The use of mulch and amelioration in peatlands to increase production of red chili plants

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Abstract. Red chili is a strategic commodity, production consistency in quality and quantity is needed. Peatland with all its limitations has the potential to be used as an area for chili crop development, but appropriate land management technology is needed. The purpose of this study was to determine the effect of using mulch and amelioration and fertilization for chili plants in peatlands during the rainy season. The research was conducted at Landasan Ulin, Banjarbaru. The treatments were: The use of mulch (without mulch and silver black plastic mulch) and a combination of inorganic and amelioration fertilizer doses (P1 = 50% model of inorganic fertilizer + 15 t ha⁻¹ manure), P2 = 50% model of inorganic fertilizer + 30 t manure ha⁻¹), P3 = Model 100% Inorganic Fertilizer + Manure 15 t ha⁻¹), P4 = Model 100% Inorganic Fertilizer + Manure 30 t ha⁻¹, P5 = Farmer Model. The results showed that the use of black silver mulch combined with 325 kg ha⁻¹ urea, 225 kg ha⁻¹ SP 36 and 200 kg KCl kg ha⁻¹ KCl and 30 t ha⁻¹ a manure showed fruit yields of chili plants reached 15 t ha⁻¹.

1. Introduction
One of the horticultural crops that have an important and strategic role in Indonesia is the chili plant (Capsicum annuum) [1]. Usually chili plants are grown seasonally. To prevent the occurrence of fluctuations in production and price fluctuations that often occur and have a negative impact on farmers’ income, it is necessary to strive for cultivation that can last for years through off-season cultivation. Chili farming planted outside the season has a risk of crop failure due to pests and diseases. Based on this fact, it is necessary to find alternatives to be able to plant chili outside the season, one alternative is to use plastic mulch. The benefits of using mulch in chili cultivation are that it can stabilize soil temperature conditions, prevent the growth of weeds which are sources of inoculums or disease hosts and prevent insect pests [2,3].

Peat soil has physical properties suitable for vegetable growth [4]. Cultivation of vegetable crops such as chili (Capsicum annuum) can be done on deep peat soil with a thickness of >3 m [5]. Chili develops very well in loose, crumbly soil, rich in organic matter, sufficient nutrients and water [6] with 6-7 degrees of acidity [7].

Based on several research results, the production of vegetables cultivated on peatlands is still low. Peat soils generally have a low pH level, have a high cation exchange capacity, low base saturation, contain low K, Ca, Mg, P elements and also contain low micro-elements (such as Cu, Zn, Mn and B) [8]. It is necessary to add nutrients to peat soils to increase plant growth and development. Efforts are made to increase productivity and reduce soil acidity can be done by providing ameliorants. Ameliorant is a material that can be added to the soil so that it can increase soil fertility by improving
the physical and chemical conditions of the soil. Amelioration of peat soils is given to overcome the high acidity of the soil, low soil fertility, and increase the productivity of peatlands [9]. The purpose of this study was to determine the effect of using mulch and amelioration and fertilization for chili plants in peatlands during the rainy season.

2. Materials and methods
The research was conducted on the Landasan Ulin Village, South Kalimantan. The treatments consisted of a combination of mulch use and a combination of doses of inorganic fertilizers and amelioration of land, the arrangement of the treatments as follows:

1. Use of mulch
   1.1. Without mulch (M 1)
   1.2. Black Plastic Silver Mulch (M 2)

2. Combined dosage of inorganic fertilizers and land amelioration
   2.1. 50% model of inorganic fertilizer + 15 t ha\(^{-1}\) manure (P1),
   2.2. 50% model of inorganic fertilizer + 30 t manure ha\(^{-1}\) (P2),
   2.3. Model 100% Inorganic Fertilizer + Manure 15 t ha\(^{-1}\) (P3),
   2.4. Model 100% Inorganic Fertilizer + Manure 30 t ha\(^{-1}\),
   2.5. Farmer Model (P5)

Before the research was carried out, the land was prepared by clearing or cutting the bush. Land arrangement was done by making beds and trenches around the plot of the planting plot. The bed was 20 cm high and the trench depth was 30 cm. Meanwhile, the preparation of plant seeds was carried out by sowing the seeds in polybags.

