The role of shallot extract concentration application on soybean varieties production

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Abstract. The application of natural plant growth regulator (PGR) is one treatment that plays a role in increasing soybean production. One of the natural PGR that can be used is shallot extract. The objective of the research was to evaluate the role of shallot extract application on soybean production. The research was done at the Faculty of Agriculture Experimental Field, Universitas of Sumatera Utara using a Factorial Randomized Block Design with two factors and three replications. As the first factor were soybean varieties (Devon-1, Dering-1 and Anjasmoro). The second factor was the concentration of shallot extract (0%; 25%; 50% and 75%). The results indicated that Dering-1 has the highest number of filled pods, while Anjasmoro and Devon-1 soybean varieties produced a higher harvest index and dry weight of 100-seeds compared to Dering-1. The application of shallot extract concentration at 75% has produced the highest number of filled pods, seed dry weight per plant and harvest index. The interaction between Dering-1 variety and the concentration of 75% shallot extract produced the highest number of filled pods, while application of 50% shallot extract in Devon-1 variety produced the highest harvest index and dry weight of 100 seeds.

1. Introduction
Soybean is one of the families of Leguminocoe, which plays an important role in fulfilling food needs as a source of protein and processed food industry materials. Soybean are also very beneficial for health because it contains secondary metabolite such as isoflavones [1-2], which are proven to have many biological functions, such as antioxidants [3], prevention of osteoporosis [4], anti-inflammatory [5] and also reduction in women’s menopausal syndrome [6].

The increasing need for soybeans in Indonesia is not in line with soybean production. Based on Biro Pusat Statistik (Central Bureau of Statistics) data [9] it was noted that soybean production in 2018 was 982,598 tons with a harvest area of 680,373 ha. However, soybean production in 2018 only reached 2.83 million tons. Therefore, to increase soybean production, land intensification and extensification are needed.

One effort to intensify land by increasing production without increasing land area is by applying natural plant growth regulator (PGR). Natural PGR applications are expected to be able to control the metabolic and physiological processes that occur in plants. The effectiveness of natural PGR on plants is depended by plant species, affected parts of plants, concentration and stage of plant growth.

The use of shallot extract is an alternative to natural PGR that can be applied to soybeans. Some studies stated that shallot extract contains auxin hormones, gibberellins, and cytokinins, which are very important to stimulate plant growth and development [10], [11]. In addition, on the crushed shallot
contains allithiamin compounds which can facilitate the metabolism of plant tissues and can be fungicidal and bactericidal [12]. Application of shallot extracts at 20% indicated a significant increase in root length of banana plantlets when plants treated once a week [13].

Natural PGR has an important effect on plant growth and development, but there is still few information of natural PGR related to the increasing of soybean production. Therefore, according to the background, this study aim was to evaluate the role of natural PGR on soybean varieties production.

2. Materials and methods

2.1. Research site and materials

This research was conducted at the Faculty of Agriculture Experimental Field, Universitas Sumatera Utara, Medan on December 2018 to March 2019. The materials used in this research were soybean varieties (Devon-1, Anjasmoro and Dering-1), top soil, Urea fertilizer, TSP, and KCl, shallot extract, aquades, insecticides, fungicides and polybags with a size of 30 cm x 40 cm. The equipment used in the research namely blender, hand sprayer, scales, sieves and bucket. The soil characteristics used as growing media can be seen in Table 1.

### Table 1. The soil characteristics of growing media

| Parameter | Value | Analytical methods |
|-----------|-------|--------------------|
| N-Kjedhal (%) | 0.51 | Walkley & Black Kjedhal |
| P-total (mg/kg) | 2676.13 | Spectrophotometry |
| K-total (mg/kg) | 139.90 | Flamephotometry |
| C-organic (%) | 4.68 | Dry ashing |
| pH | 5.8 | Electrometry |

Source: Socfind’s Indonesia Ltd. Laboratory (2019)

2.2. Procedures

The experimental design used in this study was a factorial randomized block design with two factors and three replications. As the first factor was soybean varieties (Devon-1, Dering-1 and Anjasmoro). The second factors were the concentration of shallot extract (0%; 25%; 50% and 75%).

