The Impact of Making Canal Blocking on Growth Red Chili Plant Production (*Capsicum Annuum* L.)

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**Abstract.** Increased chili production continues to meet the demand for chili in an area. This study aimed to determining the importance of the influence of making canal blocking on water availability to increase growth and production of red chili plants. This study used a survey method, the method consisted of several stages including determining the location of sampling taken by purposive sampling, namely deliberate sampling with the required sample requirements. The results obtained from interviews and filling out the questionnaire stated that the water source they found for their plant water needs was the water available on the canal. The canal which was around the land was a secondary and tertiary canal, while the primary canal was located quite far approximately 300-500 m which was located around the edge of the road. The result of the analysis showed that making canal blocking in an effort to increase the availability of water there was no significant difference in the parameters of flowering and harvest age. Making canal blocking could increase plant canopy width, plant height, fruit weight/plant weight and fruit weight/m², and canal blocking could increase water availability for plants so as to increase production to 20 tons.ha⁻¹.

1. **Introduction**

Red chili (*Capsicum annuum* L.) is a commodity that has important economic value in Indonesia. Chili contains nutrients that are very necessary for human health, such as protein, fat, carbohydrates, calcium, phosphorus, iron, vitamins and alkaloid compounds such as capsaicin, flavonoids, and essential oils. Chili is one of the important horticultural crops that are commercially cultivated in tropical countries. Now, the use of chili is not only for fresh consumption but has been processed into a variety of processed products, such as chili sauce, chili sauce, chili paste, chili powder, anesthetics, and ointments [1].

The chili plant is a plant that really needs water in its growth. If the chili plants get a lack of water supply, its growth will be hampered, but if the chili plants get excess water, the chili plants will be disrupted their growth which causes the chili plants to rot so that it can reduce the yield of these plants. [2] states that the availability of enough water to meet water needs for plants is very important. The role of water in plants as a solvent for various organic molecular compounds (nutrients) from the soil into the plant, photosynthetic transportation from the source (source) to sway (sink), maintain cell turgidity including cell enlargement and opening of stomata, as the main constituent of protoplasm and temperature control for plants. If the availability of groundwater is lacking for plants, consequently water as a raw material for photosynthesis, transportation of nutrients to the leaves will be hampered so that it will have an impact on the products produced.
Water that can be absorbed from the soil by plant roots is called available water, is the difference between the amount of water in the soil at the field capacity (water stored in the soil that does not flow due to gravity) and the amount of water in the soil at the percentage of permanent withering (the percentage of humidity at which the plant will wither and will not be fresh in the atmosphere with 100% relative humidity) [3]. To overcome the need for water over a large area, a canal is needed to save on plant maintenance costs. Therefore, by making a canal can accommodate rainwater that falls, so the availability of water for plants can be available. However, the construction of a canal alone cannot guarantee the need for water for chili cultivation land, because if the water in the canal is not maintained, the available water will continue to flow into the tributaries which cause the water in the canal to be insufficient, especially if there is a dry season.

By making a system of regulating the entry and exit of water in a canal or so-called canal blocking will be able to regulate water entering the canal. [4] states the canal blocking (canal blocking) which was built serves to hold the swift flow of water from the peat dome down, directing the flow of water to the side. With the water barrier, the road will look sideways, not only in one direction, so that it will give effect to wet peat, and reduce the occurrence of drainage in the dome where the water source is located. In addition, with the construction of canal blocking, this serves as a place to source water in case of fire, to extinguish the fire. In coastal areas, peat areas facing directly to the coast such as the Tohor River, canal blocking serves to hold the rate of saltwater intrusion, helping to reduce the entry of saltwater into the peatland so that plants can grow well. This study aimed at determining the importance of the influence of making canal blocking on water availability to increase growth and production of red chili plants.

2. Methodology
The research was carried out on agricultural land owned by Langsat Permai village in Bunga Raya District of Siak Regency. Farmers’ land used for sampling was 0.5 ha. Analysis of the initial soil chemical properties was carried out at the Soil Science Laboratory, Agriculture Faculty, Riau University, Bina Widya Campus KM 12.5, Simpang Baru Village, Tampan District, Pekanbaru. This research has been carried out for 8 months starting from July 2017 to March 2018.

