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# Growth Performance of Two Cowpea Varieties with Application of Water Hyacinth Root Extract as Seed Priming

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***Abstract***

*Nagara cowpea seeds are susceptible to deterioration during storage, thus seed viability performance must be improved with various techniques including seed invigoration. Organic priming is an invigoration technique that can be obtained from several plants that contain growth regulators. Water hyacinth is an aquatic plant in swampy areas that can be used as a raw material for organic priming. Therefore, it is necessary to study the concentration of water hyacinth root extract on seeds to support the cowpea growth phase. This study aims to determine the response and the best concentration of water hyacinth root extract on the growth of two cowpea varieties. This study used a completely randomized design (CRD) split plot with the main factor being cowpea varieties (G) consisting of 2 levels, G1 (Nagara cowpea) and G2 (KT9 cowpea). The subplot factor is water hyacinth root concentration (C) consisting of 4 levels C0 (without priming), C1 2.5%, C2 5.0%, C3 7.5%. The results showed that the application of water hyacinth root extract affected the growth of two cowpea varieties on plant height, number of branches and number of leaves. The highest plant height was in KT9 cowpea soaked with 5% concentration of root extract. The highest number of branches in Nagara cowpea soaked in water hyacinth root extract at concentration 2.5%. The highest number of leaves in cowpea KT9 soaked in water hyacinth root extract at concentration 7.5%.*

*Keywords: Cowpea, Gibberellin, Invigoration*

## 1. Introduction

Cowpea is an alternative source of vegetable protein besides soybeans. cowpea protein content reaches 24.09% protein [1]. While soybean protein content reaches 36.5%. Cowpea in Indonesia is spread across several islands, one of which is in South Kalimantan Province.

Nagara cowpea in the lebak swamp is only planted once per year, which can reduce seed quality (seed viability), growth and yield. Efforts to improve seed quality include seed invigoration, which is an effort to maximize seed viability potential through seed priming. Priming is very helpful in increasing the percentage of cowpea seedling emergence [2].

Water hyacinth (*E. crassipes*) is a tropical species belonging to the Pontederiaceae family, which are aquatic plants originating from the Amazon watershed in South America [3]. Water hyacinth, is a local resource that is widely found in the South Kalimantan wetlands. The invasive presence of water hyacinth has been considered disruptive to aquatic ecosystems. So that some people, looking for alternatives to the utilization of these weeds.

Many utilizations of water hyacinth in agriculture and the environment are as a source of organic matter and photoremediation [4, 5, 6]. Exploration of the utilization of water hyacinth has also been claimed to be a source of plant growth regulator in the form of gibberellins. Several studies on the effectiveness of water hyacinth on plant germination as scientific support in the utilization of water hyacinth as a source of plant growth regulator [7, 8, 9].

Generally, water hyacinth is utilized by the community as raw material for handicrafts that have economic value [10]. Handicrafts that can be produced are bags, sandals, shoes, pillowcases, tissue holders, flower vases, mats, and various other crafts. Crafts from water hyacinth utilize the dried part of the stem. In addition to water hyacinth being processed into various kinds of handicrafts, it can also be utilized as a plant growth regulator for germination. Water hyacinth root extract containing the hormone gibberellin is known to act as a natural growth regulator that can increase seed viability and vigor when starting the seed germination process [11]. It is known that water hyacinth roots contain 0,18% of the hormone gibberellin, and can be used as a natural growth regulator.

Gibberellins are synthetic growth hormones that affect plant growth from germination to maturity and play a role in cell division and cell expansion [12]. Due to the high price and limited availability of synthetic gibberellins, therefore an alternative is used, namely natural gibberellins derived from the roots of water hyacinth plants.

Priming treatment of nagara cowpea seeds with water hyacinth root extract has a significant effect on all growth changes [13]. The addition of water hyacinth natural plant growth regulator is also known to have a very significant effect on dormancy, germination, germination speed, vine length and seed growth percentage [14, 15]. Soaking seeds with plant growth regulator solution before sowing can soften the seed coat, making it easier for gas and water to diffuse into the plant to help the germination process. The hormone gibberellin in water hyacinth root extract is also able to affect plant growth by increasing the process of protein synthesis, allowing cells to divide and cell elongation occurs which shows an increase in plant growth [16].