The research began by clearing the land from garbage, root remains and weeds. The experimental plot used with a size of 190 cm x 70cm, the distance between plots was 70 cm and the distance between blocks was 50 cm. As a growing medium, 10 kg of topsoil is used which is put into a polybag with a size 30 cm x 40 cm. Planting seeds was done by making a planting hole as deep as about 3 cm in polybags and then planted one seed/planting hole and covered with topsoil.

The making of shallot extract with a concentration of 100% was obtained from weighing 500 g of shallot and 50 ml of distilled water then mashed using a blender, and the filtered was taken about 100 ml of shallot filtrate. The concentration of 25%, 50%, and 75% were obtained from dilution of the shallot filtrate. Shallot extract with the appropriate concentration of treatment, sprayed using a hand sprayer to all parts of the soybean plant until evenly distributed. Spraying was done on 2-6 week after planting (WAP). Calibration is done before spraying.

Fertilization is carried out according to recommended doses of 50 kg of Urea/ha (0.25 g of Urea/polybag), 100 kg of TSP/ha (0.5 g of TSP/polybag) and 75 kg of KCl/ha (0.375 g of KCl/polybag). Urea was taken half a dose at planting and the rest at four WAP. TSP and KCl fertilizers were applied entirely during planting.

Watering plants done every morning and evening. Weed control was done manually, while plant pest control was conducted using an active insecticide Profenofos (2 g/litre of water). The plants were harvested after showing harvest criteria such as most of the leaves are yellowed, but not because of pests or diseases, the pod starts to change colour from green to brownish yellow and cracked, or the pods look old, yellow stems rather chocolate.
The variables observed included number of filled pod, number of empty pod, dry weight of 100 seeds, seed dry weight/plant and harvest index. Determination of the harvest index is calculated using the formula: harvest index = economical yield/biological yield.

2.3. Data analysis
Data were analysed statistically using the analysis of variance (Anova) procedure, if there is a significantly effect, further test was carried out by Duncan’s Multiple Range Test at level $\alpha = 5\%$.

3. Result and discussion

3.1. Result

3.1.1. Number of filled pod and number of empty pod. Based on the result of this research (Table 1), it can be seen that Dering-1 (26.81 pods) variety has a significantly higher number of filled pods compared to Anjasmoro (21.06 pods) and Devon-1 (19.58 pods). The application of shallot extract with a concentration of 75% produced the highest number of filled pods (26.50 pods) compared to without and 25% shallot extract applications. The result indicated that the application of shallot extract up to 75% can increase the number of filled pods up to 59.83% compared to control (0% of shallot extract).

Dering-1 and Devon-1 varieties had the lowest of number of empty pod than Anjasmoro. The concentration of shallot extract at 50% decreased the number of empty pod than 0% and 75%. The interaction of shallot extract concentration at 50% and Dering-1 variety or Dering-1 decreased the number of empty pod.

3.1.2. Seed dry weight/plant. The application of shallot extract significantly affected on seed dry weight per plant, while the difference in varieties had no significant effect on seed dry weight per plant. It was identified that the Anjasmoro variety tend to produce higher seed dry weight compared to Devon-1 and Dering-1 (Table 1).

Increasing the application of shallot extract concentration significantly increased seed dry weight per plant. It was found that the concentration of 75% concentration of shallot extract produced the highest seed dry weight (Fig. 1). Seed dry weight per plant increased 56.42% by application of 75% concentration of shallot extract compared to control (0% concentration of shallot extract). The interaction between variety and concentration of shallot extract had no significant effect, it was identified that there was a tendency that the application of 50% shallot extract concentrations in Dering-1 varieties tended to produce the highest seed dry weight/plant (10.37 g).

