase (particular α amylase)* in endosperms of cereal seeds (Finch-Savage and Leubner, 2006). The positive effects might be due to its role in influencing the permeability of the membranes which ultimately leads to activation of enzymes involved in protein synthesis and carbohydrate metabolism (Preece and Read, 1993). The effect of GA_3 1000 ppm combined with 0.3% KNO_3 was reported to result in the highest final germination percentage on *Ramonda serbica*, while the concentration of GA_3 500 ppm gave higher germination percentage on *R. nathalie*

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(Gashi *et al*., 2012). The use of KNO3 infact has important role in increasing germination of shallots as nitrate provided exogenously acts as a signal molecule favouring germination (Alboresi *et al*., 2005). Increased germination percentage of onion seeds compared to control was also reported by Duman (2002) and Yıldırım *et al* (2002).

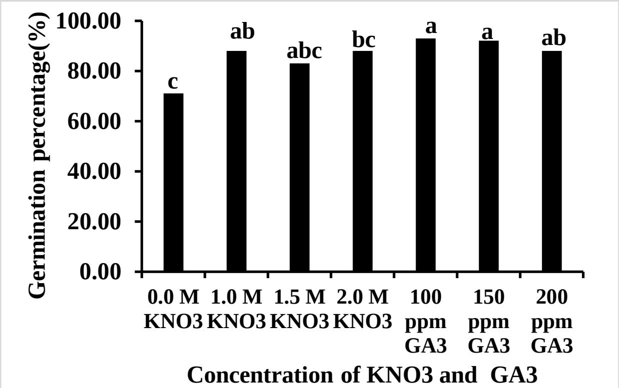

Fig. 1: Effect of KNO_3 dan GA_3 concentrations on germination percentage of true shallot seeds.

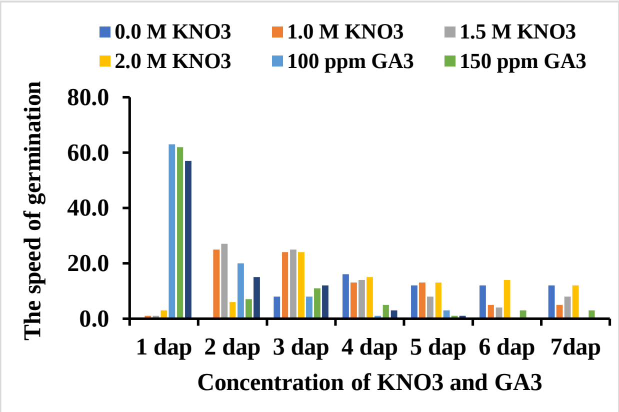

Fig.2: Effect of KNO_3 dan GA_3 concentrations on the speed of germination (% germinated seeds day^{-1}).

3.2 Seedling Vigour Index (SVI)

Vigour of seedling is an important factor to indicate the power of seedlings to grow and establish further. Such power is often reflected from seedling vigour index (SVI). The higher SVI indicates higher vigour of the seedling, guarantying they can be survived in unfavourable condition for growth. In this experiment GA_3 and KNO_3 concentrations resulted in average seedling vigour index of 2.43 higher than control (Fig. 3). The effects of GA_3 concentration were not significantly different from that of KNO_3 although this compound's ability in increasing seed germination was significantly lower. Higher average seedling vigour index indicated higher potential of seedlings to determine the potential for rapid uniform emergence and development of normal seedlings under a wide range of field conditions. Increased seedling length due to effects of KNO_3 concentration could be resulted in vigourous seedlings, the similar effect found in tomato (Farooq *et al*., 2005). The ability of GA_3 in increasing seedling vigour was associated with the role of GA_3 as an activator of seed germination (Finkelstein *et al*., 2008) and as a promoter of seedling elongation and growth.

