*Available Online at SAINS TANAH Website : http://jurnal.fp.uns.ac.id/index.php/tanah/*
*SAINS TANAH – Journal of Soil Science and Agroclimatology, 14 (2) , 2017, 42-50*
*RESEARCH ARTICLE*

# THE EFFECT OF SEED DORMANCY CRACKING TECHNIQUE AND SOLID INORGANIC FERTILIZING AT PRODUCTIVE PHASE TO THE QUALITY OF SEEDLESS WATERMELON AT DRYLANDS

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*Submitted : 2017-09-04 Accepted : 2018-02-22*

**ABSTRACT**

The difficulty of seeding and sweetness quality of seedless watermelon is an obstacle for farmers. The objectives of this study were to know the successful of shoots growth with seeding treatment and production quality due to fertilizing package for seedless watermelon with the variety of Riendow F1. The experiment was conducted in dry season at upland areas in Palangkaraya. The experimental design for seeding randomized block design (RBD) 3x3 with treatment consisting of a control (G0), cracking seed by hitting (G1), cracking seed using pincette (G2). The experiment of fertilizing package at productive phase used of fertilizer used RBD 4x3. The treatment consisted of several packages of fertilizer, namely: without fertilization (P0), low fertilizer package (P1), medium fertilizer package (P2), and high fertilizer package (P3). Before the experiment, soil analysis was first conducted to determine land suitability classes. The results showed that the study site area has marginal suitability class with limiting factor involving rooting condition (S3rc). The highest germination was obtained in the cracking treatment compared to control, otherwise, the rate of death seeds for control was lower than cracking treatment although it is not significantly different according to statistics. For the parameter of fruit perimeter, it indicates that treatment of high fertilizing package was significantly different from the control, respectively, 64.25 cm and 53.96 cm. It also includes the weight of fruit, respectively, 4.05 kg and 2.80 kg. For the quality of watermelon, it showed that fertilizing packages at productive phase is significantly different from controls. The sweetness level at the medium fertilizing package (P2) has the highest level of 11.73$^{o}$Brix, followed by the high fertilizing package (P3), 11.00$^{o}$Brix, low fertilizing package (P1), 9.92$^{o}$Brix and the lowest for control, 8.98$^{o}$Brix. Application of medium fertilizing package at productive phase can then produce the highest quality level of watermelon.

**Keywords**: dry season, fertilizing package, seedless watermelon, sweetness level, uplands

**How to Cite**: Firmansyah, M.A.; Bermana A. (2017). The Effect of Seed Dormancy Cracking Technique and Solid Inorganic Fertilizing at Productive Phase to The Quality of Seedless Watermelon at Dry Lands. Sains Tanah Journal of Soil Science and Agroclimatology, 14 (2): 42-50 (doi: 10.15608/stjssa.v14i2.877)

**Permalink/DOI**: http://dx.doi.org/10.15608/stjssa.v14i2.877

## INTRODUCTION

In 2015, the production of watermelon in Central Kalimantan province, Indonesia increased up to 3,341.6 tons compared to the average of five years earlier reached, while average production from 2010 to 2014 is only 3,035.34 tons (Tantri, 2016). Generally, farmers cultivate watermelon at various agro-ecosystem, such as uplands, swamplands, and tidal lands.

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The main problems found in farming include low production and fruit quality.

The constraint of using triploid watermelon seeds or seedless is because of its hard seeds naturally. Several ways to provide germination are then conducted through the broke technique broken. According to Siunarlin, Zam, & Purwanto (2012), the broken can be done through cracking the seeds and it can increase germination of seeds from 38% to 65%.

Adequacy of nutrients is a major factor of watermelon to produce optimally with high production quality. The needs of nutrient, both macro and micro will be stored in vegetative and fruit. The nutrients of N, P, K, S are generally are stored in fruit with percentage respectively; 61.2%; 75.0%; 78.0%; 62.5%, while Ca and Mg is deposited in vegetative part of the plant with percentage respectively 92.7% and 70.5%. Microelements involving B and Cu, are mostly stored in the fruit respectively, 53.2% and 60.6%, while Fe, Mn, Zn is deposited in vegetative respectively, 66.9%; 94.1%; and 51.1% in seedless watermelon of "Precious Petite" in Brazil (Santos, Cássia, & Dias, 2016).