3.1.3. Dry weight of 100 seeds. Based on Table 1, it can be known that the difference in varieties had a significantly effect on dry weight of 100 seeds. Devon-1 and Anjasmoro varieties have higher seed sizes than Dering-1. In each variety there was a difference in response to the application of shallot extract, which was in Devon-1 variety, increasing the concentration of shallot extract (up to 75%) resulted not significantly different of dry weight of 100 seeds, with large seed size ($> 13$ g). In Dering-1 variety, increasing in the concentration of shallot extract (up to 75%) resulted not significantly different of dry weight of 100 seeds, with small seed sizes ($> 13$ g). Whereas in Anjasmoro variety, increasing in the concentration of shallot extract (25% to 50%) actually resulted in a higher seed dry of 100 seeds. Increasing the concentration of shallot extract up to 25% in Anjasmoro variety resulted not significantly different of dry weight of 100 seeds, with medium seed size (11-12 g), while increasing the concentration of shallot extract 50% to 75% in Anjasmoro variety resulted not significantly different of dry weight of 100 seeds, with large seed sizes ($> 13$ g).

3.1.4. Harvest Index. Devon-1 and Anjasmoro varieties have a significantly higher harvest index than Anjasmoro. Application of shallot extract 25% to 75% significantly increased the harvest index when compared to control (0%). In general, for each variety (Devon-1, Dering-1 and Anjasmoro), the
The application of 50% shallot extract produced the highest harvest index, while without shallot extract (0%) produced the lowest harvest index (Table 2).

### Table 2. The number of filled pod, number of empty pod, seed dry weight per plant, dry weight of 100 seeds and harvest index of soybean varieties on natural PGR application

| Variety            | Number of filled (pod) | Number of empty pod (pod) | Seed dry weight per plant (g) | Dry weight of 100 seeds (g) | Harvest index. |
|--------------------|------------------------|---------------------------|------------------------------|-----------------------------|----------------|
| Devon-1 (V1)       | 19.58b                 | 5.16b                     | 8.05                         | 13.50a                      | 0.56a          |
| Dering-1 (V2)      | 26.81a                 | 4.85b                     | 8.28                         | 10.37b                      | 0.50b          |
| Anjasmor (V3)      | 21.06b                 | 5.85a                     | 8.47                         | 13.08a                      | 0.55a          |

| Concentration of shallot extract | Number of filled (pod) | Number of empty pod (pod) | Seed dry weight per plant (g) | Dry weight of 100 seeds (g) | Harvest index. |
|----------------------------------|------------------------|---------------------------|------------------------------|-----------------------------|----------------|
| 0% (B0)                          | 16.58c                 | 5.75a                     | 6.15c                        | 12.14                       | 0.49b          |
| 25% (B1)                         | 21.58b (30.16%)        | 5.05ab                    | 7.85b (27.64%)               | 12.10                       | 0.54a          |
| 50% (B2)                         | 25.27ab (52.41%)       | 4.58b                     | 9.42a (53.17%)               | 12.55                       | 0.58a          |
| 75% (B3)                         | 26.50a (59.83%)        | 4.77a                     | 9.62a (56.42%)               | 12.49                       | 0.54a          |

V x B

| V1B0                             | 17.66ef                | 6.41b                     | 7.32                         | 13.69a                      | 0.58abc        |
| V1B1                             | 17.58ef                | 5.41cd                    | 7.29                         | 13.35a                      | 0.53de         |
| V1B2                             | 18.75de                | 4.33e                     | 7.76                         | 13.68a                      | 0.60a          |
| V1B3                             | 24.33c                 | 4.5ced                    | 9.81                         | 13.29a                      | 0.55a-d        |
| V2B0                             | 14.16f                 | 5.58bc                    | 4.55                         | 10.57c                      | 0.37f          |
| V2B1                             | 27.58b                 | 5.08cde                   | 8.48                         | 10.27c                      | 0.55a-e        |
| V2B2                             | 32.25a                 | 4.33e                     | 10.37                        | 10.27c                      | 0.56a-e        |
| V2B3                             | 33.25a                 | 4.41cde                   | 9.72                         | 10.37c                      | 0.52de         |
| V3B0                             | 17.91de                | 5.25cede                  | 6.60                         | 12.14b                      | 0.51e          |
| V3B1                             | 19.58de                | 4.66cede                  | 7.80                         | 12.66b                      | 0.54cede       |
| V3B2                             | 24.83bc                | 5.08cde                   | 10.13                        | 13.70a                      | 0.59ab         |
| V3B3                             | 21.91cd                | 8.54a                     | 9.34                         | 13.81a                      | 0.56a-e        |

