PENGARUH JARAK TANAM PADA BERBAGAI VARIETAS PADI GOGO BERAS MERAH TERHADAP PERTUMBUHAN DAN PRODUKSI YANG DITANAM PADA LAHAN TANAMAN KARET BELUM MENGHASILKAN

SKRIPSI

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ABSTRACT

Aita Pitri Batubara. 168210001. Effect of Planting Distanceon The Growth and Production of Various Red-Grain Rice Plant Varieties Grown on Immature Rubber Plantation.The making of this thesis is supervised by Dr. Ir. Sumihar Hutapea, MS as Advisor I and Ir. Asmah Indrawati, MP as Advisor II.The purpose of this study was to determine the effect of planting distance on the growth and production of various red-grain upland rice varieties planted on immature rubber plantations.This research was conducted at the Sungei Putih Research Institute, Rubber Center, Galang District, Deli Serdang Regency, with an altitude of 80 meters above sea level from September 2020 to February 2021.This study was conducted using the Split Plot Design method using two factors, namely:Factor 1 in the form of Varieties Test with the notation (V) consisting of 4 varieties, namely V1 (Sigambiri Merah), V2 (MSP 17), V3 (Hamparan Perak), V4 (Kambiri Lumat), and Factor 2 in the form of Planting Distance with the notation (J) which consists of 4 levels, namely J1 (20cm x 20cm), J2 (25cm x 25cm), J3 (20cm x 30cm), and J4 (40cm x 20cm).This research was conducted with 2 replications. Observation parameters consisted of plant height, number of tillers, age of flowering, age of harvest, number of panicles per bed, number of panicles per plant sample, weight of grain per bed, weight of grain per plant sample, and weight of grain per 1000 grains.The results showed that the best plant height was in treatment V1 (140.31cm), number of tillers (stems), flowering age (days), harvest age (days), number of panicles per sample (grams), number of panicles per bed (kg), the best grain weight per sample (grams), the best grain weight per bed (kg) was in treatment V2, the best planting distance was in treatment J4 on the parameters of plant height and number of tillers, while the best grain weight per bed was found in treatment J1.

Keywords: *Red-Grain Gogo Rice Plant, Planting Distance, Intercropping, Immature Rubber*

CHAPTER I

INTRODUCTION

1.1. Background of Study

Rice is a food crop commodity that plays a pivotal part in Indonesia's economic aspect. For Indonesian people, rice as a staple food is very difficult to replace with other alternatives, such as corn, tubers, sago, and other carbohydrate sources (Saragih, 2001 in Magfiroh et al., 2017). Therefore, the availability of rice should be addressed properly.

According to Statistics Indonesia, rice production in Indonesia as of 2018 was 83,037,150 tons. In terms of rice consumption, population growth is increasing every year. According to Statistics Indonesia, Indonesia's population in 2018 reached 265 million. The growing number annually struggles to fulfill food needs by planting upland rice. This is a variety of rice cultivation in dry soil (Pirhat et al. 2015).

Rice has various shapes and colors as well as colors. Rice with reddish color (brown rice) in Indonesia has begun to garner attention as is the case with white rice because people begin to understand that brown rice contains good nutrition, especially people in urban areas who have already begun to consume brown rice. Therefore, the demand for brown rice is increasing, however, superior varieties have limited availability among farmers (Swasti, et al 2017). Brown rice is rich in anthocyanin pigments, phytochemicals, proteins, and vitamins. Brown rice is categorized as a whole grain because the grain from the rice is only treated by peeling the hull but no grinding and milling are required because brown rice has a reddish layer (Pengkumsri, et al 2015).

Brown rice is commonly planted on dry soil/upland land but some are planted in paddy fields. Upland rice only relies on rainwater to add nutrients and energy to its growing mass. Traditionally, dry soil is located in hill landscapes. Nevertheless, this type is still not widely cultivated because the yield is rather not optimal. The dry soil is mostly acidic with a low pH of <5 (Sitohang, et al 2014).

Apart from being the main crop with a monoculture pattern, upland rice can be cultivated intercropping with plantation crops and industrial forest plantations (Toha, et al 2009 in Hairmanis, 2016). Rice is grown between plantation crops such as oil palm, coconut, rubber, and cocoa, and industrial forest plantations such as teak, acacia, and meranti. In addition, upland rice is possibly to be planted on the sidelines of annual horticultural crops, including oranges and durian. In this ecosystem, upland rice can be planted between the main crops until the shade reaches 50% (Sopandi et al., 2003 in Hairmanis, 2016).

Intercropping between rubber trees does not interfere with the growth of rubber stem coils. Further, in former studies, the growth of rubber stem coils is better in the intercropping system compared to the use of groundcover peanuts (Sahuri, 2015). The intercropping system carried out will provide added economic value, yet entail negative impacts on the main crop or vice versa. Because these interactions can arise competition for nutrients or sunlight, one of the problems is low pH and drought (Imam, et al 2015).

One of the efforts to increase rice production is through spacing adjustment. Spacing is influenced by the nature of the rice variety planted and soil fertility. Rice varieties with high tillering properties require a wider spacing than those with low tillering (Muliasari and Sugiyanta, 2009 in Arsyad, 2019). Similarly, the opinion of (Sohel, et al, 2009 in Magfiroh, 2017) suggests that spacing will affect the growth and yield of rice. The wide spacing allows the plant to emerge a lot of tillers. Conversely, the narrow spacing generates a small number of tillers. Even at tapering spacing, one plant only produces a few tillers.

