Tropical Wetland Journal
Journal homepage: twj.ulm.ac.id | Published by Postgraduate Program - Lambung Mangkurat University | e-ISSN: 2654-279X

Original article
DOI number

The Effect of Temperature and Relative Humidity Inside the Shade Netting on the Growth of Pepper Fruiting Branch Cuttings

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Received: 13 January 2021; Accepted: 14 December 2021; Published: 17 December 2021

ABSTRACT

Pepper *(Piper nigrum* L.) has many benefits, especially in its seeds, commonly used as a food flavoring. Pepper effectively increases appetite, increases the digestive glands' activity, and accelerates fatty substances' digestion. In general, pepper production per unit area in Indonesia is low. The average is below 1 ton of dry pepper per hectare. This low productivity is mainly due to inadequate cultivation techniques, such as improper fertilization and inadequate care. The development of pepper cultivation is still running slowly due to the many obstacles faced by farmers. This productivity could be increased if farmers could apply good and correct cultivation techniques. Generally, pepper cultivation in Indonesia uses standards. This technique is expensive and requires intensive maintenance. The pepper seeds commonly planted by farmers come from running shoots. The experimental design used was the split-plot design with shade netting as the first factor and the administration of husk charcoal as the second factor. Other factors observed were climatic factors, including temperature and relative humidity, bird bud burst time, sprouting time, and root-shoot ratio. The results indicated that the shade netting and husk charcoal treatment on the planting medium significantly affected bird bud burst time, sprouting time, and root-shoot ratio. This study aimed to investigate the effect of climate on the growth of pepper cuttings. The results indicated that the best bird bud burst time occurred in treatment n_0 (100%), a_0 (1:1) 34.67 days, and not significantly different from n_0 (100%) a_2 (0: 1) 35.00 days. The best sprouting time occurred in treatment n_0 (100%) a_2 (0: 1) 32.00 days, not significantly different from n_0 (100%) a_0 (1: 1) 32.50 days. The root-shoot ratio was significantly different in treatment n_0 (100%) a1 (1; 0) 5.28 g.

Keywords: cuttings, fruiting branch, pepper, relative humidity, temperature

1. Introduction

Pepper (*Piper nigrum* L.) has many benefits, especially in its seeds, commonly used as a food flavoring. Pepper effectively increases appetite, increases the digestive glands' activity, and accelerates fatty substances' digestion. Pepper seeds have a spicy taste. This spiciness comes from piperine, piperanine, and chavicin. Chavicin is compounds from piperine with alkaloids. Black pepper has a moisture content of 8-13%, 11% protein, 22-42% carbohydrates, 1-4% essential oil, 5-9% piperine. White pepper has a moisture content of 9.9-15%, 11% protein, 50-65% carbohydrates, essential oils less than black pepper, and 5-9% piperine (Rismunandar, 1990). The many benefits and uses of pepper make the demand both in Indonesia and other countries high.

Pepper plants are introduced in Indonesia around 100 BC. Now, it has grown in 20 provinces whose territories are suitable for pepper cultivation. However, pepper production per unit area is relatively low, with an average of less than 1 ton of dry pepper per hectare. Whereas in other countries, Brazil and

Malaysia, production can reach an average of 4-6 tonnes of dry pepper per hectare (Jayasamudra & Cahyono, 2006).

According to Auzay Hamid (1991) in (Jayasamudra & Cahyono, 2006), this low yield is mainly due to suboptimal farming techniques, such as improper fertilization and maintenance. The development of pepper cultivation is still moving slowly due to the many obstacles faced by farmers. This productivity can be improved by applying proper and correct cultivation techniques.

In Indonesia, pepper cultivation generally uses standards. This technique is expensive and needs high-maintenance. The pepper is commonly propagated vegetatively through cuttings the runner shoots. This technique requires both living and non-living standards to trail the pepper. According to Yuhono (1997) in (Jayasamudra & Cahyono, 2006), the costs incurred for the purchase of non-living standards is 58.55% of the investment costs in the first stage. The rate of export demand increased by 5.44% per year. The rate of expansion of the cultivation area increased by 4.69% per year. It has led to an increase in demand for standards, especially non-living standards, which are increasingly rare, challenging to find, and expensive. One alternative to substituting running shoots is the fruiting branch. The utilization of fruiting branch planting material will produce shrub-shaped plants.

Fruiting branch cuttings have several advantages over regular runner shoots cuttings. It does not require standards; the number of plant populations per unit area is higher, maintenance is more manageable, plant material for seed propagation is widely available, and plants produce early. Fruit harvesting is also easier because it does not require other tools such as ladders. However, fruiting branch cuttings have weaknesses, such as a low growth percentage, many cuttings die from drought or fallen leaves, and longer time for root growth, up to 2 months (Rismunandar, 1990).