Note: - The numbers followed at the different letters at the same treatment and parameters indicated significantly different based on Duncan’s Multiple Range Test (p=0.05)
- Number in brackets indicated the percentage increase compared to control (0% of shallot extract)

![Figure 1. Effect of shallot extract concentration on soybean seed dry weight/plant](image-url)}
3.2. Discussion
The results indicated that the treatment of 75% shallot extract in the Dering-1 variety produced the highest number of filled pods and the lowest number of empty pods. The application of shallot extract as a natural PGR containing auxin, gibberellin and cytokinin was thought to cause increased photosynthetic activity hence photosynthesize for filling pods increases. Nurlaeni [14] reported that the pod formation phase affects the number of seeds formed supports this. Plants that are inhibited in photosynthesis in the pod-filling phase (R5-R6), will cause fewer photosynthates to be produced, therefore the empty pods increase.

The result of previous studies indicated there were differences in the way in changes in endogenous auxin and cytokinin concentrations. In soybean plant, the supply of assimilates and endogenous plant growth regulators play an important role in the process of forming and filling the pods. The application of timing and type of natural PGR greatly influenced the yield and yield components. Therefore, it is interesting to understand the responses of plant growth regulators that are applied exogenously [15]. Based on the analysis of natural PGR by Research Institution of Medicinal Plants and Spice (Bogor), it can be seen that shallot has 0.0027% indole acetic acid, 0.0021% GA3, and 0.0022% cytokinin. This provides for the role of shallots as natural plant growth regulator (PGR) on soybean production [16].

Auxin contained in shallot can release root growth, which is needed in the photosynthesis process, while thiamin (vitamin B1) plays an important role in the reformation containing energy in plants. In shallots, a collection of allicin and thiamine (vitamin B1) can form the chemical bond of allithiamin, which has important components in biological activities that form the ability to increase cell growth and increase energy. The body compared to vitamin B1, hence this composition will make vitamin B1 more efficient can be used by plants [17] and more easily absorbs the existence of this composition. The results indicated the concentration of shallot extract at 75% produced the highest number of filled pods, the dry weight of the seeds per plants and harvest index. This was related to cytokinins contained in shallot extract, which have a positive effect on pod composition. Several previous studies reported that cytokinin application had the positive effect on pod formation [18], [19], [20], and [21].

In the generative phase of soybean plants, translocation of energy is not only carried out on organs such as roots, stems, and leaves, but also on seeds. Therefore, during filling of seeds, most of the newly formed and stored photosynthesis results are used to increase seed weight. The more number of seeds per plant most likely will affect the seed dry weight per plant, which will also be higher. This is thought to be due to the application of natural PGR to provide photosynthates for increasing seed dry weight per plant.

4. Conclusion
Anjasmoro and Devon-1 soybean varieties produced a higher harvest index and dry weight of 100-seeds compared to Dering-1, while Dering-1 has the highest number filled pods. Application of the concentration of 75% shallot extract has produced the highest number of fill pods, seed dry weight per plant and harvest index. The interaction between Dering-1 variety and the concentration of 75% shallot extract produced the highest number of filled pods, while application of 50% shallot extract in Devon-1 variety produced the highest harvest index and dry weight of 100 seeds.

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