Rubber plantations in Indonesia cover a total of 3,305.40 thousand hectares in 2020, coming from private and state-owned plantations and smallholder rubber (Statistics Indonesia, 2020). However, the hindrance with rubber plants is that the price that keeps worsening which directly affects the income of the rubber farmers. The use of land between rubber rows to plant brown rice brings a positive influence on the growth of smallholder rubber plants and utilizing intercropping can provide additional income to rubber farmers.

1.2. Formulation of Study

Only small rubber farmers use the intercropping pattern system by utilizing land between rubber rows to plant various types of vegetation that can be advantageous or increase income, especially when the price of rubber is plunging so as to maintain the income stability of rubber farmers. On the other hand, the growing public demand for brown rice, while brown rice production is low, requires the use of unproductive rubber land as a site for rice cultivation with an intercropping system as a solution that should be considered, and to increase rice production yields. It is necessary to adjust the spacing of the plants.

1.3. Objective of Study

1. To understand the effect of spacing on the growth and yield of upland brown rice planted on unproductive rubber plantations.
2. To understand the production potential of various upland rice varieties of brown rice planted on unproductive rubber plantations.
3. To understand the interaction of spacing treatments of various upland rice varieties of brown rice planted on unproductive rubber plantations.

1.4. Hypothesis

1. The effect of plant spacing significantly increases the growth and yield of upland brown rice planted on unproductive rubber plantations.
2. The effect of various upland rice varieties of brown rice significantly increases the growth and yield of upland brown rice planted on unproductive rubber plantations.
3. The interaction between the spacing of various upland rice varieties of brown rice planted on unproductive rubber plantations significantly increases growth and yield.

1.5. Significance of Study

1. As scientific information for writing a thesis as one of the requirements for a Bachelor's degree (S1) in the Agrotechnology Study Program, Faculty of Agriculture, Universitas Medan Area.
2. As a source of information for further research and development for the regulation of spacing of several upland rice varieties of brown rice on unproductive rubber plantations.

CHAPTER II

LITERATURE REVIEW

2.1. Systematics and Morphology of Upland Rice Red Rice

Brown rice is widely available in Asia, including Indonesia, and also in the Americas. However, brown rice in America is deemed as a weed of rice plants that can disrupt the selling value of white rice (Ahuja et al., 2007 in Hasibuan, 2019). The classification of brown rice in plant botany is as follows; division: *Magnoliophyta*, subdivision: *Spermatophyta*, class: *Liliopsida*, order: *Poales*, family: *Poaceae,* and species: *Oryza nivara* L (Widi, 2012 in Hasibuan, 2019).

Upland brown rice is an annual plant or young plant, which is a plant that is usually short-lived, under a year, and only produces once. After harvesting, it will die or be removed with a fibrous root system. Rice can be grouped into two parts; the vegetative part and the generative part. The vegetative part consists of roots, stems, and leaves. The generative part encompasses panicles or grains, flowers, fruit, and the grain shape. (Heni, 2007 in Julfa, 2019).

2.1.1. Root

Upland brown rice roots are classified as *Guinea* plants that have a fibrous root system. During germination, primary roots appear together with other roots called seminal roots. Furthermore, the seminal roots will be replaced with adventitious roots that emerge from the bottom of the stem. Fibrous roots are located at a depth of 20-30 cm. Fibrous roots appear from the stem and the roots develop rapidly when the stem begins to form tillers (Utama, 2015).

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2.1.2. Stem

Rice stems belong to the *Ginae* plant group with stems composed of hollow internodes. Both ends of the empty hood are insulated by nodes. The length of the internodes varies, the shortest is at the base of the stem, while the second internode, the third internode, and so on are longer than the internode that preceded it. The growth of rice stems is clumped, namely a single stem/main stem of 6 buds, namely buds 1, 3, and 5 on the right and buds 2, 4, and 6 on the left. From each of these buds, arisen shoots are referred to as first-order shoots (Brackets, 2018).

2.1.3. Leaf

The leaves of the upland brown rice grow on the stems in alternating arrangements, one leaf on each node. Each leaf consists of a leaf blade, a leaf midrib that wraps around the segment, an auricle, and a leaf tongue (Ligue). Auricle and Ligue in rice can be used to distinguish them from grasses during the seedling stage because the grass leaves have either a Ligue or auricle or neither of them. At the top of the stem, there is a flag leaf that is wider than the lower leaf side (Ismunadji, et al 1988 in Julfa, 2019).

2.1.4. Fruit

The grain of upland brown rice is a dry single true fruit, which is a single true fruit with rigid outer and shriveled skin. Upland brown rice is divided specifically; a single true fruit that is dry when ripe, unbreakable. It is included in thin-walled rice grain, containing one seed, and the skin of the fruit is attached to the seed coat. Therefore, the grains consumed are the fruits (Makarim and Suhartatik, 2009 in Arsyad 2019).

