Growth response and yield of several local yam plants with hormax applications

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Abstract. This study aimed to determine the growth and yield of several types of local yam with Hormax application. The study was conducted in Pososalongo Village, Banggai Tengah District, Banggai Laut Regency, Central Sulawesi Province, from January to July 2019. This research was arranged following the Split Plot Design. As the main plot was the type of yam namely Butuli, Tu'u, Manui, Pau-Pau Ateno, Sombok, and Kulaluk, while as a subplot is the concentration of Hormax solution consisted of four levels namely 0, 2.0, 4.0, and 6.0 mL/L water. The results showed that the type of yam Butuli had the fastest sprouting speed of 25.50 days, the highest number of leaves was 337.58 strands, and the highest number of tubers was 1.81 pieces. The concentration of Hormax 4 mL/L water treatment resulted in the longest stem which was 491.47 cm, the highest number of leaves was 274.56 strands.

1. Introduction
Food is the most basic and absolute basic human need to be fulfilled. Fulfilment of staple food needs, especially rice in a region of Indonesia at any time, will be a serious problem if there is a decrease in domestic production due to production interruptions such as drought, flooding, or pests that cause crop failure [1]. The drought that always occurs in every dry season results in decreased rice production. Indonesia should not be included as a food insecure country because it has its own food source in accordance with the surrounding natural conditions, therefore local food as an alternative food source needs to be improved. Efforts to maximize the availability of community food can be done through diversifying food consumption based on local resources so that dependence on rice as a staple food can be reduced slowly and replaced with other carbohydrate sources such as tubers, one of which is yam.

One of the regencies in Central Sulawesi Province, namely the Banggai Laut Regency, has several types of yam found in the area, including: Butuli, Tu'u, Manui, Pau-pau Ateno, Sombok and Kulaluk. Yam in the local language is called the standard. Yam is a food crop that is consumed by the indigenous people of the Banggai Laut community as a staple food. Aside from being a staple food yam also has an efficacious antioxidant function. Ube tubers contain thick mucus which consists of glycoprotein and water soluble polysaccharides that function as bioactive food fiber which is hydrocoid which is useful for reducing blood glucose levels and total cholesterol levels.
Yam produces tubers for storing flour, can be used as food by boiling, baking or frying. In Banggai Laut, yam is used as a staple food, which is boiled, fried, grated and then wrapped in banana leaves and cooked called *payot*, or made as baby food porridge and Banggai Laut typical porridge which is cooked with coconut milk and salt called *nalum*. In addition, yam is also used as a medium of exchange in the sale and purchase of goods including animals and livestock. The diet by consuming yam as the main menu is basically a healthy diet and must be maintained and developed [2].

The development of yam in the Banggai Laut area is generally very limited due to the community's knowledge about yam is still limited and does not know its nutritional content. Farmers cultivate yam by using whole tubers and are not yet aware of the multiplication of seed tubers by using small pieces of tubers so that seed procurement is still very limited. To support the growth of shoots from these pieces of tubers, growth stimulants are needed. One product that contains growth compounds is Hormax. Hormax contains the hormones auxin, gibberellins and cytokines [3]. According to Supatno [4], several advantages and benefits of Hormax include: containing hormones or organic growth stimulants complete, stimulating the release of roots, extending and multiplying root fibers and shoots, stimulating growth processes, enlarging the size of cells and tissues, stimulating enlargement in the rhizomes and tubers. Plant regulator compounds in Hormax is expected to increase growth and yield of yam plants. Thus, this study aims to determine the response of growth and yield of plants of several species of Banggai Laut local yam with Hormax application.

2. Materials and method
This research was carried out in Pososlalongo Village, Banggai Tengah District, Banggai Laut Regency, Central Sulawesi Province. The study took place in January to July 2019. The experiments were arranged using Split Plot Design (SPD) with three replications. Type of yam (V) was set as the main plot which consisted of 6 types of yam, namely: Butuli (v1), Tu'u (v2), Manui (v3), Pau-pau Ateno (v4), Sombok (v5), and Kulaluk (v6), while as subplot was the concentration of Hormax (P) solution consisted of 4 levels, namely the concentration of Hormax solution 0 mL/L water (p0), the concentration of Hormax solution 2.0 mL/L water (p1), the concentration of Hormax 4.0 mL/L water (p2), and the concentration of Hormax solution 6.0 mL/L water (p3).

Land management in the nursery was conducted by hoeing the entire trial area evenly then made beds. Planting was done manually. Each test was made of 24 plots so that there were 72 test plots. Each bed was planted with 20 pieces of tubers with a spacing between seeds 40 cm x 40 cm and spacing between beds 50 cm, as well as a distance of 50 cm replications. The observed character in the nursery is the speed of germination.