This study used a survey method. This survey method consisted of several stages including the determination of the location of sampling conducted by purposive sampling, namely deliberate sampling with the required sample requirements. Requirements needed in the sampling were farmers’ land had an area of 0.5ha, this was because the average half of the chili farmers in the village had an area of 0.5ha of chili farmers using superior varieties, namely Aldo F1. After the farmers’ land requirements for the sample based on those that have been determined were met, then obtained a number of farmers as many as 12 farmers. Every farmer was drawn to determine the point (plot) of plant samples and then taken as many as 4 sample plots per farmer, then a total of 48 plant sample plots were obtained, then each plot was taken as many as 4 plant samples so that a total of 192 plant samples were obtained. After obtaining the location and sample points, the samples were examined to observe the chemical properties of the soil, as well as the growth and production of red chili plants before canal blocking and after canal blocking. To compare the data obtained from the results of the study were analyzed by paired t-test at 5% level using the SPSS Statistical version 23 application.

3. Result and Discussion
The result obtained from farmer interviews and filling out questionnaires stated that the water source they found for their crop water needs was the water available on the canal. Canals found around the land were secondary and tertiary canals, while the primary canal was located quite far approximately 300-500m which was located around the edge of the road. The irrigation system carried out by farmers was using pumping, which pumps took water that was in the canal and then flows using a hose that was directly connected to the subsurface irrigation system.

Before the construction of the canal blocking irrigation system, the water available on the canal was said to be less available, because the water contained in the canal did not reach half of the height
of the canal. The lack of water availability was due to the absence of a barrier on the final canal (the end of the canal) which caused water to always flow towards the tributary. As a result of the insufficient water obtained by farmers for their land, the growth and production of chili plants were not optimal. Farmer land planted with red chili was land that has a type of peat soil, after taking samples and brought to the laboratory it found that the land planted was buried peat soil, this was proven during the process of soil processing using a plow in a part of the topsoil found inception soil while the bottom was peat soil. According to [5], landfilled peat is peat soils that have accumulated or accumulated with mineral soil. The land is said to be buried when a new surface is 30-50cm thick. Or the pile layer is half or more thick than the thickness of the buried land.

3.1. Soil Chemical Properties

The analysis result (Table 1) then harmonized with soil fertility criteria found that all sample points reacted very sour (Extreme Acid) pH <4.5 with a range of pH values between 3.51 - 4.43. Soil reaction (pH) was a parameter that was controlled by the electrochemical properties of soil colloids. This term indicated the acidity and basicity of the soil whose degree was determined by the level of hydrogen ions in the soil. The level of soil acidity can affect the availability of nutrients that can be absorbed by the roots of plants in which each nutrient

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Table 1. Analysis of the chemical properties of buried peat soils

| Farmer Sample (P) | pH     | N Total (%) | P Total (%) | K Total (Ppm) |
|-------------------|--------|-------------|-------------|---------------|
| P1                | 4.33 (EA) | 0.54 (H)   | 7.8 (M)     | 1.88 (VL)     |
| P2                | 3.96 (EA) | 0.32 (M)   | 7.7 (M)     | 1.63 (VL)     |
| P3                | 3.99 (EA) | 0.34 (M)   | 4.8 (L)     | 1.61 (VL)     |
| P4                | 4.72 (SM)| 0.33 (M)   | 6.6 (L)     | 2.88 (VL)     |
| P5                | 5.51 (A)  | 0.55 (H)   | 6.4 (L)     | 4.86 (VL)     |
| P6                | 3.57 (A)  | 0.41 (M)   | 7.2 (M)     | 1.39 (VL)     |
| P7                | 4.43 (EA) | 0.53 (H)   | 7.2 (M)     | 2.48 (VL)     |
| P8                | 3.97 (EA) | 0.43 (M)   | 7.0 (M)     | 2.17 (VL)     |
| P9                | 4.35 (EA) | 0.39 (M)   | 5.9 (L)     | 2.87 (VL)     |
| P10               | 3.98 (EA) | 0.40 (M)   | 6.4 (L)     | 2.46 (VL)     |
| P11               | 4.26 (EA) | 0.44 (M)   | 5.7 (L)     | 2.79 (VL)     |
| P12               | 4.30 (EA) | 0.40 (M)   | 6.6 (L)     | 2.34 (VL)     |

