Vegetative appearances of hanjeli (Coix lacryma-jobi L.) as affected by number of seeds and plant spacing

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ABSTRACT
This research aimed to observe the appearance of Coix lacryma-jobi L. as affected by number of seeds and plant spacing. Randomized Blok Design comprised of 2 factors (number of seeds, J; plant spacing, T) with 3 replications was arranged, while the parameters included plant height, stem diameter, number of leaf, length and width of leaf. The experiment was conducted at experimental field of Agriculture Faculty in Teuku Umar University, Meulaboh, from March to October 2017. The results showed that the number of seeds significantly affected plant height in 49 days after planting, 63 days after planting, and also showed a significant effect on leaf length in 77 days after planting. Statistical analysis showed the interaction effect among the factors. The most significant effect was observed in plant height and leaf length in 21 days after planting.

Key words: Coix lacryma-jobi L., Number of seeds, Plant spacing, Vegetative.

INTRODUCTION
Hanjeli plant has been considered a high potential commodity for alternative food source. In addition, hanjeli plants are reported to have beneficial effects on health such as warts, cracked skin, rheumatism, anti-inflammatory Hsu et al. (2003), cardiovascular, intestinal health Wang et al. (2011), reduced level of blood fat, and antioxidants Yu et al. (2011). In Aceh Province, hanjeli plants are widely cultivated in subdistrict of Kawai 16, district of West Aceh. Based on interviews with field workers, hanjeli is a potential plant to be developed in the area. Deskinned hanjeli is sold at high cost and exported to China. To improve production of hanjeli, a specific guidance covering agronomical aspects is required since local farmers apply conventional method in the plant cultivation. In some cases, they use excessive number of seeds, ranging between 5-8 seeds per hole, with irregular spacing. Their current agronomical practices remarkably affect plant growth. Meanwhile, number of seeds and plant spacing are essential factors to obtain desirable yield.

Number of seeds per hole significantly affects the plant growth. The use of excessive seed number does not always produce better yield, vice versa. Furthermore, this practice also increases costs and also affects the competition of nutrients in cultivated plants. Number of seeds per hole strongly relates to the population, and higher population leads to higher competition for nutrition, water and light. In addition, the high competition showed a marked effect on agronomical appearance of the crops Sangtam et al. (2017).

Additionally, plant spacing is also essential to achieve equal growth rate, distribution of nutrient, effective land use, easy maintenance, reduced pest and disease, and to determine how many seeds are needed (Nurlaili, 2010). Several studies in various countries related to spacing are exhibited in Table 1. Therefore, it is necessary to understand the effects of number of seeds and spacing on growth performance of hanjeli plant. The results are important as reference for hanjeli farmers to obtain better production.

MATERIALS AND METHODS
This research was carried out in Experimental Field of Agricultural Faculty, Teuku Umar University, Meulaboh Aceh Barat, and held from January to October 2017. Factorial randomized block design was arranged with 3 replications. The first factor was number of seed per hole (J) consisting of three levels (J1 = 1 seed, J2 = 2 seeds and J3 = 3 seeds), and the second factor was spacing (T) consisting of three levels (T1 = 25 × 25 cm, T2 = 20 × 20 cm and T3 = 25 × 20 cm). Data were then evaluated using analysis of variance (ANOVA) with general linear model in Minitab version 17. Significant differences between means were compared using Least Significant Difference (LSD) at P<0.05. This research included some stages. First, seed selection was performed by soaking for 1 hour, floating seeds were removed. The remaining seeds were then selected for seeding at density of ± 100 seeds per tray. One-week seedling was then transferred into experimental plots. Prior to planting, the soil was plowed by hand tractor and then the ground was leveled with the hoe. The weeds were also removed. Planting was carried out in the plot of 2 m × 1.5 m (total 27 plots). Each experimental block consisted of 9 plots, and each plot consisted of 10 plant samples, yielding a total

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Table 1: Studies on plant spacing for various plant species.

| Species                     | General name       | Reference                      |
|-----------------------------|--------------------|--------------------------------|
| Vicia pannonica Crantz      | Hungarian Vetch    | Iptas, (2002)                  |
| Triticum aestivum L.        | Wheat              | Liu et al. (2015)              |
| Zea mays L.                 | Corn               | Sangtam et al. (2017)          |
| Zea mays L.                 | Corn               | Chen et al. (2017)             |
| Vigna radiata               | Mung bean          | Kumar et al. (2013)            |
| Pimpinella anisum L.        | Aniseed            | Ullah et al. (2015)            |
| Vigna aconitifolia (Jacq.)  | Moth bean          | Sadashivanagowda et al.(2015)  |

sample of 270 plants. Seedlings were planted in accordance with the plant spacing and number of seeds, forming a rectangle plot, with inter-bed section to facilitate the treatment. NPK fertilizer was applied at 300 kg/ha (Qosim et al., 2013) and at four stages, i.e 1st, 8th, 12th, 16th weeks after planting. The crop maintenance included watering, stitching, pest and disease control and weeding.