2.2. Terms of Growing Upland Rice Plants Red Rice

Upland brown rice requires water throughout its growth and the needs rely on rainfall. This plant can grow in either lowland or highland areas. However, planting must be carried out within 4 months of the wet season so that the water supply is sufficient. The average good rainfall is 200 mm/month for 3 consecutive months or 1500-2000 mm/year. Rice can be grown in the dry season, however, production will increase as long as the irrigation system is always available. Optimal growth of rice requires an altitude of 0-650 meters above sea level with a temperature of 22ºC – 27ºC, whereas in the highlands it should be placed at 650-1,500 meters above sea level with a temperature of 19ºC - 23^{0}C (Perdana, 2010 in Julfa, 2019).

Upland brown rice can grow on various types of soil, such as crumb soil structure, clay type, fine dust, fine loamy to coarse soil, and sufficient available water is available. Rocky soil is not recommended, if any, it should be < 50%. The acidity (pH) of the soil varies from 5.5 to 8.0. At lower pH soil, disturbances of P nutrient deficiency, Fe and Al toxicity are generally found. Meanwhile, if the pH is above 8.0, it can experience Zn deficiency (Perdana, 2010 in Julfa, 2019).

2.3. Upland Brown Rice Cultivation Techniques

2.3.1. Variety Selection

The selection of upland red rice varieties is based on several things, including the level of adaptability of varieties to surrounding environmental conditions, appropriate plant age to facilitate cropping patterns, resistance to pests/diseases, productivity of upland brown rice, resistance to drought and lodging, and farmer preferences (Agriculture Technology Research Body North

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Maluku, 2017). Furthermore, seeds are the most important part because upland rice production is determined by more than 50% by good seeds. The use of seeds is according to the correct (labeled) source of the seed from a trusted institution, the pithy, resistant to pests and diseases seeds, germination above 85%, free of pests and diseases (seed transmitted).

The variety of rice used is also a determining factor for the success of cultivation. The variety should follow the available land, namely dry land. Yet, the varieties used in this study are two types of varieties (high-yielding varieties and local varieties). High-yielding varieties are one of the technologies that play a role in proliferating rice yields. The real contribution that can be seen from high-yielding varieties to increasing national rice production is reflected in the achievement of food self-sufficiency in 1984. The assembly and improvement of new high-yielding varieties are one of the main determining pivotal points for growing rice production (Indonesian Center for Rice Research, 2004 in Nyoman, 2018).

Local rice varieties among farmers are those planted and selected by nature for decades. Local rice cultivation is favored by farmers for its good adaptability to sub-optimal environments, including dryland ecology, good flavor, fragrant, and good quality, despite the production is not as satisfying as new varieties. The new varieties are less favored among farmers because they require intensive maintenance, higher inputs of production and labor, and under par flavor, besides the economical price (Hidayat, 2002 in Yonki, 2009). Local varieties have naturally been tested for their resistance to pests and diseases so they are a priceless collection of genetic resources (Ifansyah and Priatmadi, 2003 in Yonki, 2009).

2.3.2. Plant Spacing for Upland Brown Rice

The use of spacing is to allow plants the possibility to grow properly without competing in water, nutrients, and sunlight needs. Proper spacing is important in the optimal utilization of sunlight for photosynthesis. In the correct spacing, plants will obtain a balanced growing space (Warjido, et al. 1990 in Turiono, et al. 2018).

Spacing will affect the growth and yield of rice. The wide spacing allows the plant to grow a lot of tillers. On the other hand, a narrow spacing only produces a small number of tillers, even at a narrow spacing, one plant can sprout a few tillers. (Salahuddin, et al. 2009 in Magfiroh, et al. 2017) spacing affects panicle length, number of grains per panicle, and yield per hectare but a wide spacing is prudent to be unproductive. Many parts of the land are not occupied by plants, particularly if they do not have enough tillers, thus leaving out free space. This unoccupied space ultimately causes a decrease in the rice yield per unit area of land, in other words, the productivity of the land becomes low.

The current low productivity of agriculture in Indonesia is due to various factors, one of which is the use of incorrect spacing. Farmers are more likely to assume that the narrower the spacing, the more yields will be under the assumption that more plants can be sowed. Spacing will influence agricultural production because it is related to the availability of nutrients, sunlight, and space for plants (Sakti Karokaro, et al 2014).

The spacing of the plants in this study was 20 cm x 20 cm according to (Indonesian Center for Rice Research, 2015). Plant spacing of 25 cm x 25 cm with jajar *legowo* planting pattern resulted in better grain yields per hectare, more tillers, more panicles per clump, longer panicles, and more grain. This is in accordance with the opinion (Magfiroh, et al 2017) that spacing 20 cm x 30 cm should use *jajar legowo* planting system 2 : 1 or with a spacing of {(20 x 10) x 30} cm, 4-5 grains/hole (Indonesian Center for Rice Research, 2017), and in spacing 40 cm x 20 cm, it showed that the Inpago 9 variety with *jajar legowo* 40 cm x 20 cm resulted in the highest productivity (5.5 tons/ha) compared to the Inpago 8 variety and other cropping systems (Sahara and Kushartanti, 2019).