The availability of nutrients is generally derived from organic and inorganic materials. Nutrients derived from organic materials and commonly used for watermelon farming are chicken manure. This fertilizer has optimum effects on production of watermelon. The dosage of chicken manure 20 ton $ha^{-1}$ still showed high response in watermelon harvest up to 211% in Abakaliki and 479% in Asaba, Nigeria, as well as in Lafia 194.8% compared to the control (Aniekwe & Nwokwu, 2015; Dauda, Ajayi, & Ndor, 2008; Enujeke, 2013).

The manure derived from cows, sheep, chickens, and birds increase the production of watermelon with cultivars Shapah from 0.81 to 2.1 kg each, while chemical fertilizer only improves 0.32 kg higher than controls. However, in terms of sweetness quality, the use of chemical fertilizer NPK 20:40:25 reached 10.4 and it is still lower than manure of birds application that has sweetness level 10.6% (Massri & Labban, 2015).

In order to reduce the negative impact to the environment and human health, the application of fertilizer must be balanced between organic and inorganic fertilizer. According to Massri & Labban (2015), the application of organic fertilizer to the watermelon cultivation affect both quality and productivity and it has is closely relative to inorganic fertilizer.

The sweetness level is important because, in the field, production of watermelon gathered by collectors will be prioritized that has a sweet taste with a higher price, while for less sweet watermelon, in the market, it usually has a lower price and it will be distributed after the stock of sweet watermelon is lacking.

The objectives of this study were to determine the effect of inorganic fertilizer packages during the productive phase to the yield and quality of seedless watermelon with a variety of Riendow at uplands on the dry season in Palangkaraya, Central Kalimantan.

## MATERIALS AND METHODS

The experiment was conducted at uplands dominated by sandy clay loam soil texture with altitude 40 m above sea level. It was conducted in the dry season from June to September 2016. The study was conducted on-farm research located in Banturung, Bukit Batu sub-district, Palangkaraya, Central Kalimantan.

The study consisted of two main parts: at the first part, the experiment was conducted to determine seed treatment to seeding phase, and the second is the effect of fertilizing at productive phase to the growth, production and fruit quality of watermelon. The first part includes seed treatment using a randomized block design (RBD), namely: control (G0), cracking seed by hitting (G1) and cracking seed using pincette, in this experiment nail clippers was employed (G2). Each treatment consisted of 10 seeds and repeated 4 times. Seeds were planted in transparent plastic polybag media with a size of 3 cm x 5 cm, which has been filled with topsoil. Each polybag has planted a seed with growing point position or taper part is planted into soil. Seeds are placed in seedbeds and after the seeds are planted, water was supplied to keep moisture, followed by Furadan application thinly and evenly. After Furadan application, seedbeds were then covered with 3 layers transparent plastics, then on the top plastics was further covered by piece reeds and then covered using tarpaulin. At around of seedbeds was then placed soils in order to keep the temperature inside. Seeds ripening process was conducted for 2x24 hours before opening for viewing the results. Measurement of seedbeds for temperature and humidity inside and outside of covered seedbeds was conducted at 09.00 am - 12:00 am - 15:00 pm. The germinating seeds that have been occurring from covered seedbeds were then maintained 8 days before planting. Parameters measured include the percentage of germination for each treatment when the cover is opened and height of growth shoot at the age of 8 days after it opened. For the second part of this study, the experiment that was conducted in the application of continued fertilizing at productive phase with RBD consisting of a control (P0), low dosage (P1), medium dose (P2), high dose (P3).