EA = Extremely Acid, A = Acid, VL = Very Low, L = Low, M = Medium, H = High, VH = Very High [8]

Table 1. Analysis of the chemical properties of buried peat soils

Total nitrogen of the soil described the content of all the nitrogen present in the soil both in the form available and in a form that was still fused as an organic compound. Nitrogen content in the study sites was generally in the moderate category with values ranging from 0.32% to 0.55% (Table 1). According to [9] stated the total N value is influenced by the content of decomposed organic matter in the soil, most of the nitrogen in buried peat soils is in organic form. Proteins and amino acids obtained decompose into ammonium (NH₄⁺) and nitrate (NO₃⁻) which are the largest contributors of N in the soil, decomposition of organic matter will produce compounds containing N.

The results of total P element content analysis showed that the lowest P-value was found in the P3 soil sample which was 4.8 and the highest in the P1 soil sample was 7.8 (Table 1). Based on the criteria for the evaluation of soil properties by the Soil Research Institute, the total P content at the
study site can be classified into 4 categories of nutrient status namely, very low, low, medium, and very high. The availability of low-status phosphate can occur because phosphate in the soil was in a form that was not immediately available or because of the pH, aeration, temperature, organic matter and microelements that can affect the availability of phosphate. The principle of supply of phosphate in the P cycle must be considered to overcome this. According to [10] the principle of providing P for plants in the P cycle showed that the water content of P-solution was the result of a balance between P supply from weathering P minerals, solubility, P-fixation, and P-organic mineralization and P loss in the form of immobilization by plants and P. fixation. In addition, the provision of P in the soil can be done by liming to control the solubility of Al and Fe, binding of Al by adding a lot of P fertilizer and Al chelate by adding organic matter [11].

Based on the analysis of soil samples for the total K element, it can be determined that the average K value shows a very low category of <10. The total K value is influenced by the availability of K in the soil, K availability is affected by water. According to [9], Potassium availability is also affected by groundwater. Potassium in soil and potassium solutions can be exchanged and absorbed by the surface of the colloidal soil. Most of the available potassium in the form of potassium is interchangeable and easily absorbed by plants. Potassium availability is due to the influence of carbonate water. Total K values are also influenced by soil pH.

3.2. Growth of Red Chili Plant

The result of the analysis using paired t-test (Table 2), it can be seen that the manufacture of canal blocking in an effort to provide water for the red chili plants experienced significant changes in plant height and plant width, while the flowering age parameters did not get the results significant because the results shown in the table that the calculated t-value is smaller than the t-table value.

| Observation Variable | Before Canal Blocking | After Canal Blocking | Value t-Count | Value t-Table |
|----------------------|----------------------|---------------------|---------------|---------------|
| Plant height         | 96.10 cm             | 97.10 cm            | 5.353         | 2.228         |
| Plant Head Width     | 73.58 cm             | 74.98 cm            | 6.347         | 2.228         |
| Age of flowering plants | 45.33 HST            | 45.38 HST           | 1.000         | 2.228         |

If the value of t-count > t-table, then there is a significant difference in the growth of red chili plants.

The comparative value of the red chili plant height indicated a significant difference in the growth of the red chili plant height, before the canal blocking of the plants with the highest growth was 96.10 cm, while after the canal blocking the plant height could reach 97.10 cm. From a number of samples, the values presented in the average table got a large enough value which meant that making canal blocking could make enough water available for chili plants so as to make plant height growth better. Genetically on red chili plants, the average height of plants ranges from 87-120 cm. The water that has been available due to the construction of canal blocking in an effort to provide optimal water, was used by farmers for their plants so that water remains available for plants so that plants could utilize the water for their metabolism so that the high growth of chili plants could grow well. [3] explained that the process of increasing plant height occurs because of an increase in cell numbers and enlargement of cell size. Plants that experience a deficit (lack of) water, turgor in plant cells become less maximum, consequently, nutrient absorption and cell division were inhibited. Conversely, if the plant's water needs could be met optimally, the increase in plant growth would be maximized because photosynthate production could be allocated to plant organs (Table 2).
The width of the plant canopy before the blocking canal was made of 73.58cm while after the canal blocking the average canopy width of the plant could reach 74.98cm. The increase in canopy width was also factored in by the availability of sufficient water for plants. The availability of sufficient water and good care for plants could make plant growth better because one of the functions of water for plants was as nutrient transfer, which water was useful for carrying nutrients to all parts of the plant so that every part of the plant gets the nutrients enough.