Following 50% seedlings growth in the seedbed, the seedlings are then transplanted into mounds with a spacing of 75 cm x 75 cm and a spacing between 75 cm. Each mound was planted with 4 seeds. Plant maintenance included watering, weeding and controlling pests and diseases. Pest and disease control was done when the plant is 78 days after planting. Harvesting was conducted when the plants are 5 months old according to harvest criteria. Harvesting was done manually. The characters observed in the field were stem length, number of branches, number of leaves, number of tubers, and tuber weights per plant. Observation data obtained were analyzed using analysis of variance and if there was a real effect of treatment then it was continued with 0.01% of Tukey’s Honestly Significance Difference test.

3. Results and discussion

3.1. Early sprout growth
The results of observations of early sprout and variance showed that the treatment of some concentrations of Hormax solution and its interactions had no significant effect, while the treatment of yam species had a very significant effect on early sprout.

Table 1 shows that the yam Butuli species produced the fastest germination rate of 25.50 days compared to other yam species except the yam Pau-pau Ateno species which was 35.58 days. It is
suspected that the type of yam Butuli does not have a dormancy period in the tuber so that the tubers germinate quickly. Yam Manui species produce late budding speeds of 53.08 days. According to [5] that tubers that have a dormancy period will spend their dormancy period where the tubers will not sprout until a certain time. The length of the dormancy period is influenced by the variety, the age of the tubers at harvest and the environmental conditions at planting and the storage conditions of the tubers.

Table 1. Average early sprout (days) of 6 types of yam at several concentrations of hormax solution

| Hormax concentration | Type of yam | Mean | Pau-pau | Manui | Tu'u | Butuli |
|----------------------|-------------|------|---------|-------|------|--------|
|                      | (v1)        | (v2) | (v3)    | (v4)  | (v5) | (v6)   |
| p0 : 0 mL/L water    | 23.67       | 41.67| 61.67   | 36.00 | 37.33| 38.33  |
| p1 : 2 mL/L water    | 29.67       | 43.00| 39.33   | 32.67 | 37.67| 31.33  |
| p2 : 4 mL/L water    | 23.00       | 38.33| 49.67   | 29.67 | 37.00| 43.00  |
| p3 : 6 mL/L water    | 25.67       | 43.33| 61.67   | 44.00 | 49.33| 50.67  |
| Mean                 | 25.50a      | 41.58bc| 53.08c | 35.58ab| 40.33bc| 40.83bc |
| HSD 0.01             | 15.15       |      |         |       |      |        |

Values in each average in a row followed by different letters for each treatment showed significant differences according to HSD 0.01.

3.2. Rod length
Observation of stem length and variance showed that the treatment of yam species and their interactions had no significant effect, while the treatment of Hormax solution concentration had very significant effect on stem length.

Table 2. Average of stem length (cm) of 6 types of yam at several concentrations of Hormax solution

| Hormax concentration | Type of yam | Mean | Pau-pau | Manui | Tu'u | Butuli |
|----------------------|-------------|------|---------|-------|------|--------|
|                      | (v1)        | (v2) | (v3)    | (v4)  | (v5) | (v6)   |
| p0 : 0 mL/L water    | 451.67      | 449.50| 459.33 | 407.33| 359.00| 400.67 |
| p1 : 2 mL/L water    | 495.17      | 485.67| 535.83 | 465.33| 322.33| 454.33 |
| p2 : 4 mL/L water    | 504.33      | 480.00| 507.67 | 560.50| 444.67| 451.67 |
| p3 : 6 mL/L water    | 482.33      | 480.50| 529.33 | 444.67| 367.67| 461.67 |
| Mean                 | 483.38      | 473.92| 508.04 | 469.46| 373.42| 442.09 |

Values in each average in a row followed by different letters for each treatment showed significant differences according to HSD 0.01.

Table 2 shows that the treatment concentration of Hormax solution 4 mL/L water has the longest stem length of 491.47 cm, and is not significantly different from the treatment of other Hormax solution concentrations, but it is very significantly different from the control. The control treatment resulted in the shortest stem length of 42.25 cm. Yam Manui species have the longest tuber length of 23.40 cm compared to other types of yam. It is assumed that yam Manui types have special characteristics and characteristics that differ from each other. According to Beukema and Zaag [6] that the size of the tuber depends on the variety that can be genetically derived. According to Alam [7] that the end result of a plant is a function of the yield component.

3.3. Number of leaves
The results of observation of the number of leaves and variance showed that the treatment of Hormax concentration significantly affected the number of leaves and the treatment of yam species
significantly affected the number of leaves, while the interaction had no significant effect on the number of leaves.