**Table 1.** The Application of Fertilizing During Growth Phase and Productive Phase at Experiment of Watermelon Cultivation on Dry Season 2016, in Banturung, Bukit Batu, Palangka Raya

| Fertilizing | Treatments | | | |
|---|---|---|---|---|
| | P0 | P1 | P2 | P3 |
| *Basic Fertilizing* | | | | |
| Chicken manure (g plant$^{-1}$) | 2.100.0 | 2.100.0 | 2.100.0 | 2.100.0 |
| Dolomite (g plant$^{-1}$) | 218.9 | 218.9 | 218.9 | 218.9 |
| SP-36 (g plant$^{-1}$) | 43.8 | 43.8 | 43.8 | 43.8 |
| NPK 16:16:16 (g plant$^{-1}$) | 32.8 | 32.8 | 32.8 | 32.8 |
| *Continued Fertilizing (Growth phase)* | | | | |
| 4 DAP- NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 2.3 | 2.3 | 2.3 | 2.3 |
| 8 DAP - NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 3.4 | 3.4 | 3.4 | 3.4 |
| 12 DAP - NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 4.6 | 4.6 | 4.6 | 4.6 |
| 16 DAP - NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 4.6 | 4.6 | 4.6 | 4.6 |
| 20 DAP - NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 5.8 | 5.8 | 5.8 | 5.8 |
| 24 DAP - NPK 16:16:16 (g 100ml$^{-1}$plant$^{-1}$) | 5.8 | 5.8 | 5.8 | 5.8 |
| *Continued Fertilizing at productive phase* | | | | |
| 28 DAP - NPK 16:16:16 (10 g plant$^{-1}$) | 0 | 1 | 2 | 3 |
| 28 DAP - KCl (20 g plant$^{-1}$) | 0 | 0 | 1 | 2 |
| 45 DAP - NPK 16:16:16 + NPK 15:15:15 + KCl (1:1:1) (15 g plant$^{-1}$) | 0 | 4 | 5 | 6 |

DAP = Days After Planting

Fertilization of productive phase was done twice, at the age of 30 and 45 DAP using manure solids. At the age of 30 DAP, it uses fertilizer NPK 16:16:16 only, while for 45 DAP use a mixture of fertilizer NPK 15:15:15 + NPK 16:16:16 + KCl with the ratio of 1: 1: 1. The treatment of fertilization dosage use pours technique and for productive phase, it uses manure solids to as provide at Table 1, whereas the experimental plot design is presented in Figure 1. The number of plants per unit of the trial as many as 10 plants and 5 plants control was measured randomly. Parameters measured involve plant length at the age of 45 and 60 DAP, fruit weight, fruit diameter, fruit height, fruit hardness, flesh color, fruit sweetness level.

Seedless watermelon varieties used are Riendow F1, while for the source of pollen, it was taken from watermelon seed of Baginda varieties. The planting pattern of "double row" in which each bed covered with transparent plastic mulch. Planting space is 0.7 x 1 x 7 m, in which 0.7 meters spacing in the row, 1 meter spacing between rows, and 7 meters for the vine. For cultivation, it includes weeding, pollination at the age of 30-35 days after planting (DAP), pest control using Antracol, Lanate, Amistartop, and Furadan. Watering is conducted if the soil condition is a lack of water. Harvesting was conducted at the age of 30 DAP after pollination or 65 DAP. In order to know the difference between means of treatment, it used Duncan's Multiple Range Test at the 5% level.

## RESULTS AND DISCUSSION

Rainfall condition at the site location during the study was 463.7 mm. Water application was conducted to supply crop growth (Table 1). Land characteristic considered as a main limiting factor for crop growth is soil texture, where land condition at study areas is dominated by sandy loam soil texture. This kind of soil characteristics cannot be changed even through high improvement. According to Table 2, the land suitability class for watermelon is marginally suitable for the limiting factor rooting condition (S3rc).

**Table 2**. Land suitability classification in the study area for seedless watermelon in Banturung, Palangka Raya

| Land characteristics | Land suitability class | | | | Land requirements | Actual land suitability | Potential land suitability |
|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | N | | | |
| **Temperature (tc)** | | | | | | | |
| Mean temperature (°C) | 22-30 | 30 - 32<br>20 - 22 | 32 - 35<br>18 - 20 | > 35<br>< 18 | 25 – 30 | S1 | S1 |
| **Water availability (wa)** | | | | | | | |
| Rainfall during growth (mm) | 400-700 | 700 – 1.000<br>300-400 | >1.000<br>300-400 | <200 | 463.7 | S1 | S1 |
| Humidity (%) | 24-80 | 20-24<br>80-90 | <20<br>>90 | | 79-89 | S2 | S2 |
| **Oxygen availability (oa)** | | | | | | | |
| Drainage | Well-drained | Moderately well drained | Somewhat poorly drained | Poorly drained | Well-drained | S2 | S1 |
| **Rooting condition (rc)** | | | | | | | |
| Texture | Fine, moderately fine | - | Moderately fine | Somewhat coarse | Sandy Loam | S3 | S3 |
| Rough materials (%) | < 15 | 15 - 35 | 35 - 55 | > 55 | < 15 | S1 | S1 |
| Soil depth (cm) | > 50 | > 50 | 30-50 | < 30 | >50 | S1 | S1 |
| **Peat:** | | | | | | | |