The availability of sufficient water was very important to meet the water needs of plants. The role of water for plants was as a solvent for various organic molecular compounds (nutrients) from the soil into the plant, photosynthetic transportation from the source (source) to sway (sink), maintain cell turgidity including cell enlargement and opening of stomata, as the main constituent of protoplasm and temperature control for plants. If the availability of groundwater was lacking for plants, consequently water as a raw material for photosynthesis, nutrient transportation to the leaves would be hampered so that it would have an impact on the production produced [2].

The age of chili plants began flowering before the canal blocking was made when the plants were 45.33 days old, whereas after the canal blocking was made the plants began flowering at 45.38 days starting from the beginning of the plants in the seedlings (Table 2). The results of the paired t-test showed that half the number of samples that obtained significant results between the age of flowering with canal blocking in providing enough water. This situation occurred because there were several factors such as the location of the chili field. The location of the land near the tertiary canal could result in water sources that were not optimal compared to land near the secondary canal. Samples that got smaller t-values than the t-table showed the average age of flowering does not accelerate, in which the average plant starts flowering at the same age both before and after the canal blocking was made.

Plants that got adequate sources of nutrition and optimum water in its vegetative growth, the metabolic process would also be better. The better vegetative growth, the faster the plant would enter the generative stage, the water available in plants could increase photosynthesis in the vegetative phase which caused cell division and growth. [3] explained that if a plant experiences a deficit (lack of) water, the plant would experience a decrease in the rate of photosynthesis and could slow down the generative growth process in plants. In addition to being allocated to be stored in organs, some photosynthates were revamped to synthesize dissolved organic compounds to reduce cell osmotic potential (osmoregulation) so that plants can survive drought conditions so that dry weight was reduced.

3.3. Red Chili Plant Production

The results of the analysis using paired t-test (Table 3), it can be seen that the manufacture of canal blocking in an effort to provide water for the red chili plant experienced significant changes in fruit weight/m2, fruit/plant weight and crop production due to the results shown in the table that the value of t-count is greater than the value of t-table, while the age of flowering and age of harvest does not get significant results.

| Observation Variable | Before Canal Blocking | After Canal Blocking | Value t-Count | Value t-Table |
|-----------------------|-----------------------|---------------------|---------------|---------------|
| Harvest Age           | 77.55 HST             | 77.00 HST           | 1.968         | 2.228         |
| Fruit Weight per m² (kg.m⁻²) | 1.16kg | 1.27kg | 5.550 | 2.228 |
| Fruit Weight per Plant | 875.69g | 970.34g | 7.510 | 2.228 |
| Crop Production       | 7.955kg               | 9.172kg             | 7.433         | 2.228         |

If the value of t-count> t-table, then there is a significant difference in the production of red chili plants.
The results after conducting a comparative test on the harvest age of red chili plants obtained several samples that obtained a smaller t-count value than the t-table which meant that there were no significant changes in the age of the harvest, before the canal blocking was made when the plants were 77.55 days, after the average canal blocking was made when the plant was 77 days old (Table 3). The factor that influences this was that the temperature during the planting season was high enough so that the flowers in the chilies fall out so that the fertilization process was disrupted which results in a long harvest. High temperatures could cause the transpiration rate to be faster so that the water in the soil or plants was reduced. This caused the plant to become stressed so that when the plants were flowering, the flowers in the chili plants fall out which results in slow fruiting of the plants and makes the age of flowering longer.

Water was an essential resource for plants. In the process of growth and production of each plant, water functions as a substance solvent for food or chemical reactions maintain the plant's body temperature, and as a constituent of protoplasm. The situation of plants that lack water was usually called water stress. When plants lack water or underwater stress conditions cause stress to the plant, which had the potential to cause biological stress (both physiological processes and functional activities) on living organisms caused by environmental factors, the response of plants that were in water stress conditions ie plants will close or narrowing stomata [12].