Moreover, it also requires a higher dosage of nutrients. Selection of the right media is crucial. Planting media is the main component required in plant cultivation. There are various types of growing media, but not all growing media types are suitable for the pepper plant. The planting medium must be accustomed to the type of the plant, including a shrub pepper. The media should retain water for the growth of fruiting branch cuttings, contain sufficient organic matter, pH between 5.5-5.8, and contain a high CEC, providing nutrients for plants (Akhyar, 2003).

Selection of the right media is vital to improve the soil or media's texture so that nutrients are available, for example, by using rice husk charcoal. Rice husk charcoal has several advantages as a planting medium. Its physical properties can loosen the soil and maintain soil moisture content. Its chemical properties, which contain high CEC, can increase the availability of nutrients for plants. Its biological properties can provide a food source for decomposer microorganisms. Incomplete combustion of rice husk by roasting or incomplete combustion will produce husk charcoal and not husk ash. Husk charcoal is a plain and sterile planting medium made from rice husks which can only be used for one growing season. It is produced by burning dry rice husks on a stove, and before the coals of the husks turn to ashes, clean water is poured over it. Yati Supriyati and RC Herlina in (Gustia, 2014) suggest that husk charcoal can provide adequate aeration and drainage, but it still contains pathogenic organisms that can inhibit plant growth. Therefore, burning is carried out to eliminate the pathogens. Husk charcoal is a medium containing organic matter that can keep the soil moist. The husk charcoal is more porous so that the macro and micropores are almost balanced, making the air circulation quite good and has high water absorption (Gustia, 2014).

The shade is used to reduce leaves falling or drought. The shade is expected to maintain moisture content so that the plants do not dry out quickly. Each type of plant requires a different light intensity for growth. Light intensity significantly affects photosynthesis products. If the light intensity is too low, the results of photosynthesis products are not optimal.

In contrast, if the light intensity is too high, it will affect leaf stomata cells' activity in reducing transpiration, resulting in plant growth inhibition. Light intensity is an environmental factor that significantly affects plant growth. Therefore, the optimal light intensity is needed for maximum growth. Shade utilization is expected to reduce evaporation and transpiration so that the media's humidity can be maintained (Irawan & Hidayah, 2017).

This study aims to investigate the effect of climate on the growth of pepper stem cuttings.

2. Research Methods

This research was conducted in Bekambit Asri Village, Pulau Laut Timur District, Kotabaru Regency, South Kalimantan. The materials used were Natar-1 pepper seeds, ultisol soil, rice husk charcoal, shade nettings with a density of 25%, 50%, and 75%. Rice husk charcoal and shade nettings were used as treatments in this study. The tools used were polybags, scales, machetes, sprayers, watering can, stationery, and camera.

Experimental design

The method used was an experimental method carried out in a polybag. The experimental method used was the split-plot design with a randomized block design pattern. The first factor was the shade netting (n), and the second factor was the rice husk charcoal (a).

The first factor was the provision of shade, which was arranged as the main plot, consisting of three levels, namely:

n1: 100 % (shade netting)
n2: 50 % (shade netting)
n3: 75 % (shade netting)

The second factor was the rice husk charcoal, which was arranged as a sub-plot, consisting of five levels, namely:

a0 = 1:1 (soil: rice husk charcoal)
a1 = 1:0 (soil: rice husk charcoal)
a2 = 0:1 (soil: rice husk charcoal)
a3 = 2:1 (soil: rice husk charcoal)
a4 = 1:2 (soil: rice husk charcoal)

There were 20 treatment trials. Each treatment was repeated three times. Therefore, there were 60 experimental units.

3. Results and Discussion

Result

Observation of climatic data during the study included monthly average daily temperature and monthly average relative humidity. Observation of climate data during the study is presented in Table 1. Observation of Climate Data

Table 1. The average temperature during the study

	Temperature (0C)		
Month	n1	n2	n3
September	29,75	30,65	30,83
October	30,41	30,91	31,31
November	30,05	30,84	30,85
December	29,84	30,44	30,38
January	29,78	30,15	29,94

Note: the figures above are the average temperature of each shade nettings during the study

Table 2. Average relative humidity during the study

	Relative Humidity (%)		
Month	n1	n2	n3
September	76,57	72,95	75,01
October	75,07	66,25	65,81
November	79,21	70,19	70,81
December	81,99	73,85	74,53
January	86,69	82,40	84,09

Note: the figures above are the average relative humidity of each shade during the study

Observation data of the average temperature and relative humidity during the study are presented in Table 1 and Table 2. These data indicate that both the lowest temperature and the highest relative humidity occurred in the 100% shade netting treatment (N0).