Some research on seed quality growth can be overcome by the application of plant growth regulator. Priming technology is very helpful in increasing the percentage of cowpea seedling emergence [17]. Based on the description above, the purpose of this study is to determine the response of water hyacinth root extract to cowpea seed growth. Therefore, it is necessary to study the concentration of water hyacinth root extract on cowpea seeds to support the development of agricultural food crops.

## 2. Material and Methods

The materials used were nagara cowpea and KT-9 cowpea seeds, water hyacinth roots, urea fertilizer of 50 kg $ha^{-1}$, SP-36 fertilizer of 100 kg $ha^{-1}$, KCl fertilizer of 100 kg $ha^{-1}$, Methanol, water, furadan, agrept, and dithane. The tools used include hoes, paddles, label paper, nameplates, blenders, scissors, measuring cups, measuring pipettes, funnels, filter paper, analytical balances, gauze, meters, cameras, and plastic cups.

This study used an experimental method with a factorial design consisting of two factors arranged incompletely randomized design (CRD) split plot. The main plot factor is cowpea varieties consisting of 2 levels and the sub-plot factor is water hyacinth root concentration consisting of 4 levels. There were 8 treatments with 3 replications so there were 24 experimental units.

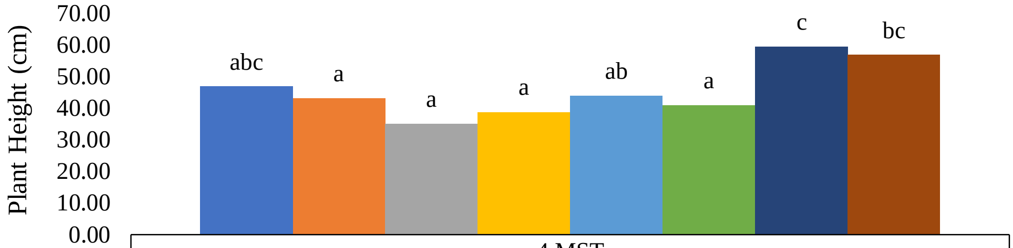
The main plot factor is cowpea variety (G) which consists of 2 levels, G1 (local variety Nagara) and G2 (superior variety KT-9). The subplot factor is the concentration of water hyacinth root extract (C) which consists of 4 levels, K (Control or without priming), C1 (2.5%), C2 (5.0%), and C3 (7.5%).

Observation parameters include plant height, number of leaves, and number of branches. Observation data were tested for homogeneity using Bartlett's variance homogeneity test. If the data is homogeneous, data analysis is continued with One Way Analysis of Variance (ANOVA) and if the data is not homogeneous then data transformation is performed. If the treatment has a significant effect, it is continued with the DMRT test (Ducan's Multiple Range Test) at the 5% level. All data were tested using Microsoft Excel.

## 3. Results and Discussion

### 3.1 Plant Height

The interaction of cowpea varieties and the concentration of water hyacinth root extract had a significant effect on plant height at the age of 4 weeks after planting (WAP). Plant height is presented in Figure 1.




| | 4 MST |
|---|---|
| G1 C0 | 46.77 |
| G1 C1 | 43.13 |
| G1 C2 | 35.03 |
| G1 C3 | 38.80 |
| G2 C0 | 43.93 |
| G2 C1 | 40.97 |
| G2 C2 | 59.37 |
| G2 C3 | 56.73 |

Note : $C_0$ = Control (Without priming) $G_1$ = Nagara
$C_1$ = 2,5% $G_2$ = KT-9
$C_2$ = 5,0%
$C_3$ = 7,5%

Figure 1
Plant height 4 WAP of two varieties of cowpea with seed priming on water hyacinth root extract

Plant height is a measure of plants that is often observed as an indicator of growth that can be used to measure the effect of the environment or treatment applied. Height increase in plants shows the vegetative growth activity of a plant. The results of the analysis (Figure 1) stated that the growth of plant height during the vegetative period in nagara cowpea with water hyacinth root extract cowpea was the highest with a concentration of 5.0% water hyacinth root extract in KT-9 (G2C2), G1C0, and G2C3. While the lowest plant height was obtained in the treatment of water hyacinth root concentrations of 2.5%, 5.0%, 7.5% in nagara cowpea and at a concentration of 2.5% water hyacinth root extract in KT-9.

