The Effect of polyethylene glycol concentration on some varieties of kenaf (Hibiscus cannabinus L.) in enhancing the germination viability

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Abstract. The purpose of this study was to see the interaction between the concentration of Polyethylene Glycol and various varieties of kenaf (Hibiscus cannabinus L.) On plant germination. This study used a completely randomized factorial design with 3 replications. The factors used for the study were varieties of kenaf (Karang Proso 6, Karang Proso 9 and Karang Proso 15) and the concentration of Polyethylene Glycol (0, 3, 5, and 7 ppm). Data were analyzed using analysis of variance (F test) using least significant difference (LSD) test of 5%. There was an interaction between the concentration of Polyethylene Glycol and kenaf varieties on germination power. Karang Proso 9 variety was consistent with several concentrations of Polyethylene Glycol which had higher germination compared to other varieties. Polyethylene Glycol concentration did not affect hypocotyl length, seed germination uniformity, dry weight of the varieties of Karang Proso 6, Karang Proso 9 and Karang Proso 15.

1. Introduction

Kenaf (Hibiscus cannabinus L.) is an annual plant and belongs to the Malvaceae family. Kenaf tree bark can be used to produce fiber. Kenaf fiber is used as raw material for pulp and paper, bio-composites, drain fiber, particleboard, car dashboards and bio-plastics [1]. In addition, kenaf seeds can also be used as food, because they contain 20% unsaturated fatty acids such as palmitic acid, oleic acid and linoleic acid. The composition of kenaf seed sterol oil is similar to that of soybean and cottonseed sterol [2]. In addition, kenaf leaves contain 24% crude protein, so it is best used as feed for poultry and ruminants. Program Intensifikasi Serat Karung Rakyat (ISKARA) has been developing kenaf since 1978/1979. Kenaf reached the peak of its plantation in 1986/1987 with an area of 26,000 ha, and the average productivity was around 0.9-1.2 tonnes/ha [3]. Kenaf plantations are spread across Lampung, West Java,
East Java and South Kalimantan. However, the high competition for plastic packaging has led to a drastic decrease in kenaf use. The decline in the use of kenaf has an impact on the decline in the development of the kenaf area. The total area of kenaf in Indonesia is approximately 1,308 ha, and its location is in Lamongan, East Java Province. Fiber production is around 1,254 tons with a productivity of 0.96 tons/ha. This value is far lower than the optimal potential that must be achieved (2-4 tonnes/ha) [4]. Various methods were used to increase kenaf production, such as variety selection, nursery management, fertilization management and testing of kenaf plants on various types of soil (podzolic red-yellow and Incepticole) [5]. Balai Penelitian Tanaman Pemanis dan Serat (Balittas) has produced some of the best varieties including Karang Proso 6, 9, 11, 12, 14, 15, 16 and 19 [6]. However, information on the level of productivity of these varieties is still limited.

On the other hand, a good germination management strategy is an important factor in increasing kenaf production. However, a decrease in seed quality will occur due to errors in germination treatment. The result of these conditions will cause a decrease in seed viability. This problem can be solved by the priming method. The priming method is an accelerating and simultaneous germinating method through water absorption control. Osmoconditioning is a general treatment of the priming methods used for germination. The osmoconditioning process is carried out by immersing the seeds in a solution of Polyethylene Glycol. Polyethylene Glycol solution is a compound to control imbibition and hydration processes in seeds. Although Polyethylene Glycol solution can accelerate germination, the concentration of this solution is still little known. Therefore, this study will examine the concentration of Polyethylene Glycol variety Kenaf (Hibiscus cannabinus L.) in increasing germination viability.

2. Methods

This study used a completely randomized factorial design with 3 replications. The factors used in this study were varieties of kenaf (Karang Ploso 6, Karang Ploso 9 and Karang Ploso 15) and the concentration of Polyethylene Glycol (0, 3, 5, and 7 ppm). Data were analyzed using analysis of variance (F test) at the level of α 5%. If the treatment has a significant effect, it is followed by the least significant difference (LSD) test. Data analysis was examined using STAR 2.0.1 software. After the preparation of kenaf seeds is ready, Polyethylene Glycol 6000 will be made with concentrations of 3, 5, and 7 ppm following the equation N1.V1 = N2.V2. The main solution will be made 100 ppm PEG 6000 = 500 mg which will be dissolved in 500 ml water. PEG 6000 will be diluted into several concentrations. The paper will be dried and damp cotton will be placed on the paper. Parameters were observed 1 week after the seeds were germinated. The seeds will be arranged on wet cotton. In the next stage, the seeds will be covered with wet paper. Observations will be made after seven days. The parameters to be measured were the percentage of germination, hypocotyl length, dry weight and germination time.

3. Results and discussion

3.1 Percentage of Germination

Polyethylene Glycol concentrations of 0, 3, 5 and 7 ppm were not significantly different. There was an interaction between the PEG concentration and the kenaf variety. Varieties of Karang Proso 9 had the highest germination rate compared to Karang Proso 6 and Karang Proso 15 at various concentrations of PEG. It was assumed that Karang Proso seeds had higher viability than the other two varieties. Seed viability was the viability of the seeds as indicated by the ratio of normal sprouts to the total seeds that were tested for germination [7].
### Table 1. Percentage of Sprouts (%) in some kenaf varieties and Polyethylene concentrations

| Variety          | Polyethylene Glycol Concentration (ppm) | Average |
|------------------|----------------------------------------|---------|
|                  | 0         | 3       | 5       | 7       |         |
| Kalang Proso 6   | 51.67 d   | 71.67 bc| 56.67 cd| 43.33 d | 55.83 c |
| Kalang Proso 9   | 100.00 a  | 100.00 a| 100.00 a| 100.00 a| 100.00 a|
| Kalang Proso 15  | 80.00 b   | 71.67 bc| 83.33 ab| 85.00 ab| 80.00 b |