| Land characteristics | Land suitability class | | | | Land requirements | Actual land suitability | Potential land suitability |
|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | N | | | |
| Thickness (cm) | < 50 | 50-100 | 100 - 150 | > 150 | - | | |
| Ripeness | saprik + | saprik, hemik | hemik, fibrik | fibrik | - | | |
| **Nutrient retention (nr)** | | | | | | | |
| CEC (cmol) | > 16 | 5-16 | <5 | | 14.02 | S2 | S2 |
| Base saturation (%) | > 35 | 20 - 35 | < 20 | | 49.36 | S1 | S1 |
| pH $H_2O$ | 5.8 – 7.6 | 5.5 – 5.8 | < 5.5 | | 5.53 | S3 | S1 |
| | | 7.6 – 8.0 | > 8.0 | | | | |
| C-organic (%) | > 1.2 | 0.8 – 1.2 | < 0.8 | | 0.97 | S2 | S2 |
| **Nutrient available (na)** | | | | | | | |
| N Total | medium | low | very low | | Medium | S1 | S1 |
| $P_2O_5$ (mg/100g) | high | medium | Low-very low | | very high | S1 | S1 |
| $K_2O$ (mg/100g) | medium | low | Very low | | Low | S2 | S1 |
| **Toxicity (xc)** | | | | | | | |
| Salinity (dS/m) | < 4 | 4 - 6 | 6 - 8 | > 8 | - | | |
| **Sodicity (xn)** | | | | | | | |
| Alkalinity/ESP (%) | < 15 | 15 - 20 | 20 - 25 | > 25 | - | | |
| **Toxicity sulfidic (xs)** | | | | | | | |
| Depth of sulfidic (cm) | > 100 | 75 - 100 | 40 - 75 | < 40 | - | | |
| **Erosion hazard (eh)** | | | | | | | |
| Slope (%) | < 3 | 3 - 8 | 8 - 15 | > 15 | < 8 | S1 | S1 |
| Erosion hazard | | Very low | Low-moderate | High-very high | Very low | S1 | S1 |
| **Flooding (fh)** | | | | | | | |
| Inundation | F0 | - | - | > F0 | F0 | S1 | S1 |
| **Land preparation (lp)** | | | | | | | |
| Stoniness (%) | < 5 | 5-15 | 15 - 40 | > 40 | < 5 | S1 | S1 |
| Rock outcrops (%) | < 5 | 5-15 | 15 - 25 | > 25 | < 5 | S1 | S1 |
| **Land suitability class** | | | | | | **S3 - rc/nr** | **S3rc** |

Source: (Ritung, Nugroho, Mulyani, & Suryani, 2011).

### *Breaking Dormancy*

The air temperature will affect the temperature of the soil, for this, high temperatures will increase soil temperatures. The air temperature inside the containment is higher than outside (Figure 1). The seed of watermelon seeding requires an optimum soil temperature of 35$^o$C (Mayberry & Meister, 1972).

Breaking dormancy through containment results in a level of success 52.5% after 54 hours covered, and it was not a significant difference with breaking treatment by hit and tongs (Table 2). Based on plant height at the ages of 6 DAS, it showed that without breaking, it has the highest germination with a lower percentage of death shoot comparing to breaking treatment. The seed is not damaged due to breaking treatment. The breaking seed treatment takes a long time process. The breaking dormancy technique using containment and without breaking treatment, then become a general option for the local farmer (Figure 2-5).

### *The Growth and Yield*

Plant growth parameter at the age of 25 days after planting (DAP) showed that among treatment were not different (Table 3). This is due to fertilization application was conducted on productive phase at the age of 28 DAP and this research was conducted to production and quality of fruit. This data then indicates that the performance of sample plants on each treatment is relatively uniform.