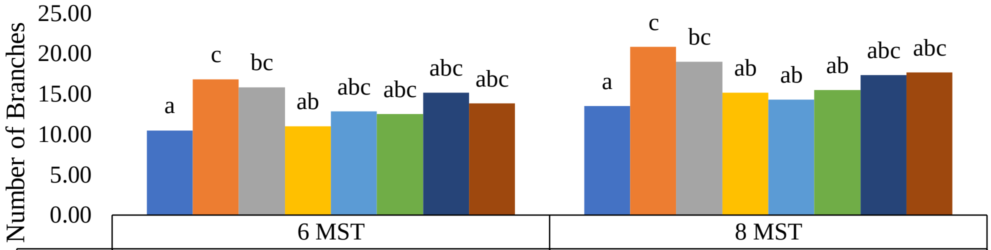
There was a difference in the response of Nagara and KT-9 cowpeas to water hyacinth root extract immersion. Nagara cowpeas when soaked in water hyacinth root extract gave a negative response indicated by a reduction in plant height. While KT-9 showed a positive response to water hyacinth root extract immersion at a concentration of 5.0% better than 0% and 2.5%. This is suspected that superior varieties and local varieties have different responses to water hyacinth root extract. Each variety of each plant will provide different growth responses and production levels [18]. In addition, the genetic characteristics of each variety or cultivar of the plant affect the production results of a plant [19, 20]. Genetic diversity in each soybean variety is different. Genetic diversity in superior varieties tends to have more good properties so that it is expected to increase plant productivity. The genetic diversity of a plant variety is usually formed from the results of a fairly long adaptation to its environment [21].

KT-9 cowpea which interacts with water hyacinth extract produces better height compared to nagara cowpea, at a concentration of 5.0% water hyacinth root extract in KT-9 (G2C2) is able to provide good growth for plant height growth. However, when given a concentration of 7.5% water hyacinth root extract, plant height decreased. Giving growth regulators with excessive concentrations disrupts cell functions, inhibiting plant growth [22].

However, control plants produced higher plant heights compared to water hyacinth root extract soaking. This is thought to be due to the immersion time with water hyacinth root extract being inappropriate and the absence of gibberellin in increasing plant height. This is thought to be caused by gibberellin contained in too high a concentration so that it is unable to increase the percentage of plant height. Water hyacinth contains growth regulators such as auxin, cytokinin, and gibberellin. One of the effects of auxin on plants is to support stem growth, if the concentration of water hyacinth roots is given in high concentrations it can inhibit plant growth. Auxin is able to stimulate the growth of new shoots because auxin is found in the tips of young shoots and in the meristem tissue at the tip, this hormone functions as a regulator of cell enlargement and triggers cell extension in the area behind the tip meristem and helps the stem growth process [23]. In addition, water hyacinth roots have a high tendency for heavy metals, one of which is Cu metal. If the metal content is at a high concentration, it will inhibit enzyme activity and protein formation or have a toxic effect on plants. Metal concentrations that exceed the maximum limit can cause reduction in plant organs, plant size becomes stunted, flowers become smaller than normal size or even not form, causing chlorosis, the fatal effect is causing death [24].

### 3.2 Number of Branches

The interaction of varieties with water hyacinth root extract significantly influenced the number of branches at 6 WAP and 8 WAP. Water hyacinth root extract has a significant effect on the number of branches at 6 and 8 WAP. The number of branches in the interaction of varieties and extracts is presented in Figure 2. The number of branches in the single factor treatment of water hyacinth root extract is presented in Figure 3.




| | 6 MST | 8 MST |
|---|---|---|
| G1 C0 | 10.50 | 13.50 |
| G1 C1 | 16.83 | 20.83 |
| G1 C2 | 15.83 | 19.00 |
| G1 C3 | 11.00 | 15.17 |
| G2 C0 | 12.83 | 14.33 |
| G2 C1 | 12.50 | 15.50 |
| G2 C2 | 15.17 | 17.33 |
| G2 C3 | 13.83 | 17.67 |