1. Legowo Planting System

Jajar legowo is a technological change in rice spacing that was developed from a symmetrical or tiled planting system that has developed in the community. The term *legowo* is taken from the Javanese language, Banyumas, derived from the words *lego* and *dowo*. *Lego* means broad and *dowo* implies elongated. The application of the *legowo* planting system has several advantages, including sunlight that can be optimized for the photosynthesis process, fertilization, and controlling plant-disturbing organisms which is easier to do in the spaces. In addition, the *legowo* system also improves the plant population (Pahruddin, Maripul, and Rido, 2004 in Magfiroh, et al. 2017). A better spacing pattern is the 3:1 with *jajar legowo* pattern that can produce taller plants and the use of spacing of 25 cm x 25 cm produces more tillers, more panicles per clump, longer panicles, and more grain (Magfiroh et al., 2010). 2017).

2. *Tugal* Planting System

The safe way to plant upland rice is the *tugal* system because the seeds can be penetrated at a depth of 2-3 cm and with sufficient soil moisture after the hole is filled. *Tugal* planting is carried out to anticipate erratic rainfall. An important spacing arrangement can form straight rows of plants to facilitate maintenance (weeding, spraying, and fertilizing). The planting system uses a 2:1 *jajar legowo* planting system or with a spacing of {(20 x 10) x 30} cm, 4-5 grains/hole. This way of adjusting the spacing can be conducted with the assistance of planting tools such as rakes or ticks that will form rows that are 20 cm and 30 cm apart (Indonesian Center for Rice Research, 2017).

When the array hole has been provided (with a depth of 2-3 cm), the seeds are immediately planted in a space between 10 and 15 cm, then the hole is covered with soil or mature manure. If the land is dry (difficult to plow) or not loose, the tool should use a harrow with a sufficiently large nail point that can form a straight line on the soil surface (Indonesian Center for Rice Research, 2017).

2.3.3. Planting

Planting upland rice uses *tugal* pattern. In this way, the prepared land is managed by making holes using *tugal* pattern. After the holes are formed, five seeds are sowed into each hole and then covered with soil. It is recommended before planting, the seeds are immersed for 12 hours, then dried for 12 hours. In this method, the seed requirement is ± 30 kg/ha, and plant maintenance will be easier. Therefore, this method is the most widely practiced by farmers, although it requires more labor for planting than the *sebat* or groove method (Suriansyah, et al. 2013).

2.3.4. Maintenance

Weeding upland rice is very difficult for farmers because the growth of weeds coincides with the growth of upland rice seeds and subsequent weed growth is faster than upland rice growth. Therefore, upland rice weed control begins a few days after sowing the seeds. Weeding can be done mechanically with a small hoe, sickle, or by hand when the plants are 3-4 weeks and 8 weeks old. Shading is carried out simultaneously with the first weeding and 1-2 weeks before panicles appear. In simple cultivated land, 1-2 days before planting the seeds in the rainy season, herbicides are applied to suppress weed growth. Meanwhile, on land treated with harrow, weeds usually do not grow not until 2 months after planting (Suriansyah, et al 2013).

The maintenance of upland brown rice plants is similar to those of ordinary rice plants, including fertilizers, replacement, weeding, irrigation, and pest and disease control. If plants are withered or stunted, then weeding is performed by replacing them with new seeds. The replacement should be done when the plants are 1-3 weeks old so that the plants grow uniformly. If there are weeds or other disturbing plants around the upland brown rice, weeding should be immediately done. Weeding is done when the upland brown rice is 3-4 weeks and 8 weeks old. Additionally, pests and disease control should be completed by spraying pesticides. The pesticide is applied every 15 days. For the nutritional needs of the brown rice plant satisfied, fertilization is recommended. The fertilization can be done using organic fertilizer/manure or inorganic fertilizer/urea, TSP, and KCL (Kusuma, 2019).

2.4. Pest and Disease Control of Upland Brown Rice

a. Upland Rice Pests

The stem borer is characterized by the appearance of butterflies (moths) in the rice crops. After that, it will lay eggs and be placed under the rice leaves. Six days later, the larvae are active, entering the rice stalks and ingesting the growing points of the rice stalks. Damage to the vegetative vase is often called dead heart and the generative phase is called white head. The most common types of stem borer are the rice yellow stem borer (*Scirpophaga incertulas*) and the rice white stem borer (*Scirpophaga innonata*). Control is carried out by adjusting cropping patterns and crop rotation. It can also be conducted using an insecticide with the active fipronil (Suriansyah, et al 2013).

Brown planthopper (*Nilaparvata lugens*) symptoms due to brown planthopper attack include yellow leaves and blackish stem bases. If the attack is severe, the plant will dwindle like burning (hopperburn). Brown planthopper sucks plant tissue fluids at all stages (from nymph to imago). Eggs are laid at the base of the leaf midrib and hatch after 9 days. Control can be done with good cultivation techniques such as planting resistant varieties, using fertilizers as needed, and planting simultaneously. It can also be countered using neem extract (*Azadirachta indica*) and chemical pesticides with active ingredients fipronil and BPMC (Suriansyah, et al 2013).

Green leafhopper (*Nephotettix virescens*) brings the tungro virus. Symptoms of infected leaves with the tungro virus are initially yellow-orange, starting from the ends, then gradually developing to the bottom and black rust spots appear. If this situation is neglected, the number of rice tillers will experience a reduction; the plants become stunted, the panicles are shorter than normal ones and many panicles are empty (hollow) so they cannot produce. Control of green leafhoppers can be done by planting resistant varieties, cleaning sources of tungro inoculums such as volunteer and *teki* grass, planting simultaneously, rice fields are not dry or dispersed, and applying pesticides with active ingredients BPMC or thiamethoxam (Suriansyah et al, 2013).

b. Rice Disease

Narrow brown spot (*Cercospora oryzae*) causes serious damage to crops on less fertile land. Symptoms on the leaves are narrow and reddish-brown spots that are parallel to the nervatio. The spots are paler if it moves to the edge. Severely attacked plants will affect the number of panicles. Control can be done by planting resistant varieties, balanced fertilization, reducing humidity through weeding, and using fungicides with active ingredients difenoconazole or econazole (Suriansyah et al, 2013).