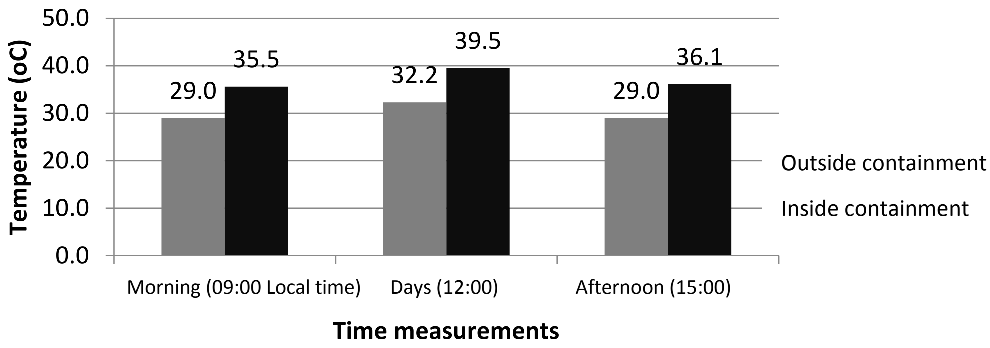


**Figure 1.** The air temperature outside and inside the containment at various time measurements

**Table 3.** The parameter of breaking dormancy and viability of seed for seedless watermelon

| Treatments | Percentage of shoot 54 HAS (%) | Height of shoot 6 DAS (cm) | Percentage of death shoot 6 DAS (%) |
|---|---|---|---|
| Without breaking | 52.5 | 5.24 | 16.0 |
| Breaking by hit | 67.5 | 4.91 | 17.5 |
| Breaking with tongs | 67.5 | 4.68 | 22.5 |

HAS = Hours after seedling, DAS = Days after seedling

**Figure 2**. Seeding of seedless watermelon. Date: 18/6/2016

**Figure 3**. The seeding covered by containment. Date: 18/6/2016

**Figure 4.** The installation of containment for seeding after growth seed. Date: 20/6/2016

**Figure 5.** The growth of shoot becomes a young plant, ready for planting in the field. Date: 24/6/2016

**Table 4.** Growth parameter of seedless watermelon at the age of 25 days after planting

| Treatment | Length of plant (cm) | Number of leaves (sheet) | Number of plant branch |
|---|---|---|---|
| P0 | 154.48 | 35.75 | 5.17 |
| P1 | 156.08 | 38.50 | 6.42 |
| P2 | 164.,00 | 40.17 | 6.58 |
| P3 | 147.33 | 38.50 | 6.20 |

**Figure 6**. The growth of seedless watermelon variety of Riendow. Date: 30/7/2016

**Figure 7**. The yield of seedless watermelon with a variety of Riendow. Date: 20/8/2016

**Table 5**. Production parameter of seedless watermelon at the age of 70 days after planting

| Treatment | Lenght of fruit (cm) | Rim of fruit (cm) | Weight of fruit (kg fruit$^{-1}$) |
|---|---|---|---|
| P0 | 18.17 a | 53.96 a | 2.80 a |
| P1 | 19.33 a | 57.21 ab | 3.20 ab |
| P2 | 18.67 a | 57.42 ab | 3,34 ab |
| P3 | 20.75 a | 64.25 b | 4.05 b |

The mean followed by the same letter is not significantly different according to the DMRT test at 5% level

The production parameter with the application of NPK 16:16:16 fertilizer at the production phase showed that at the age of 26 DAP, it results in positive effects for fruit rim and fruit weight (Table 4). The treatment of P3 results in significant effect compared to the control, respectively 64, 25 cm and 4.05 kg fruit$^{-1}$, while for control, it is respectively 53.96 cm and 2.80. kg fruit$^{-1}$