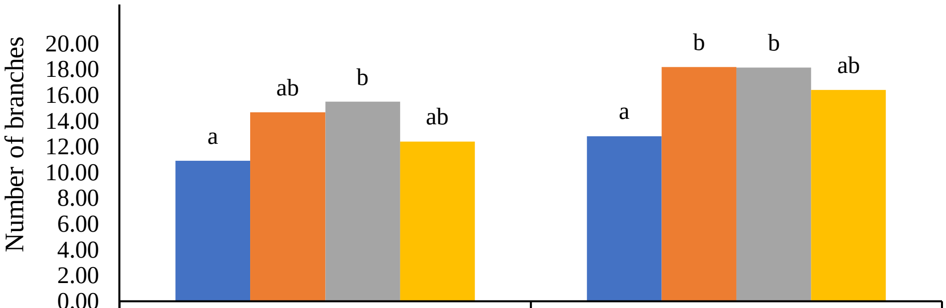
Note : $C_0$ = Control (Without priming) $G_1$ = Nagara
$C_1$ = 2,5% $G_2$ = KT-9
$C_2$ = 5,0%
$C_3$ = 7,5%

Figure 2
Number of branches 6 and 8 WAP of two varieties of cowpea with seed priming on water hyacinth root extract

Based on Figure 2, the highest number of branches 6 WAP of cowpea was obtained in the interaction of nagara cowpea with 2.5% water hyacinth root extract concentration (G1C1), which was not significantly different from nagara cowpea at 5.0% water hyacinth root extract concentration (G1C2) and in all KT-9 treatments. While the lowest number of cowpea branches was obtained in the treatment of nagara cowpea 0% (G1C0), which was significantly different from nagara cowpea at the concentration of water hyacinth roots 2.5% (G1C1) and 5% (G1C2) and KT-9 at the concentration of water hyacinth roots 7.5% (G2C3).

At 8 WAP, the highest number of cowpea branches was obtained in the treatment of nagara cowpea with 2.5% water hyacinth root extract concentration (G1C1) but not significantly different from the treatment of nagara cowpea at 5.0% water hyacinth root extract concentration (G1C2), and KT-9 at 5.0% (G2C2) and 7.5% (G2C3) water hyacinth root extract concentration. While the lowest number of cowpea branches was obtained in the control treatment (without priming) 0% in nagara cowpea, but not significantly different from nagara cowpea at a concentration of water hyacinth root extract of 7.5% (G1C3) and in KT-9 control treatment (without priming) 0% and concentration of water hyacinth root extract 2.5% (G2C1).

The nagara cowpea given 2.5% and 5.0% concentration of water hyacinth root extract consistently showed the highest number of branches at 6 and 8 weeks of planting. While KT-9 at concentrations of 0% (G2C0) to 7.5% (G2C3) had a number of branches that were not significantly different at 6 weeks after planting, but showed a real difference at 8 weeks after planting with a concentration of 7.5% (G2C3) can increase the number of branches that are not significantly different from (G1C1). It is suspected that the growth hormone contained in the water hyacinth root extract with a concentration of 2.5% is optimal for the nagara cowpea variety for the growth of the number of branches. Phytohormones such as auxin or gibberellin that are too high can inhibit plant growth. Auxin at high levels is more inhibitory than stimulating growth [25]. The relationship between growth and auxin levels in roots, stems and shoots is to stimulate growth at low levels, while inhibiting growth at high levels [26]. Gibberellin hormones work on growth genes so they require precise concentrations in some types of plants [27]. The concentration of 2.5% water hyacinth root extract in this study was able to effectively increase the number of branches. The reduction in the number of branches formed is related to the length of the main stem internode due to gibberellin. With the increasing length of the main stem internode, energy is diverted to internode growth, while energy for the growth of new branches is limited. The number of branches is influenced by the amount of photosynthate produced [28].