Blast (*Pyricularia oryzae*) attack on leaves appear oval or elliptical spots, both ends are tapered like rhombuses, and the spots expand according to the leaf veins. Symptoms can also appear on nodes, panicles, and grains. The critical stage of the plant occurs in the first month, with maximum tillers, milk stage, and early flowering. Spore is formed at a humidity of 89-90%. Spores can survive on straw and grain residue for +1 year and mycelia for 3 years at room temperature. Control is carried out by planting resistant varieties, using healthy seeds, seed treatment, rotating crops with non-rice plants, combusting the remaining affected plants, balanced fertilization, fungicides with active ingredients, difenoconazole, propiconazole, azoxystrobin, benomyl, methyl thiophanate can also be applied. (Suriansyah et al, 2013).

2.5. Harvesting Upland Brown Rice

The implementation of upland rice harvesting can be done when 95% of the grain has turned yellow. Harvest relies on variety. The average upland rice is between 110-130 days for high-yielding varieties. Harvesting methods can be done with a serrated sickle, *ani-ani* (finger knife), or harvesting machine. *Ani-ani* is generally used by farmers to harvest local rice that is difficult to fall off and tall rice plants by cutting the stalks. Sickles are commonly applied to crop new high-yielding varieties by removing the top, middle, or bottom of the clump, depending on the method of threshing. Cutting down is widely applied when threshing is done by slamming or using a pedal thresher. Harvesting by means of top or middle cut is carried out when the grain is threshed using a thresher machine (Agriculture Technology Research Body North Maluku, 2017).

2.6. Intercropping of Upland Brown Rice and Rubber Plants

Intercropping (multiple cropping) is an attempt to plant several types of plants on one or almost the same land and time. Combining types of plants in an intercropping system must be reviewed from several aspects, including plant height, root depth, nutrient requirements, and relationship. A solution to increase land productivity with intensification is the intercropping cultivation system. A study by Pujiwati and Susilo (2004) shows that rice and legumes intercropping yields were higher than monoculture (Nadya Arfani, et al 2020).

The intercropping pattern can be done as long as the rubber plants are immature by applying a cropping pattern fitting to the seasons. When rice is planted between rubber plants, with a row distance of 1 m from the rubber plantations, only 0.5 ha of rubber plantations can be used for intercropping of rice in 1 ha. Therefore, this area can meet the food needs of the farmer's family as well as income from rubber farming. Even with relatively low rubber yields, farmers can do rice intercropping between unproductive rubber plants to support family income (Sahuri, et al 2016).

Other advantages of intercropping rubber are: a) labor for planting preparation and maintenance of staple crops is reduced, b) residues of fertilizer applied to food crops are absorbed by rubber plants, c) it adds organic matter from food plant residues or waste, d) the plant is upright, e) livestock grazing can be reduced (livestock need to be kept in cages so as not to damage the food crops and livestock farming becomes more intensive), and f) organic fertilizer or manure can be used as a substitute for inorganic fertilizers or as another source of income (Research and Development Agency of the Ministry of Agriculture, 2015).

The rubber clones used in this study are clone PB 260 of 4 years of age, the spacing of rubber plants in rows was 3 meters and the spacing between rows of rubber was 7 meters. Clones PB 260 is a commercially recommended clone producing latex. Clones PB 260 are classified as resistant to major leaf diseases, such as Corynespora, Colletotrichum, and Oidium. Characteristics of clone PB

260 is that the growth of the stem coil during the unproductive stage is moderate. (Agriculture Technology Research Jambi, 2012). The rubber clone PB 260 rubber in the vegetative phase can be distinguished from other rubber clones, such as growing an obovate middle leaflet shape, shiny yellowish-green leaf color, smooth leaf texture, flat-leaf margins, the distance of ±23.6 cm, protruding the shape of the shoots, cylindrical stems, smooth bark, semicircular crown (hemisphere), fork branch, and fairly smooth tree skin (Rasidin Azwar, et al. 2015).

CHAPTER III

RESEARCH METHODS

3.1. Research Time and Site

This research was conducted at the Sungei Putih Research Center, Research Center for Rubber, Galang Subdistrict, Deli Serdang Regency, North Sumatra. It was located at an altitude of 80 meters above sea level with a wavy topography. The research period started from September 2020 to February 2021.

3.2. Materials and Tools

The materials used include superior rice variety *Sigambiri Merah* from the Seed Resources Management Unit (UPBS) Pasar Miring-Galang (250 g), Mari Sejahterakan Petani/MSP 17 from Lampung (250 g), local rice variety *Hamparan Perak* from Hamparan Perak Village, Deli Serdang Regency, North Sumatra (250 g), *Kambiri Lumat* from Simarwall Village, Karo-North Sumatra Regency (250 g), Urea fertilizer, TSP, and KCL.