*Note: The number for each main treatment and its combination followed by the same lowercase letter, is not significantly different according to the least significant difference 5%.*

The high viability of Karang Proso 9 seeds caused the osmoconditioning treatment to be ineffective, as stated in Widajati 1999 study which showed that the osmoconditioning treatment was effective in seeds that had deteriorated and germinated 72-90% [8]. The Karang Proso 6 variety with PEG 3 ppm increased the ability to germinate by 20% compared to the control, then decreased the ability to germinate at a PEG concentration of 7 ppm. PEG concentrations that were too high caused the osmotic potential value around the seeds to become increasingly negative, so that water was difficult to absorb by the seeds. The low osmotic potential of the solution could inhibit the imbibition process [9]. In the Karang Proso 15 variety the germination rate at a concentration of 5 and 7 ppm increased the ability to germinate, this indicated that the optimum concentration to support plant germination was more than 7 ppm for Karang Proso 15 variety.

#### 3.2. Simultaneous growth

The simultaneous growth of Karang Proso 6 variety was lower than Karang Proso 9 and Karang Proso 15. This showed that the seeds of Karang Proso 6 varieties had experienced a decline, supported by table 1 where the sprouts of Karang Proso 6 were lower than those of Karang Proso 9 and 15 varieties. The addition of insignificant PEG concentration increased the simultaneous growth, but there were several interactions between kenaf varieties and the dosage of Polyethylene Glycol. In Karang Proso 9 and 15 varieties, PEG 7 ppm treatment increased the simultaneous growth by 20% compared to the control (0 ppm), while the Karang Proso 15 variety was given 10% compared to the control (Table 2). Nurmauli and Nurmiaty 2010 on soybean plants, giving PEG with a concentration of 20% increased the simultaneous growth compared to PEG treatment of 10% [9]. It was assumed that the increase in PEG concentration would increase water imbibition more quickly, and affect the rate of stimulation of the gibberine hormone in changing food reserves and synchronizing plant growth [10].

### Table 2. Simultaneous growth (%) in some kenaf varieties and Polyethylene concentrations

| Variety          | Polyethylene Glycol Concentration (ppm) | Average |
|------------------|----------------------------------------|---------|
|                  | 0         | 3       | 5       | 7       |         |
| Kalang Proso 6   | 31.67 d   | 28.33 d | 46.67 cd| 31.67 d | 34.58 b |
| Kalang Proso 9   | 80.00 ab  | 78.33 b | 65.00 bc| 100.00 a| 80.83 a |
| Kalang Proso 15  | 71.67 b   | 63.33 bc| 73.33 b | 81.67 ab| 72.50 a |

*Note: The number for each main treatment and its combination followed by the same lowercase letter, is not significantly different according to the least significant difference 5%.*
3.3. Hypocotyl length and dry weight

Table 3 showed that the hypocotyl length of the three varieties of kenaf and various concentrations of Polyethylene Glycol as well as the combination of the three varieties of kenaf and various concentrations of Polyethylene Glycol showed no significant differences.

| Variety           | Polyethylene Glycol Concentration (ppm) | Average |
|-------------------|----------------------------------------|---------|
|                   | 0           | 3       | 5       | 7       |
| Kalang Proso 6    | 11,13 a     | 6,60 a  | 9,10 a  | 11,10 a | 9,48 a |
| Kalang Proso 9    | 9,57 a      | 8,53 a  | 9,17 a  | 11,00 a | 9,57 a |
| Kalang Proso 15   | 9,07 a      | 10,87 a | 9,33 a  | 9,70 a  | 9,74 a |
| Average           | 9,92 a      | 8,67 a  | 9,20 a  | 10,60 a |         |

Note: The number for each main treatment and its combination followed by the same lowercase letter, is not significantly different according to the least significant difference 5%.

Table 4 showed that the dry weight of three kenaf varieties and various concentrations of polyethylene glycol as well as the combination of three kenaf varieties and various concentrations of polyethylene glycol were not significantly different. This was because sprouts dry weight was more influenced by the length of the hypocotyl, where there was a very close correlation between the length of the hypocotyl and the dry weight of the sprouts. Increasing hypocotyl length could increase sprouts dry weight [11].

| Variety           | Polyethylene Glycol Concentration (ppm) | Average |
|-------------------|----------------------------------------|---------|
|                   | 0           | 3       | 5       | 7       |
| Kalang Proso 6    | 73,52 a     | 43,58 a | 60,09 a | 73,30 a | 62,62 a |
| Kalang Proso 9    | 63,17 a     | 56,35 a | 60,53 a | 72,64 a | 63,17 a |
| Kalang Proso 15   | 59,87 a     | 71,76 a | 61,63 a | 64,05 a | 64,33 a |
| Average           | 65,52 a     | 57,23 a | 60,75 a | 70,00 a |         |

Note: The number for each main treatment and its combination followed by the same lowercase letter, was not significantly different according to the least significant difference 5%.

4. Conclusion
Karang Proso 9 varieties were consistent with several concentrations of Polyethylene Glycol which had higher germination rates compared to other varieties. Polyethylene Glycol concentration did not affect hypocotyl length, seed germination uniformity, dry weight of the varieties of Karang Proso 6, Karang Proso 9 and Karang Proso 15.

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