**Table 3.** Average number of leaves (strands) 6 types of yam in several concentrations of Hormax solution

| Hormax concentration | Types of yam | Mean | SV HSD 0.01 |
|----------------------|--------------|------|-------------|
|                      | Butuli (v1)  | Tu'u (v2) | Manui (v3) | Pau-pau (v4) | Ateno (v5) | Sombok (v6) | Kulaluk (v6) |
| p0 : 0 mL/L water    | 378.17       | 253.67   | 186.50      | 285.67       | 221.33     | 228.33      | 258.94ab     |
| p1 : 2 mL/L water    | 290.83       | 229.00   | 163.00      | 269.00       | 223.00     | 237.50      | 235.39b      | 38.54 |
| p2 : 4 mL/L water    | 369.50       | 253.67   | 187.33      | 307.50       | 276.67     | 252.67      | 274.56a      |
| p3 : 6 mL/L water    | 311.83       | 224.83   | 173.50      | 203.83       | 212.50     | 256.00      | 230.42b      |
| Mean                 | 337.58a      | 240.29ab | 177.58ab    | 266.50ab     | 233.38ab   | 243.63ab    |

Values in each average in a column and a row followed by different letters for each treatment showed significant differences according to HSD 0.01.

Table 4 shows that the treatment of Hormax solution concentration of 4 mL/L water has the most number of leaves which is 274.56 strands, very significantly different from the concentration of other Hormax solutions except with a control treatment that is 258.94 strands. The concentration of Hormax solution of 6 mL/L of water had the lowest number of leaves at 230.42 strands. Table 4 also shows that the treatment of yam Butuli species has the highest number of leaves, which is 337.58 strands, and is significantly different from other types of yam except for yam Tuwi species, which is 240.29 strands. Yam Manui species have the fewest number of leaves, 177.58 strands. The effect of Hormax solution concentration treatment on the number of leaves produced is in line with the effect of Hormax solution concentration treatment on the number of branches produced. It is assumed that the more branches formed it will be possible to have more segments, causing the number of leaves produced to increase. According to Rasyid [8], that the level of concentration used can affect the permeability of plant leaf cells and determine whether or not the concentration has an impact on optimal or not plant growth.

### 3.4. Number of bulbs

The results of observations of the number of tubers per plant and variance showed that the treatment of some concentrations of Hormax solution and its interactions had no significant effect, while the treatment of yam species significantly affected the number of tubers.

**Table 4.** Average number of bulbs of 6 yam species at several concentrations of hormax solution

| Hormax Concentration | Types of yam | Mean | SV HSD 0.01 |
|----------------------|--------------|------|-------------|
|                      | Butuli (v1)  | Tu'u (v2) | Manui (v3) | Pau-pau (v4) | Ateno (v5) | Sombok (v6) | Kulaluk (v6) |
| p0 : 0 mL/L water    | 1.50         | 1.53   | 1.58        | 1.42         | 1.42       | 1.94       | 1.57         |
| p1 : 2 mL/L water    | 1.83         | 1.33   | 1.17        | 1.00         | 1.86       | 1.50       | 1.45         |
| p2 : 4 mL/L water    | 2.42         | 1.33   | 1.08        | 1.25         | 1.42       | 1.25       | 1.46         |
| p3 : 6 mL/L water    | 1.50         | 1.36   | 1.58        | 1.22         | 1.39       | 1.22       | 1.38         |
| Mean                 | 1.81a        | 1.39ab | 1.35b       | 1.22b        | 1.52ab     | 1.48ab     |

Values in each a row followed by different letters for each treatment showed significant differences according to HSD 0.01.
Table 5 shows that the treatment of the yam Butuli species, in addition to quickly sprouting, also produced the highest number of tubers, 1.81 tubers, and was significantly different from other types of yam. The treatment of the yam Pau-Pau Ateno species has the lowest number of tubers 1.22 tubers. This means that the more branches, the more tubers are formed. The large number of tubers formed is influenced by genetic traits. Differences in genetic traits in each type of yam give effect to the number of tubers produced differently.

3.5. Bulb weight per plant

The results of tuber weight per plant and variance showed that the treatment of yam species and the treatment of Hormax solution concentration and their interactions did not significantly affect the tuber weight per plant.

![Stem Diagram of tuber weight per plant (kg) 6 types of yam in several concentrations of hormax solution](image)

Figure 1. Stem Diagram of tuber weight per plant (kg) 6 types of yam in several concentrations of hormax solution

Figure 1 shows that the treatment of Manui yam species immersed in Hormax solution with a concentration of 6 mL/L of water produced the highest tuber production per plant at 0.67 kg, while the Tu’u yam type treatment immersed in Hormax solution with a concentration of 2 mL/L of water yields the lowest tuber weight per plant which is 0.21 kg. The interaction between the treatment of yam species and the concentration of Hormax solution had no significant effect on all observed characters. It is assumed that all types of yam used have the same response to the treatment of Hormax so that it does not cause any interaction effect. According to [9], there is no interaction between the two treatment factors because the two factors are not able to synergize (work together) so that the mechanism of action is different or one of the factors does not play an optimal role or even is antagonistic, which is to suppress each other's influence.

4. Conclusions

1. Butuli yam has the fastest sprouting speed of 25.50 days, the highest number of leaves is 337.58 strands, and the highest number of tubers is 1.81 pieces.
2. The concentration of Hormax solution 4 mL/L of water produced the longest stem which was 491.47 cm and the highest number of leaves was 274.56 strands.
3. There is no interaction between the types of yam and the concentration of Hormax solution on the growth and yield of several types of yam.
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