The observation on 3.4 plant height, the plant height was determined from stem base above the ground to the highest end of the leaf. This parameter was measured starting at 21 days after planting until 91 days after planting, with a 2-week interval. Stem diameter, the stem diameter was determined at 21 days after planting until 91 days after planting with a 2-week interval. The diameter was measured using caliper. Number of leaves, number of leaves was determined at 21 days after planting with a 2-week interval. Only fresh and productive leaves were considered. Leaf length, the leaf length (cm) was determined at 21 days after planting with a 2-week interval. The length was measured using ruler. Leaf width, leaf width (cm) was measured at 21-91 days after planting with a 2-week interval. The leaf was measured at center of the leaf surface using a ruler.

RESULTS AND DISCUSSION

Plant height and leaf length: As presented in Table 2 and Table 3, number of seeds resulted in significant effects on plant height (at 49 and 63 days after planting) and leaf length (at 77 days after planting). Meanwhile, plant spacing did not affect plant height and leaf length, although both parameters showed an increase from 21 days after planting to 91 days after planting. The significant effects of seed number on the plant growth may indicate that J3 treatment still enables the plants to reach maximal growth, absorb soil nutrients optimally, and utilize all growth factors in which the availability of nutrients, light, water and other factors are still sufficient.

Available nutrient serves as an important factor, enabling the plants to carry out metabolic activities for production of proteins, hormones, and enzymes required for plant growth. N-nutrients such as N present on the soil are sufficiently available for plants, thus the plants are able to grow maximally. They absorb N present on the soil in proportion to its relative concentration on the soil (Bloom, 2015). Gregersen (2011) and Singh et al. (2011) reported that N nutrients served in improving biomass in plants and production of high quality seed, and nutrient content in cereal grains Tauzs et al. (2017). Besides presence of nutrient, water is an essential component for plant growth. Abou El-magd et al. (2008) said that the availability of water on the soil could improve physical properties of soil, leading to enhanced aeration and drain ease which enabled to raise capability of absorbing nutrients, Kumar et al. (2018) said that management of irrigation plays a significant role in optimizing plant production. There is a very significant interaction of both variables (the number of seeds and plant spacing) to plant height and leaf length at 21 days after planting (Table 4 and 5). The highest plant growth at 21 days after planting was attributed to J2T3 treatment, yielding plant height of 27.46 cm. Growth of plant height was continue to increase, and at 91 days after planting, the highest growth of plant height was found in J2T3 treatment with average height of 151.33 cm. The highest leaf length was found in J2T3 treatment with leaf length of 20.58 cm. Long leaf growth was continue to increase until 91 days after planting.

| Table 2: Effects of seed number (J) and plant spacing (T) on plant height. |
|-----------------------------|-----------------------------|-----------------------------|
| Treatments | Plant age (days after planting) | 21 | 35 | 49 | 63 | 77 | 91 |
| J | 1 | 23.17 | 27.84 | 46.44a | 76.53b | 105.11 | 128.33 |
|   | 2 | 25.14 | 33.28 | 58.06ab | 91.93ab | 121.20 | 147.37 |
|   | 3 | 24.36 | 34.93 | 62.26a | 96.02a | 119.86 | 144.13 |
| T | 1 | 24.56 | 31.51 | 52.20 | 83.44 | 113.71 | 140.62 |
|   | 2 | 24.00 | 33.46 | 60.27 | 94.13 | 115.51 | 137.93 |
|   | 3 | 24.11 | 31.08 | 54.31 | 86.91 | 116.95 | 141.28 |
| Mean | 24.228 | 32.02 | 55.59 | 88.16 | 115.39 | 139.95 |
| SE | 0.45 | 1.36 | 2.65 | 3.21 | 5.51 | 4.15 |

Mean followed by similar characters in the same column did not show significant difference by LSD at P<0.05.
### Table 3: Effects of seed number (J) and plant spacing (T) on leaf length.