Bird Bud Burst Time

The observations on the bird buds burst time on pepper plants on the provision of shade and various planting media are presented in Table 3.

Table 3. Treatment interaction with bird buds burst time

Shade netting	Rice husk charcoal				
	a0 (1:1)	a1 (1:0)	a2 (0:1)	a3 (2:1)	a4 (1:2)
n1100%	34,67 a	42,00 abcd	35,00 a	36,67 ab	43,00 abcd
n2 50%	41,33 abcd	42,00 abcd	54,67 e	35,00 ab	36,67 ab
n3 75%	42,33 abcd	46,33 bcde	39,67 abc	50,00 de	48,00 cde

Note: The average number followed by the same letter is not significantly different based on the DMRT test at α = 0.05%

Based on the DMRT test, the fastest bird bud burst time occurred in 100% shade netting treatment and 1: 1 rice husk charcoal (n1a0) (34.67 days) and very significantly different from 75% shade and husk charcoal 2: 1 (n3a3) (50.00 days).

Sprouting Time

The observations on sprouting time on shade netting and various growing media are presented in Table 4.

Table 4. Treatment interactions with sprouting time

Shade netting	Rice husk charcoal				
	a0 (1:1)	a1 (1:0)	a2 (0:1)	a3 (2:1)	a4 (1:2)
n1100%	32,50 a	39,50 abc	32,00 a	33,00 ab	39,00 abc
n2 50%	38,50 abc	52,50 d	39,00 abc	33,00 ab	34,00 ab
n3 75%	40,00 abc	43,00 bcd	36,50 abc	46,50 cd	45,50 cd

Note: The average number followed by the same letter is not significantly different based on the DMRT test at α = 0.05%

The DMRT test showed that the plants sprouted within 32.00 days occurred in 100% shade treatment and 0: 1 rice husk charcoal (n1a2). The longest sprouting time occurred at 50% shade treatment and 1: 0 rice husk charcoal (n2a1).

Root to Shoot Ratio

The observations on the root-shoot ratio of pepper plants with shade and various growing media are presented in Table 5.

Table 5. Treatment interactions with Root-Shoot ratio

Shade netting	Rice husk charcoal				
	a0 (1:1)	a1 (1:0)	a2 (0:1)	a3 (2:1)	a4 (1:2)
n1100%	3,21 abc	5,28 d	3,13 ab	2,51 a	3,13 ab
n2 50%	2,81 a	4,31 bcd	3,25 abc	3,10 a	2,89 a
n3 75%	2,55 a	2,95 a	2,80 a	3,27 abc	2,99 a

Note: The average number followed by the same letter is not significantly different based on the DMRT test at α = 0.05%

Table 18 shows that the highest root-shoot ratio was found in 100% shade netting treatment and 1: 0 husk charcoal (n1a1) with a weight of 5.28 gr. The 100% shade netting treatment and 2: 1 husk charcoal (n1a3) only produced a weight of 2.51 grams

Discussion

Temperature

The temperature significantly affected this study because 25% shade netting treatment with the same media composition as other shade treatments (50%, 75%, and 100% shade) produced different results. The 25% shade netting did not respond well. The cuttings could not grow because the temperature was too high. Other shade netting treatments indicated an influence from the treatment or the interaction between the treatments given. In addition to shade netting, plastic hoods were also used in all treatments. According to(Rusmayadi et al., 2011), a plastic hood is needed to maintain moisture around the nursery. (Kolo & Raharjo, 2016) stated an interaction between the rice husk charcoal and the frequency of watering on soil temperature at 25 DAS and 75 DAS. They found that soil temperature in plots administrated with rice husk charcoal at a dose of 0.5 g per planting hole and watered every five days produced the highest value. In this study, climatic conditions significantly affect plant growth because it is difficult to modify and control according to plant needs. The most crucial step that must be considered in choosing a pepper farming location is the suitability of the climate besides the soil conditions because the soil conditions are easier to modify. Air temperature positively affects the plant's metabolic process. Air conditions that are not following the plant's needs will interfere with the plant's metabolic processes, resulting in stunted growth. Improper air temperature will affect the age of the plant. Hence, it affects productivity. Pepper plants can grow well and have high productivity in areas with high rainfall that are evenly distributed throughout the year. (Suwarto & Hermawati, 2012) state that suitable air temperature ranges from 20oc - 34oc. The best temperature range in the morning between 21-27oC, 26-32oC during the day, and 24-30oC in the afternoon. The intensity of sunlight radiation positively affects the photosynthesis process. Sufficient sunlight is required for the optimum growth and production of the pepper. The sunlight intensity also affects the nutrient absorption process.