The tools used are tractor, hoe, tripe, rope, watering can, tape measure, book, pen, and net 1 cm.

3.3. Research Methods

The study used a Split Plot Design consisting of 2 factors. Factor I is the Variety Test which was given the notation (V) comprising 4 varieties, namely:

V1 = Sigambiri Merah (superior)

V2 = MSP 17 (superior)

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V3 = Hamparan Perak (local)

V4 = Kambiri Lumat (local)

Factor II, Plant Spacing, was given a notation (J) and consisted of 4 treatments, namely:

J1 = 20 cm x 20 cm (recommended by Indonesian Center for Rice Research, 2017)

J2 = 25 cm x 25 cm (recommended by Magfiroh et al., 2017)

J3 = 20 cm x 30 cm (recommended by Indonesian Center for Rice Research, 2017)

J4 = 40 cm x 20 cm (recommended by Sahara and Kushartanti, 2019)

Thus, 16 treatment interactions were obtained, namely:

V1J1	V2J1	V3J1	V4J1
V1J2	V2J2	V3J2	V4J2
V1J3	V2J3	V3J3	V4J3
V1J4	V2J4	V3J4	V4J4

Keterangan :

Number of replications	= 2 replications
Number of experimental plots	= 32 plots
Size of experimental plots	= 100 cm x 100 cm
Rice plant spacing	= 20 cm x 20 cm, 25 cm x 25 cm, 25 cm x 30 cm, 40 cm x 20 cm
Plants per plot	= 25 plants (20 cm x 20 cm)
	= 16 plants (25 cm x 25 cm)
	= 15 plants (20 cm x 30 cm)

= 15 plants (40 cm x 20 cm)

Number of samples = 5 samples

Total of plants = 568 plants

Total samples = 160 plants

Spacing between plots = 50 cm

Distance between replications = depends on the rubber plant population

3.4. Analysis Method

The research data were analyzed using variance based on the linear model as follows:

$$\dot{Y}ijk = \mu o + \rho i + \alpha j + \varepsilon ij + \beta k + (\alpha\beta)jk + \sum ijk$$

Information:

$\dot{Y}ijk$: The results of observations from each experimental plot using various varieties of upland brown rice (PU) at the jth level and carrying out the k-th level of plant spacing (AP) in the jth replication.

μo : Effect of Median (NT)/general mean

ρi : Effect of ith test

αj : The effect of using various varieties of upland brown rice (PU) at the j-th level

εij : Random effect of the kth experimental unit that obtains the jth interaction (PU Error)

βk : Effect of plant spacing (AP) at kth level

$(\alpha\beta)jk$: Effect of various upland brown rice varieties at the jth level and plant spacing at kth level

∑ijk : Effect of error in the use of various upland rice varieties, brown rice, grade j, and the provision of various spacings placed on the ith replication

If the results of the treatment in this study have a significant effect, further testing will be carried out with the Duncan distance test.

3.5. Research Implementation

3.5.1. Seed Preparation

The first step to do was to prepare the seeds. V1 (Sigambiri Merah) seeds were procured from the Sources of Seed Production Unit (UPBS) Pasar Miring Jl. Raya Galang Km. 8 Lubuk Pakam. V2 (MSP 17) seeds were purchased from the online shopping site Shopee which was sent from Lampung. Meanwhile, V3 (Hamparan Perak) seeds were obtained from local farmers in Hamparan Perak Village, Deli Serdang Regency, North Sumatra. The last variety, namely V4 (Kambiri Lumat), was obtained from Simarwall village, Karo Regency, North Sumatra through direct purchase with farmers. Furthermore, the seeds of each brown rice variety were dried under direct sunlight for 6 hours. Furthermore, before planting, seeds were immersed for 12 hours in order to break the seed dormancy period and choose pithy seeds so they could grow quickly and uniformly. Then, the seeds were strained for 12 hours.

The V1 (Sigambiri Merah) and V2 (MSP 17) seeds are classified as superior varieties (Agriculture Technology Research, 2017), while V3 (Hamparan Perak) and V4 (Kambiri Lumat) are classified as local varieties. The physical characteristics of V1 (Sigambiri Merah) seeds are a slightly round shape with a seed length of ± 0.7 cm, and hairless, whereas V2 (MSP 17) seeds exhibit a longer shape compared to the Sigambiri Merah variety with a length of ± 0.8 cm and is hairy. The V3 (Hamparan Perak) seeds have a more pointed shape than the seeds of other varieties, and the length of the seeds is ± 0.9 cm and hairless. The physical characteristics of V4 (Kambiri Lumat)seeds are almost similar to V2 (MSP 17) with a seed length of ± 0.8 cm but hairless.

3.5.2. Soil Management

The first procedure to do before entering the land management stage is to measure the land. In this study, 16 m of length between rubber rows was provided, while the width of the land was adjusted to the rubber plant spacing of 7 m. Two plots between rubber rows were prepared because this research used 2 replications. Subsequently, the land clearing was carried out by rolling up plastic pipes from last year's research that were available and weeding using a weeding machine. Soil management was completed by tractor land that was been previously measured and cleared and cleaned the remnants of grass from the plot. Furthermore, land management was done by making beds of 1 m x 1 m with a height of 30 cm, and 32 beds were designed.