| Perlakuan | Umur tanaman (HST) | 21 | 35 | 49 | 63 | 77 | 91 |
|-----------|--------------------|----|----|----|----|----|----|
| J         |                    |    |    |    |    |    |    |
| 1         | 18.38              | 19.42 | 31.42 | 54.97 | 55.71<sup>b</sup> | 59.28 |
| 2         | 18.07              | 22.97 | 38.35 | 61.31 | 59.44<sup>b</sup> | 59.48 |
| 3         | 17.26              | 23.60 | 40.95 | 58.71 | 64.46<sup>b</sup> | 58.31 |
| T         |                    |    |    |    |    |    |    |
| 1         | 18.08              | 21.64 | 35.02 | 54.53 | 56.66 | 58.28 |
| 2         | 17.98              | 23.00 | 40.31 | 59.28 | 61.53 | 57.11 |
| 3         | 17.65              | 21.35 | 35.40 | 61.17 | 61.42 | 61.68 |
| Mean      | 17.90              | 22.00 | 36.91 | 58.33 | 59.87 | 59.03 |
| SE        | 0.46               | 0.91  | 1.76  | 1.63  | 1.36  | 0.99 |

Mean followed by similar characters in the same column did not show significant difference by LSD at P<0.05. **Very significant; NS-Non Significant.

### Table 4: Plant height as a result of interaction between number of seeds and plant spacing.

| Days after planting | Treatments | T | Mean | SE |
|---------------------|------------|---|------|----|
| 21                  | J          | 1 | 25.53<sup>b</sup> | 22.5<sup>b</sup> | 21.49<sup>c</sup> | 24.228 |
|                     |            | 2 | 24.03<sup>b</sup> | 23.93<sup>b</sup> | 27.46<sup>a</sup> | 2.05  |
|                     |            | 3 | 24.13<sup>b</sup> | 25.56  | 23.93<sup>b</sup> |     |
| 35                  | J          | 1 | 28.33  | 31.06  | 24.13  | 32.02 |
|                     |            | 2 | 33.33  | 30.60  | 35.93  | 1.36  |
|                     |            | 3 | 32.86  | 38.73  | 33.20  |     |
| 49                  | J          | 1 | 41.66  | 55.26  | 42.40  | 55.59 |
|                     |            | 2 | 56.26  | 51.63  | 61.80  | 2.65  |
|                     |            | 3 | 58.66  | 69.40  | 58.73  |     |
| 63                  | J          | 1 | 72.8   | 85.33  | 71.46  | 88.16 |
|                     |            | 2 | 90.00  | 91.40  | 94.4   | 3.21  |
|                     |            | 3 | 87.53  | 105.66 | 94.86  |     |
| 77                  | J          | 1 | 99.67  | 114.27 | 101.4  | 115.39|
|                     |            | 2 | 121.4  | 113.67 | 128.53 | 3.51  |
|                     |            | 3 | 120.07 | 118.6  | 120.93 |     |
| 91                  | J          | 1 | 116.73 | 139.4  | 128.87 | 139.95|
|                     |            | 2 | 158.33 | 132.47 | 151.33 | 4.15  |
|                     |            | 3 | 146.8  | 141.93 | 143.66 |     |

Mean followed by similar characters in the same column did not show significant difference by LSD at P<0.05. **Very significant; NS-Non Significant.

### Table 5: Average length of leaf growth affected by interaction of number of seeds and plant spacing.

| Days after planting | Treatments | T | Mean | SE |
|---------------------|------------|---|------|----|
| 21                  | J          | 1 | 18.96<sup>b</sup> | 17.73<sup>abc</sup> | 15.10<sup>c</sup> | 17.909 |
|                     |            | 2 | 17.53<sup>abc</sup> | 17.03<sup>abc</sup> | 20.58<sup>a</sup> | 0.460  |
|                     |            | 3 | 16.46<sup>b</sup> | 19.20<sup>b</sup> | 18.56<sup>abc</sup> | **     |
| 35                  | J          | 1 | 20.80  | 19.26  | 18.20  | 22.00 |
|                     |            | 2 | 22.13  | 22.66  | 24.13  | 0.91  |
|                     |            | 3 | 22.00  | 27.06  | 21.73  |     |
| 49                  | J          | 1 | 28.00  | 37.46  | 28.80  | 36.91 |
|                     |            | 2 | 38.80  | 35.86  | 40.40  | 1.76  |
|                     |            | 3 | 38.26  | 47.60  | 37.00  |     |
| 63                  | J          | 1 | 45.26  | 60.73  | 58.93  | 58.33 |
|                     |            | 2 | 60.33  | 58.00  | 65.60  | 1.63  |
|                     |            | 3 | 58.00  | 59.13  | 59.00  |     |
| 77                  | J          | 1 | 52.00  | 60.13  | 55.00  | 59.87 |
|                     |            | 2 | 54.93  | 61.00  | 62.40  | 1.36  |
|                     |            | 3 | 63.06  | 63.46  | 66.86  |     |
| 91                  | J          | 1 | 56.20  | 59.40  | 62.26  | 59.03 |
|                     |            | 2 | 60.80  | 55.80  | 61.86  | 0.99  |
|                     |            | 3 | 57.86  | 56.13  | 60.93  |     |