| | 6 MST | 8 MST |
|---|---|---|
| C0 | 10.92 | 12.83 |
| C1 | 14.67 | 18.18 |
| C2 | 15.50 | 18.17 |
| C3 | 12.42 | 16.42 |

Note : $C_0$ = Control (Without priming)
$C_1$ = 2,5%
$C_2$ = 5,0%
$C_3$ = 7,5%

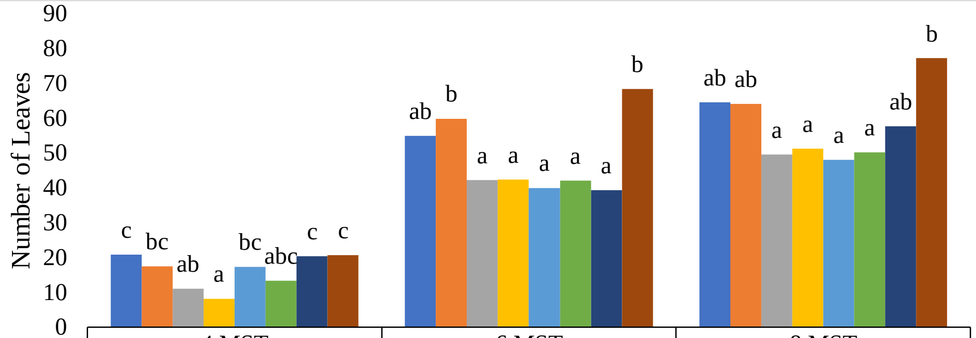
Figure 3
Number of branches 6 and 8 WAP of cowpea with seed priming on water hyacinth root extract

In all types of cowpea both in nagara and KT-9 varieties, the highest number of branches at 6 WAP was at the concentration of water hyacinth root extract 5.0% (C2), but not different from the concentration of water hyacinth root extract 2.5% (C1) and 7.5% (C3). While at 8 WAP, the highest number of branches is at the concentration of water hyacinth root extract 2.5% (C1) but not significantly different from the concentration of water hyacinth root extract 5.0% (C2) and 7.5% (C3).

The highest number of branches was at the concentration of water hyacinth roots with 5.0% treatment although it was not significantly different from 2.5% and 7.5%. While the least number of branches was in the control (without priming). This shows that the application of water hyacinth root extract is recommended to increase the growth of the number of cowpea branches because it provides the nutrients needed by plants. Gibberellin can affect stem length, encourage flowering, fruit formation, and shoot growth, when it was given at the precise concentration. Conversely, if the concentration is not as needed, it will inhibit plant growth [29].

### 3.3 Number of Leaves

The number of leaves of nagara cowpea at 4 WAP, 6 WAP, and 8 WAP were significantly affected by the interaction of water hyacinth extract and cowpea genotypes. The number of leaves is presented in Figure 4.




| | 4 MST | 6 MST | 8 MST |
|---|---|---|---|
| G1 C0 | 20.83 | 54.83 | 64.50 |
| G1 C1 | 17.50 | 59.83 | 64.00 |
| G1 C2 | 11.00 | 42.17 | 49.50 |
| G1 C3 | 8.17 | 42.33 | 51.17 |
| G2 C0 | 17.33 | 40.00 | 48.00 |
| G2 C1 | 13.33 | 42.00 | 50.17 |
| G2 C2 | 20.33 | 39.33 | 57.67 |
| G2 C3 | 20.67 | 68.33 | 77.17 |

Note : $C_0$ = Control (Without priming) G1 = Nagara
$C_1$ = 2,5% G2 = KT-9
$C_2$ = 5,0%
$C_3$ = 7,5%

Figure 4
Number of leaves 4, 6, and 8 WAP of two varieties of cowpea with seed priming on water hyacinth root extract

Observations of the number of leaves at 4 WAP showed the highest value at 0% water hyacinth root extract (without priming) (G1C0), but not different from the concentration of 2.5% water hyacinth root (G1C1) in nagara cowpea and at KT-9 at the concentration of 5.0% water hyacinth root (G2C2) and 7.5% (G2C3). While the lowest number of cowpea leaves was obtained in the 7.5% treatment of nagara cowpea (G1C3), but it was significantly different from nagara cowpea in the concentration of water hyacinth root extract 0% (without priming), as well as in KT-9 in the concentration of water hyacinth root extract 5.0% (G2C2) and 7.5% (G2C3).