The average weight of fruit/m² before making canal blocking was 1.16 kg.m⁻². At the time after the canal blocking was made the average fruit weight/m² was 1.27 kg.m⁻², in which the average of each farmer produced more than 1.2 kg.m⁻² different from before which the average of each farmer's land only produced less than 1.1 kg.m⁻². The availability of water in the chili field can make the plants not lack of water and also the soil does not dry out because the water was always available so the plants can increase the yield of the chili plants.

Water was a very important physical component and was needed in large quantities for plant growth and development. Water functions as a nutrient solvent, constituent of protoplasm, the raw material for photosynthesis and so forth. Lack of water in plant tissue can reduce cell turgor, increase macroeconomic concentration and affect cell membranes and the potential chemical activity of water in plants [13]. Considering the important role of the water, then for plants experiencing water shortages can result in disruption of plant metabolic processes so that it affected the rate of plant growth and development. [14] reported that stress lack of water can inhibit photosynthetic activity and the distribution of assimilates into the reproductive organs.

The paired t-test results showed that the average fruit weights produced by each plant in each sample showed an increase. There was a significant difference in fruit weight per plant before and after canal blocking was made. Average per plant before canal blocking produces 875.69 g fruits per plant after canal blocking the average plant produces 970.34 g fruits per plant (Table 3).

Significant results obtained because at the time after the canal blocking water was needed, farmers for chili plants were always available. The availability of sufficient water can increase fruit yields in plants, during generative times chili plants really need enough water, if plants did not get enough water, it can make plant temperatures become high which results in growing flowers that would fall out so that the fruit produced was also will decrease. The available water was used by plants to produce lots of flowers so that the flowers can become fruit and can increase the yield of many fruits for these plants.

The response of plants experiencing water shortages can be changed at the cellular and molecular levels as indicated by a decrease in growth rate, reduced leaf area and an increase in the root and canopy ratio. The level of crop loss due to lack of water was influenced by several factors, including the intensity of drought experienced, the length of drought and the stage of growth when the plant was experiencing drought. Two types of plant responses that can improve the status if experiencing drought are changing the distribution of new assimilates and adjusting the degree of opening of the stomata. Changing the new assimilate distribution will support root growth rather than the canopy, so it can increase the capacity of the roots to absorb water and inhibit canopy growth to reduce
transpiration. Setting the degree of opening of the stomata will inhibit water loss through transpiration [15].

There was a significant difference in chili production after canal blocking. Production produced by farmers before the average canal blocking was made was 7.955kg.0.5ha⁻¹(15.91kg.ha⁻¹). After the canal blocking was made so that more water was available, the production produced by farmers increased to 9.172 kg.0.5ha⁻¹ (18.344kg.ha⁻¹) (Table 3). This increase occurred because the available water for plants was very sufficient so that each farmer can increase his production at least 2 ton.ha⁻¹. In addition to the maintenance factor of water availability for plants was very important in increasing crop production, this was evidenced by almost the same of each farmer in care such as using the same insecticide, fertilizer, and ZPT. Therefore, the factor that most influences the difference in yield were the proximity of the existing water source on the land and the location of the farmer's land.

Water shortages in plants occur due to insufficient water availability and excessive transpiration or a combination of these two factors. In the field, even though there was enough water in the country, plants can experience stress (lack of water). This happened if the absorption rate cannot compensate for water loss through the transpiration process. drought would reduce yield and yield components of the plant [16].

4. Conclusion
Canal blocking as an effort to increase water availability cannot accelerate the age of flowering and harvesting. Canal blocking as an effort to increase water availability can increase the growth of canopy width, plant height, increase fruit weight per plant and fruit weight.m⁻². Canal blocking as an effort to increase water availability can increase the availability of water for plants thereby increasing the production of red chili plants from 16-20 tons.ha⁻¹ or as much as 25%.

Making canal blocking in an effort to increase the availability of water cannot accelerate flowering and harvest age. Making canal blocking in an effort to increase water availability can increase growth in canopy width, plant height, increase fruit weight per plant and fruit weight.m⁻². Making canal blocking in an effort to increase the availability of water can increase the availability of water for plants thereby increasing the production of red chili plants from 16-20 tons.ha⁻¹ or as much as 25%.

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