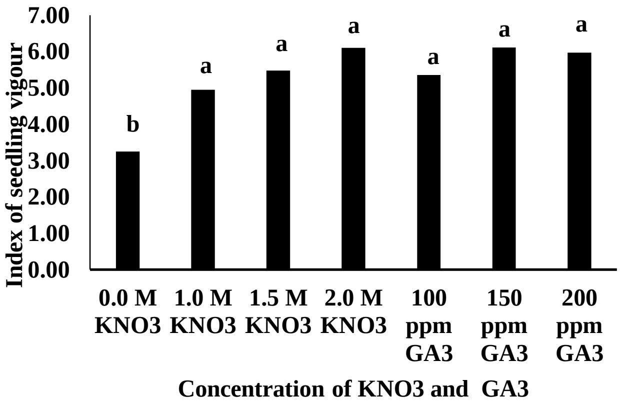

Fig. 3: Effect of KNO_3 dan GA_3 concentrations on index of seedling vigour

3.3 The Speed of Seedling Emergence (SSE)

The calculation of this variable involves number of seedlings emerge at one dap. multiply by 100 then divided by number of total seedlings emerged (Islam *et al*. (2003). GA_3 resulted in average of seedlings emergence (SSE) significantly 34.39% higher than that of KNO_3 as well as control (Fig. 4). This could be due to better permeability of the membranes, which contribute activation of enzymes involved in protein synthesis and carbohydrate metabolism (Preece and Read, 1993). Rapid emergence rate after priming or soaking may be due to increased rate of cell division in the root tips of primed seedlings as reported in wheat (Bose and Mishra, 1992) and in tomato (Farooq *et al*., 2005). Results of this experiment was not in line with that of Frett *et al*. (1991) on tomato, Demir and Mavi (2004) on watermelon and Govinden-Soulange and Levantard (2008) on other plant species, who reported that priming with KNO_3 increased emergence of seedlings.

3.4 Percentage of seedlings having true leaves (PSTL)

The effect of concentration of KNO3 2 M, which was not significantly different from that of GA_3 (100, 150 and 200 ppm), resulted in 52% higher seedlings having at least one true leaf at the of 9 dap. The lower concentration of KNO_3 (1 and 1.5 M) produced significantly lower percentage of seedlings having at least one true leaf, although they were still higher than that in control (Fig. 5). Nitrate (NO_3) that was absorbed during soaking, then used in the metabolism of the embryo, and as a nitrogen source may contribute to seedling growth and early vegetative development. KNO_3 as nitrogen-source fertilizer has a role in promoting vegetative growth of seedlings. GA_3, due to its role in stimulating cell elongation, also contributes to seedling growth. The treatment of GA_3 resulted in 34.39% more seedlings emerged in comparison to the average effect of KNO3 as well as control (Fig. 4). Seeds with high speed of emergence are indicated by their high emergence index (SVI).

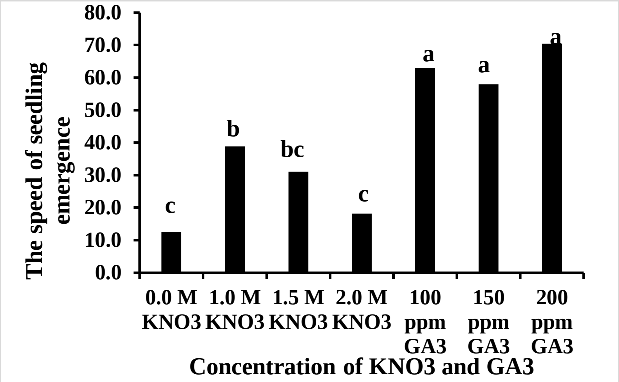

Fig. 4: Effect of KNO_3 dan GA_3 concentrations on the speed of seedling emergence (% emerged seedlings day^{-1})

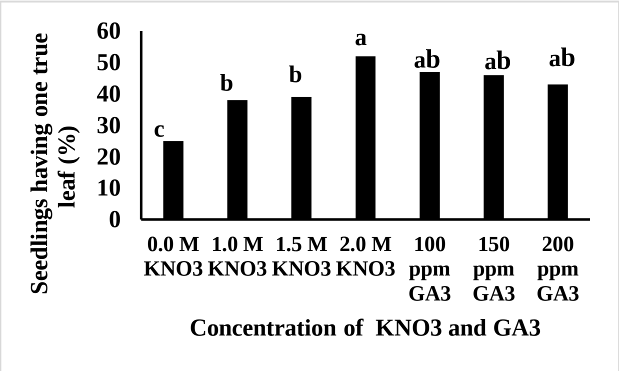

Fig. 5: Effect of KNO_3 dan GA_3 concentrations on the percentage of seedlings having one true leaf.

IV. CONCLUSION

GA_3 significantly enhanced: a) seed germination percentage (25,1% higher than control), b) The speed of seed germination (57-63% germinated at 1 dap, compared to other treatments), c) index of seedling vigour (2,43 compared to control), d) the speed of seedling emergence (34,39% seedlings day^{-1} higher than KNO_3), e) percentage of seedlings having at least one first leaf (true leaf) (52% at 9 dap). KNO_3 also had similar significant effects on the same variables, except on the speed of seed germination, the speed of seedling emergence and percentage of seedlings having one true leaf. Pre-sowing treatment with GA_3 dan KNO_3 2 M enhanced time of seedling transplanting to the field (12 days earlier than with no pre-sowing treatment).

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