Nitrogen given in the form of fertilizer up to 120 kg (N ha$^{-1}$) can accelerate flowering process from 33.4 to 28.13 days, and increase the weight of fruit from 1.53 to 2.92 kg each (Maluki, Ogweno, & Gesimba, 2016). The use of N fertilizer of 200 kg/ha can also increase the production of watermelon up to 40 ton ha$^{-1}$ in Brazilian Jaboticabal (Nowaki, Filho, De Faria, & Cortez, 2017). The use of N in the form of organic fertilizer that comes from manure and inorganic N in the form of Calcium Ammonium Nitrate can increase marketable watermelon yield (Audi, Aguyoh, & Gao-Qiong, 2013). The use of NPK fertilizers also increased the production of watermelons in Afikpo, Nigeria (Oga & Umekwe, 2015). The application of N, 60 kg N ha$^{-1}$ and K, 30 kg $K_2O$ ha$^{-1}$ can also improve yield, even there was a positive interaction (Olaniyi & Tella, 2011).

Phosphor also has a good effect on the production and quality of watermelon. The application of 100 kg ha$^{-1}$ $P_2O_5$ can increase yield up to 16% compared to the control (Maluki, Gesimba, & Ogweno, 2016).

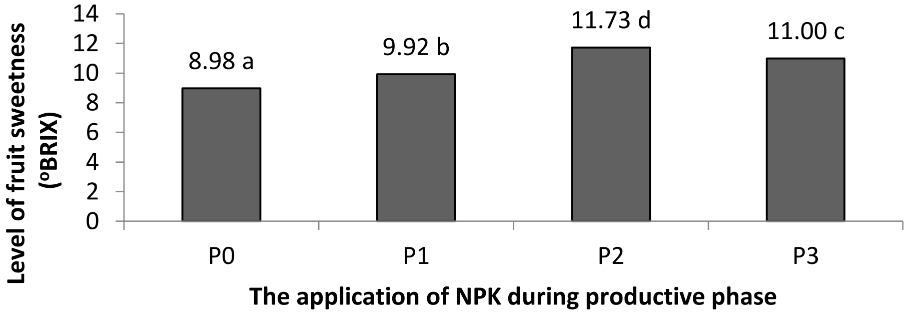


**Figure 8.** The quality of seedless watermelon based on the sweetness level

The condition of P in the soil is very high so that the fertilization of P through the basic fertilizing and follow-fertilization of compound fertilizer also plays a role in increasing production. The areas with low P content, P fertilizer application cannot increase watermelon production unless accompanied by copper or Cu (Everett, Locascio, & Fiskell, 1966).

### *The Quality of Fruit*

The quality of watermelon fruit can be felt through the level of sweetness. The higher level of watermelon sweetness is more favored by consumers. The application of fertilizer during productive phase using NPK 16:16:16 and KCl, and compound fertilizer of NPK 16: 16:16 with NPK 15:15:15 and KCl on the treatment of P2 result in higher sweet level than the higher dosage of P3. The watermelon sweetness level at P2 treatment reached 11.7$^{o}$Brix, while for P3, it reached 11.0$^{o}$Brix. The fertilizer treatment of P1 which only provides NPK 16: 16; 16 and compound fertilizer of NPK 16:16:16 and NPK 15: 15; 15 including KCl has sweetness level of 9.92 $^{o}$Brix only. However, there was a significant effect of each treatment. The application of fertilizer in a productive phase had a significant effect on the sweetness level of the fruit, comparing to on non-fertilization application on productive phases which was only 8.9 $^{o}$Brix (Figure 8). The macronutrient can increase sweetness level of the fruit.

Nitrogen supplied in the form of fertilizer can increase fruit sweetness level from 9.0 to 12.5% (Maluki, Ogweno, et al., 2016). While for Phosphor, it can also increase sweetness level 1.1 units higher than the control (Maluki, Gesimba, et al., 2016).

## CONCLUSIONS

1. The use of containment can increase the temperature of seed medium and seeding treatment using cracking technique can increase seed germination of seedless watermelon.
2. The application of fertilizer at productive phase can increase the yield of watermelon, especially for the high package (P3).
3. The quality of watermelon fruit with applying fertilizer at productive phase was significantly increased compared to the control. The value of treatment for medium fertilizing (P2) was 11.73 while for control was 8.98 $^{o}$Brix.

## ACKNOWLEDGMENT

We would like to thanks to Suroto Sasatri Wahyudi as farmer cooperator and Wiwik Rahayu as Field Extention agent of BP3K of Tangkiling for any helps and support the research.

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