Preparation of seeds was carried out before planting, in the nursery with polybags for 20 days. Fertilizer N was given 3 times, while fertilizer P and K are given all at once at the beginning of growth. The amount of fertilizer given was 325 kg ha\(^{-1}\) urea, 225 kg ha\(^{-1}\) SP 36 and 200 kg ha\(^{-1}\) KCl and 30 t ha\(^{-1}\) (100% manure and mineral fertilizer as treatment). As for the treatment of farmers, the amount of fertilizer given is 200 kg ha\(^{-1}\) of pearl compound and 50 t ha\(^{-1}\) of manure. Plant maintenance includes clearing weeds and controlling HPT. Pest and disease control was carried out regularly if there are early symptoms of an attack.

Complete initial soil analysis in the form of pH, total N, C-organic, CEC, K, available P, ash content, total P. Soil parameters observed during the maximum vegetative period were total N, organic C, CEC, and K. Plant observations were made on growth (vegetative) which was the height of the plant. The yield components (number of fruits planted, length of fruit, weight of 1 chili and weight of fruit/plant) and chili production will be observed cumulatively at the end of planting.

3. Results and discussion
The land that became the research location was land that was recently cleared, previously unused land, overgrown with shrubs. After cleaning, make beds with a bed height of 20 cm and a trench depth of 30 cm. The land that was the research location was shallow peat land with a quartz sand subratum. Based on the characterization in the field, it is known that the thickness of the peat layer ranges from 30-50 cm, the level of peat maturity tested by the squeeze method (Von Post scale) is sapris. The boundaries between the layers of soil are diffuse.

The initial soil characteristics of peat land used for research are presented in table 1. Based on the results of research that has been carried out on soil samples before being treated, it showed low soil fertility. Soil acidity is classified as very acidic, indicated by the pH of H\(_2\)O 4.12 and pH of KCl 3.49. Soil total P is classified as low at 10.95 mg 100g\(^{-1}\), total K is also low (3.73 mg 100g\(^{-1}\)). Therefore, for cultivated land, additional inputs are needed in the form of lime, manure, and inorganic fertilizers [10].

In general, based on the height data of chili plants observed when the plants were 8 weeks old, it was known that the best growth was shown by P2 - P5 treatment, and in the treatment without mulch (M1) (figure 1). This happened because in P2 - P5 treatment, the amount of inorganic and organic fertilizers given was greater than P1. In contrast to the growth data, the yield component data (figures...
2, 3, 4 and 5) and the fruit yield of chili plants (figure 6) as a whole showed that the treatment of using black silver mulch was higher. The use of plastic mulch can improve cultivation and can be used for out-of-season cultivation and improve the quality of yields [11]. The level of damage to chilies due to anthracnose can be reduced by using polyethylene mulch [12] and production of red chilies can be increased [13]. The role of mulch in the dry season is to help prevent water loss while in the rainy season it prevents water accumulation in the root zone. Water infiltrated into the soil can be used by plants to increase plant productivity. In addition, the presence of mulch can prevent solar radiation from reaching the ground, thereby reducing soil evaporation. Belel [14] reported that the use of plastic mulch in chili cultivation obtained an average number of fruits per plant; the highest fruit length and diameter. The benefits of using mulch for plants include suppressing weed growth, soil compaction, erosion, and being able to maintain moisture in the root zone [15] and more efficient use of soil nutrients so that the number of fruit can be increased [16,17]. The activity of soil microorganisms in decomposing organic matter in the soil can increase in the presence of stable soil temperatures in the rhizosphere. The photosynthetic process also has an impact with the presence of plastic mulch, the reflection of sunlight from plastic mulch so that all sides of the leaves will be exposed to sunlight evenly, so that the photosynthesis process can take place on both sides of the leaves [3]. The good growth of chili plants in the end can increase the weight per fruit. Increasing reserves of plant support components will increase photosynthesis and increase translocation of sources to storage organs [18].