Mean followed by similar characters did not show significant difference by LSD at P<0.05. **Very significant; NS-Non Significant.
Significant interactions have emerged since the early stages of plant growth, and then the plants showed similar growth rate until the end of vegetative growth. This condition presumably reflects presence of abiotic stress due to displacement of plants into field, thus they need time to adapt and adjust to the environmental changes. Such environmental stress is associated with disfunction of plant metabolism Suzuki et al. (2014), leading to accumulation of reactive oxygen species (ROS) in plants produced by mitochondrial, chloroplast and peroxisomes (Mittler 2002; Mittler et al., 2004; Noctor et al., 2015; Azevedo et al., 2011).

**Stem diameter, number of leaves, and leaf width:** As exhibited in Table 6, 7 and 8, the treatments (various seed numbers and plant spacing) did not significantly affect stem diameter, leaf number, and leaf width. All three parameters were continuing to increase from beginning to end of observation. This insignificance presumably reflects that the given treatments are still acceptable to the experimental plants for optimum nutrition absorption such as N, P, K, Ca and Mg elements. They were included essential nutrients for plants (Barker and Bryson, 2007).

Thornley (1999) reported that the development of stem diameter and plant height was influenced by CO₂ level, available nitrogen, rainfall, and ambient temperature. Development of plant vegetative was unaltered as long as the factors contributing to the growth were met in sufficient quantities in the field. Additionally, seed number and plant spacing in the field does not adversely affect light exposure, which is one of important factors. The light is required by plants in photosynthesis. Kospell and Kospell (2008) suggested that light exposure was an important factor as it affected photochemical concentrations in plants.

In this study, plant density as a consequence of different seed numbers also did not increase competition, thus unaltering aforementioned parameters. Sangtam et al. (2017) stated that less plant density and sufficient spacing led to reduction of plant competition for light exposure, water, and nutrition.

**CONCLUSION**

Number of seeds per hole significantly affected height of hanjeli plant. There was interaction contributing to significant effects on plant height and leaf length. For application, J2T3 (2 seeds per hole, plant spacing 25 cm × 20 cm) was recommended to obtain the best result.

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**Table 6:** Average diameter of stem at various periods of observation.

| Days after planting | Sample Size | Average stem diameter (mm) | StDev | CI for StDev |
|---------------------|-------------|-----------------------------|-------|--------------|
| 35                  | 27          | 4.9562                      | 0.90950 | (0.70459; 1.2659) |
| 49                  | 27          | 7.9890                      | 1.9790 | (1.5347; 2.7517) |
| 63                  | 27          | 12.720                      | 1.7528 | (1.1343; 2.9207) |
| 77                  | 27          | 12.849                      | 1.3603 | (1.0608; 1.8807) |
| 91                  | 27          | 14.352                      | 1.7339 | (1.2791; 2.5345) |

**Table 7:** Average number of leaves at various periods of observation.

| Days after planting | Sample Size | Average number of leaves | StDev | CI for StDev |
|---------------------|-------------|--------------------------|-------|--------------|
| 21                  | 27          | 2.4222                   | 0.39354 | (0.29614; 0.56391) |
| 35                  | 27          | 4.0296                   | 0.43218 | (0.33265; 0.60545) |
| 49                  | 27          | 5.6296                   | 0.61695 | (0.43902; 0.93486) |
| 63                  | 27          | 5.2963                   | 0.54736 | (0.41611; 0.77636) |
| 77                  | 27          | 5.3037                   | 0.54806 | (0.41593; 0.77869) |
| 91                  | 27          | 5.7630                   | 0.59235 | (0.41089; 0.92081) |

**Table 8:** Average leaf width at various periods of observation.

| Days after planting | Sample Size | Leaf width (cm) | StDev | CI for StDev |
|---------------------|-------------|-----------------|-------|--------------|
| 21                  | 27          | 1.04            | 0.18  | (0.12896; 0.29817) |
| 35                  | 27          | 2.37            | 0.35  | (0.28293; 0.48360) |
| 49                  | 27          | 3.07            | 0.42  | (0.32495; 0.59706) |
| 63                  | 27          | 3.83            | 0.29  | (0.19712; 0.47380) |
| 77                  | 27          | 5.28            | 0.50  | (0.39238; 0.68708) |
| 91                  | 27          | 4.19            | 0.31  | (0.23218; 0.45502) |
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