Bird Bud Burst Time

The growth response from the analysis of varience of rice husk charcoal and shade netting treatment showed a very significantly different interaction, but not with a single treatment factor. It is estimated that the amount of food reserves is abundant in the stem of pepper cuttings, so it is expected that the time for the emergence of the first leaves occurs almost simultaneously. However, it turns out that the treatment gives a different response to each treatment. This study found that utilizing 100% shade netting and the administration of balanced husk charcoal with soil media was more effective in responding to the first leaves' release. It might be due to the climate at 100% shade netting, which is not too high and is supported by the right media conditions for growing pepper. Pepper roots are easy to develop and easy to get nutrients around the roots.

Sprouting Time

Analysis of variance showed that the rice husk charcoal medium and the different shading affected the pepper plants' sprouting time. The DMRT test showed that at the age of 32 DAS, 32.50 DAS, and 33 DAS, rice husk charcoal and shade netting treatment significantly affected the sprouting time. In the observation of sprouting time, there was an interaction between the planting medium of rice husk charcoal and shade netting treatment. The DMRT test showed that the treatment of soil planting medium + rice husk charcoal (0: 1 :) and 75% shade netting resulted in a shorter time. This is estimated because the media is good and ideal for pepper cuttings' growth compared with the same growing media treatment, with different ratios. The growing medium's conditions greatly influence pepper plant growth, also called an adaptation factor. The media's physical factors affect plant growth, including aeration, groundwater content, and nutrient content (Hardjowigeno, 2003). According to (Buckman & Brady, 1982), plant height growth, leaf number, and shoot diameter are influenced by media conditions, root systems, and climatic conditions. In general, the application of fertilizers containing elements of N, P, and K in the growing media will increase plant vegetative growth and resistance to pests or diseases. According to (Rosmarkam & Yuwono, 2002), plants utilize food reserves in carbohydrates, fats, and protein to form young shoots and roots in the early growth stages. This food reserve is the result of plant assimilation, stored in the plant's vegetative structure, namely stems, roots, and fruit. After the leaves appear, it will play an essential role in increasing photosynthetic activity and assimilating production to further growth.

Root to Shoot Ratio

Analysis of variance showed that the interaction of the husk charcoal media and the provision of shade netting treatment had a very significant effect on the heading and root dry weight of pepper plants. In contrast, a single factor did not affect. It is likely because the shade conditions are very supportive of the growth of shoots and roots. Rice husk charcoal media has a good effect on the growth of pepper cuttings. (Harjadi & Tahitoe, 1991)suggests that carbohydrates also play a role in increasing the rate of cell division of the meristem tissue in the cambium, stem growth points, and root tips. The roots' absorption ability depends on the surface area of the roots, which is influenced by the number and length of the roots. Increasing the number and length of roots will increase nutrient and water uptake and increase plant photosynthetic activity. The increase in photosynthetic activity will increase plant parts' formation, accumulate into plant dry weight.

The results showed that, in general, the provision of shade and organic matter of rice husk charcoal on the growing medium tended to increase the dry weight of roots and shoots. It may be due to its ability to improve the soil structure to become crumblier to increase water absorption and facilitate root growth. According to(Kemas Ali Hanafiah, 2010), particles of organic matter are constituents of pore spaces that function as water sources and air and space for roots to penettingrate. More pore space will expand the root system. Roots will be more easily in absorbing nutrients and water in the soil. However, less pore space will result in stunted root development. This characteristic is essential for the root of the seed because it is closely related to the plant roots' physical, chemical, and biological characteristics (rhizosphere) (Putri, 2008). Plant dry weight (dry root weight and shoot dry weight) is the plant's biomass value. The greater the biomass value, the better its growth. Plants will form biomass, which is used to form their body parts during their lifetime or at a certain period (Sitompul & Guritno, 1995).

Shrub pepper has a shrub-shaped crown with a 100-150 cm diameter and a 90-120 cm plant height. Unlike the climbing pepper, which has two kinds of roots (below ground level and root sticky), shrub pepper has only one root, namely roots below the soil surface. The nursery's number of primary roots does not increase after transplanting into the garden, and only root branches develop. The shrub pepper roots are more concentrated around the soil surface and do not go more in-depth. Effective rooting only reaches a depth of 30 cm, while root penettingration can reach 60 cm (Rosman, 2005). (Nengsih & Marpaung, 2016)stated that pepper cuttings from the fruiting branch only had a live percentage of 33%, while those from running shoots had a live percentage of 80%. It may occur because running shoots have a sufficient energy source (carbohydrates) and endogenous hormones to grow balance shoots and roots in producing new plants.

4. Conclusions

The results showed that treatment of shade netting and husk charcoal on the planting medium significantly affected bird bud burst time, sprouting time, and root-shoot ratio.

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