| Table 1. The results of the initial soil analysis of the peatland research location, Landasan Ulin Village, 2018. |
|---------------------------------------------------------------|
| Parameter                  | Score  |
| pH H2O                      | 4.12   |
| pH KCl                      | 3.49   |
| C-Org (%)                   | 19.73  |
| P (ppm P)                   | 22.02  |
| CEC (cmol(+), kg⁻¹)         | 65.27  |
| P (mg 100 g⁻¹)              | 10.95  |
| K (mg 100 g⁻¹)              | 3.73   |
| Ash content (%)             | 65.99  |
| N total                     | 0.44   |

![Plant height diagram](image)
Figure 1. Height of chili plants at 4 weeks after planting on mulch treatment and ameliorant dosage, Landasan Ulin Village.

Figure 2. Number of chilies/plants in mulch treatment and ameliorant dosage, Landasan Ulin Village.

Figure 3. Length of fruits in mulch treatment and ameliorant dosage, Landasan Ulin Village.

Figure 4. Weight of 1 chili (g)
The highest yield of chili obtained from M2 P5 treatment can be related to N and K nutrient levels in the soil which also increased proportionally after the treatment application (figures 7 and 8). This can be understood because the amount of manure given is 170% higher than treatment. If economic value is one of the considerations in determining recommendations from the results of this study, then M2 P4 treatment is the best treatment (use of mulch in combination with 325 kg ha\(^{-1}\) urea, 225 kg ha\(^{-1}\) SP 36 and 200 kg ha\(^{-1}\) KCl and 30 t ha\(^{-1}\) manure). This is because the amount of manure given is only 30 t ha\(^{-1}\). This amount is much lower than the M2 P5 treatment with the amount of manure reaching 50 t ha\(^{-1}\).

Soil quality and plant productivity can be increased by applying manure [19]. The provision of chicken manure has a positive effect in improving the quality of acid soil [20]. The microorganisms
present in manure can act as decomposers that can increase and encourage the activity of soil microorganisms and reduce the C/N ratio in peat soils, so that the mineralization process can run smoothly and more nutrients become available [21]. The application of ameliorant chicken manure to peat soils significantly increased the amount of soil organic carbon (C). Organic material is a source of energy for microbes in the process of respiration to produce CO$_2$ [22]. The role of soil microorganisms is to accelerate the supply and form a source of organic matter in the soil [23]. The role of inorganic fertilizers in chili cultivation is to increase soil nutrients and fertility quickly so that it can increase growth and yield [24]. The process of cell division will run quickly with the availability of N, N plays a role in stimulating plant height growth. P plays a role in the process of photosynthesis in the dark phase, respiration and other metabolism. K elements also play a role in photosynthesis. P and K nutrients in the soil help in the process of fruit formation and improve fruit quality in terms of fruit diameter [25]. Phosphorus plays a role in increasing plant root growth, accelerating flowering, ripening seeds and fruits, besides that phosphorus also plays a role in the photosynthesis process [26].

**Figure 7.** Total soil N content in the combined treatment of mulch treatment and ameliorant dosage, Landasan Ulin Village.

**Figure 8.** Soil K levels in the combined treatment of mulch and ameliorant dosage, Landasan Ulin Village.
4. Conclusions
Cultivation of chili plants outside the season (off season) on peatlands can be done using black silver plastic mulch combined with 325 kg ha$^{-1}$ urea, 225 kg ha$^{-1}$ SP 36 and 200 kg KCl kg ha$^{-1}$ KCl and 30 t ha$^{-1}$ showed results chili production reaches 15 t ha$^{-1}$.

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