3.5.3. Fertilizer Application

The application of fertilizers carried out in this study was divided into two, the first was basic fertilization before planting and the second was fertilization after planting. Fertilization before planting using Urea, TSP, and KCL fertilizers with fertilization a week prior to planting and the application of fertilization simultaneously for each bed. The dose given is 100% of the recommendation; urea fertilizer 200 kg/ha (20 g/m^2), TSP 75 kg/ha (7.5 g/m^2), and KCL 50 kg/ha (5 g/m^2), as suggested by (Husnain, 2016). For fertilization after planting, urea fertilization was dispensed three times from the age of 10, 35, and 55 days after planting (DAP) with a dose of 200 kg/ha (20 g/m^2), for TSP and KCL fertilization was administered on the 69 DAP with a dose of TSP 75 kg/ha (7.5 g/m^2), and KCL 50 kg/ha (5 g/m^2).

3.5.4. Application of Plant Spacing Treatment

The application of spacing was done by measuring each bed that had been prepared in advance according to the treatment of the spacing of each bed; 20 cm x 20 cm with a total of 25 plants, 25 cm x 25 cm with a total of 16 plants, 20 cm x 30 cm with a total of 15 plants, and 40 cm x 20 cm with a total of 15 plants. Plant spacing measurements were carried out 2 days following the application of basic fertilization using small wood with a length of 30 cm as a sign of the growing point for upland brown rice.

3.5.5. Sowing

Before sowing, upland brown rice seeds were immersed for 12 hours which serves to break the seed dormancy period. Then, the soaked seeds were placed into small burlap and then drained for 12 hours in order to accelerate the sprout growth. Sowing was carried out simultaneously with the planting of upland brown rice in beds, where sowing was carried out on baby polybags with a size of 10 cm x 10 cm.

The contents of the seeds planted in each baby polybag should be identical to the planting hole, namely 5 seeds to make it easier to move without having to do the pruning. The use of baby polybags aimed to avoid damage to the roots of the plant when replacement occurs, which is applied when plants on the bed are neither alive nor dead.

The seedlings must have obtained enough sunlight so that the photosynthesis process of the plant could happen accordingly. During sowing the upland brown rice seeds, water should be sufficiently available (in the growing media) to accelerate the seed germination process. The optimum temperature for germination seeds is a temperature of 20ºC-30ºC because enzymes in plants are actively working at the specified temperature. Then, at a neutral pH, growth and development will occur well.

3.5.6. Planting

Planting upland brown rice was carried out exclusively. In the planting method, planting holes were made with a depth of 2 cm. Then, 5 seeds were inserted into each hole and then covered with soil. Upland brown rice planting was carried out in the afternoon because the sun's heat is not excessive for plants and is good for planting time. Planting in beds with baby polybags for seeding was done concomitantly so the age is similar to allow the researcher to observe the parameters of each upland brown rice.

3.5.7. Plant Maintenance

3.5.7.1. Spraying

Watering on upland brown rice was administered in the morning from 07:00 to 08:00 and from 4:00 to 5:00 p.m. The watering was done from the planting until harvesting the crop. When the precipitation reaches 1500-2000 mm/year, watering is only scheduled once. Watering was conducted uniformly to each bed until the soil surface appeared to be moist.

3.5.7.2. Weeding

Weeding was carried out by removing weeds that grow in the bed and its surroundings. This was done to contract competition in absorbing nutrients from the soil as it could reduce the main crop yield. Weeding was carried out together with plowing so that the roots of the rice could move freely to absorb nutrients and improve soil texture. After weeding was completed, the next process was pilling. Pilling was performed to strengthen the establishment of rice plants.

3.5.7.3. Replacing

Replacement is necessary when brown rice upland rice plants are dead or those underdeveloped are replaced (replacement). The rice plant replacement was carried out one week after planting until three weeks after planting, by replacing dead plants with others in the polybag provided earlier in order to grow rice uniformly. Seed replacement must come from the same variety that has been reserved in the baby polybag seedling.

3.5.7.4. Pest and Disease Control

Pest and disease control was done preventively by keeping the land clean from weeds that can become hosts for pests on brown rice plants. If it is uncontrollable with performed measures, then chemicals should be administered to eliminate pests and diseases in upland brown rice plants. If signs of harmful pests and diseases are found, they should be immediately sprayed because the problem among upland rice farmers in the Sei Putih area is attacks of pests and diseases that are hard to control. The dosage used should be adjusted to the recommendations of the product. In this study, Dharmabas 500 EC, with the active ingredient Butyl Phenyl Methyl Carbamate (BPMC) was used to control the brown planthopper at a dose of 0.5 l/ha for 500 liters of water, and stink bugs at a dose of 2ml/l for 500 liters of water. It was applied/sprayed to all plants attacked by brown planthoppers and stink bugs scheduled once in two weeks.

3.5.7.5. Netting

Installation of nets aims to ward off and repel bird pest attacks on agricultural land, and installation was conducted when rice plants start to produce young seeds. Netting was done not correspondingly as the flowering age of each red rice variety is separate. The first net installation began at 12 weeks after planting on the MSP 17 (V2) variety, then on the Kambiri Lumat variety (V4) at the 13 weeks after planting, and at week 15 after planting for Hamparan Perak (V3) and Sigambiri Merah (V1) varieties. When installing the net, make sure the net does not touch the rice plant directly, leaving a distance of 20 cm from the rice plant to the net.