The highest number of leaves at 6 WAP was KT-9 with 7.5% water hyacinth root extract (G2C3). However, it was not significantly different from the treatment of nagara cowpea at 0% concentration of water hyacinth root extract (without priming) (G1C0) and at 2.5% concentration of water hyacinth root extract (G1C1). While the lowest number of cowpea leaves was obtained in the KT-9 treatment with a concentration of 5.0% water hyacinth roots (G2C2), which was not significantly different from the concentration of water hyacinth roots 0% (without priming) (G2C0) and 2.5% (G2C1), and Nagara cowpea at a concentration of 5.0% (G1C2) and 7.5% (G1C3) water hyacinth roots.

The highest number of leaves 8 WAP was KT-9 at 7.5% water hyacinth root extract soaking (G2C3). However, it was not significantly different from KT-9 at 5.0% water hyacinth root extract concentration (G2C2), as well as nagara cowpea with 0% water hyacinth root extract (without priming) (G1C0) and 2.5% water hyacinth root extract concentration (G1C1). While the lowest number of cowpea leaves was obtained in the KT-9 treatment with 0% water hyacinth root concentration (without priming) (G2C0), which was not significantly different from the 2.5% water hyacinth root concentration (G2C1).

In the type of cowpea variety KT-9 with a concentration of 5.0% and 7.5%, the number of leaves responded to the application of water hyacinth extract. It is suspected that the growth hormones auxin, gibberellin and cytokinin are able to support growth, especially in the number of leaves. This is in accordance with the opinion that gibberellin enlarges the leaf area also extends the stem and affects the growth of the number of leaves [30, 31]. Cytokinin will stimulate cell division in plants. One result of cell division is the formation of leaves [32, 33, 34]. The provision of cytokinin hormones can increase the percentage of life, the number of buds, and the number of leaves on plant grafting [35, 36, 37, 38, 39].

It is possible that the number of leaves of Nagara cowpea only requires a limit of 2.5% treatment or even the control (without priming) can still provide good growth. The results showed that nagara cowpea with 0% water hyacinth root extract (without priming) (G1C0) was able to increase the number of leaves during the vegetative period, which was not significantly different from KT-9 cowpea at the concentration of water hyacinth roots at 5.0% (G2C2) and 7.5% (G2C3) treatments. The number of leaves that are almost the same indicates that the potential of plants in carrying out the photosynthesis process is relatively the same [40]. The addition of growth regulators such as auxins, gibberellins, and cytokinins or other organic extracts is still needed in the use of basic media [41]. Micro and macro nutrients that play a role in the formation of chlorophyll, facilitate the process of photosynthesis, and increase enzymes that play a role in the process of protein synthesis [42].

Each plant has endogenous hormones to stimulate leaf growth, but the hormones present in the leaves are few in numbers, so they need to be supplemented with growth-promoting substances that come from outside (exogenous). In relation to the function of growth regulators, auxin can affect the work of cytokinin, cytokinin hormones affect the emergence of buds which then differentiate into leaves. If auxin is in an optimal concentration, then cytokinin transport according to its function to initiate budding appears [43, 44].

The hormone content found in water hyacinth roots has an important role, especially in the vegetative phase of the plant, in influencing the number of leaves. The number of leaves has a role in several metabolite compound synthesis or photosynthesis processes that produce photosynthate as energy for plant growth. Water hyacinth roots containing gibberellin can stimulate cell division, especially in increasing the number of leaves [45]. An increase in the number of leaves on a plant will produce a lot of energy that can be used for plant metabolic processes [46].

## 4. Conclusion

The concentration of water hyacinth root extract gave a positive response to the number of branches, and gave a negative response to plant height and number of leaves. The best concentration of water hyacinth root extract that gives a positive response in the vegetative phase to cowpea varieties is at a concentration of 2.5% water hyacinth extract at 6 weeks after planting and 8 weeks after planting.

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