3.5.8. Harvest

Before harvesting, the plants must meet the criteria, including yellow grain, brownish-yellow leaves, and lodging stems of rice plants due to the fill of heavy grains. Furthermore, if the grains are squished, it will send a rigid sensation indicating the rice is full and ready to be harvested. Harvesting in this study was not carried out simultaneously because it used several different varieties so the harvest of each variety was different. The first variety to be harvested was V2 (MSP 17) at 95 days after planting, followed by V1 (Sigambiri Merah) at 110 days after planting, then V4 (Kambiri Lumat) at 111 days after planting, and the last was V3 (Silver Overlay) at 114 days after planting. Characteristics of rice plants that can be harvested.

3.5.9. Observation Parameter

3.5.9.1. Plant Height (cm)

Plant height was measured after the plant was 2 weeks after planting. Measurement estimated the plant from the collar of the stem to the base of the highest expanded leaf. Plant height measurements were carried out at intervals of once a week until 70% of the flowering process of rice plants in each bed. In the V2 variety (MSP 17), plant height observations were performed up to 10 WAP. Meanwhile, for other varieties, the last plant height observations were carried out until 10 WAP.

3.5.9.2. Number of tillers (stems)

The number of tillers (stems) was counted for all sample plants. The number of tillers was calculated at the age of 3 WAP until 50% of the flowering process on upland brown rice plants. The estimation of the number of tillers is counting the entire population in each clump and subtracting it from the number of upland rice hosts.

3.5.9.3. Flowering Age (days)

Flowering age was calculated from the time the seeds were planted until the plants bloomed ± 50% in each bed. The rice plant begins to flower shown by the flag leaf. Three days after the process, the upland brown rice flowers will come out. The first variety to flower was the MSP 17 (V2) variety, followed by Kambiri Lumat (V4) variety, then the Red Sigambiri (V1) variety and the last was Hamparan Perak (V3) variety.

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3.5.9.4. Number of Panicles per Sample (strands)

The number of panicles per sample plant was calculated by counting tillers that had exhibited the fully lodged panicles per sample plant. Rice plant panicle is defined as a collection of rice flowers that sprout from the top node, the rice grains are located on the first and second branches, while the main axis of the panicle is the last node on the stem. Calculation of the panicles per sample plant was carried out when the panicles started to pullulate to prevent shedding during harvesting.

3.5.9.5. Number of Panicles per Bed (strands)

Observation of the number of panicles per bed was done by counting panicles per plant in each bed that had germinated panicles as a whole. The observation of the panicles per bed was completed for all beds collectively. Calculation of the number of panicles per bed was employed when the panicles emerged to prevent shedding at the time of harvesting.

3.5.9.6. Harvest Age (days)

Harvest age was calculated from the time the seeds were planted until the rice has entered physiological maturity of ± 80% or when the rice grains turned yellow and lodged. The first harvest was the MSP 17 (V2) variety, then the Sigambiri Merah (V1) variety, then Kambiri Lumat (V4) variety, and the last was the Hamparan Perak (V3) variety.

3.5.9.7. Grain Weight per Sample Plant (g)

The weight of the grain per sample was quantified after the harvest process was completed and carried out on the same day. Harvesting was done by cutting/pruning panicles from each plant that had exhibited harvest criteria. The calculation of grain weight per sample plant was implemented by weighing all the grain obtained from each sample plant in each treatment.

3.5.9.8. Grain Weight per Bed (kg)

The weight of the grain per bed was done after the harvest process was complete and carried out on the same day. Harvesting was done by cutting/pruning panicles from each plant that already had exhibited harvest criteria. The calculation of the weight of grain per bed was continued by weighing all the grain obtained from each bed.

3.5.9.9. Weight per 1000 Grains (g)

The weight per 1000 grains per bed was obtained by taking upland brown rice grains that had undergone a dry process and then weighing as many as 1000 seeds, which was assumed from analytical balance. The results of calculating the weight of 1000 grains were expressed in g.

CHAPTER V

CONCLUSION AND SUGGESTION

5.1 Conclusion

1. The effect of plant spacing significantly increased the growth of plant height (cm), the number of tillers (stems), and the number of panicles per bed (strands) on upland brown rice on unproductive rubber plantations. Overall, an adequate plant spacing used J4 treatment, which is 40 x 20 cm, with the least number of plants and the largest spacing obtained the largest grain weight in treatment J4.
2. The effect of various upland rice varieties of brown rice significantly increased plant height growth (cm), number of tillers (stems), flowering age (days), harvest age (days), number of panicles per bed (strands), number of panicles per sample (strands), grain weight per bed (kg) and grain weight per sample (g) in upland brown rice on unproductive rubber plantations, however, did not produce results, especially in the MSP 17 variety which had the largest average grain weight value compared to other varieties.
3. The interaction between plant spacing and upland brown rice varieties on unproductive rubber plantations did not have any significant effect on increasing growth and yield.

5.2 Suggestions

Based on the results of the study, the researcher proposes several recommendations regarding upland brown rice varieties and also spacing. To obtain the highest production yields it is recommended to use upland rice varieties

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MSP 17 brown rice and use a wider spacing of 40 cm x 20 cm because the production results obtained are not much different with narrower spacing. Moreover, the seeds needed are fewer and require less effort.