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ECOPHYSIOLOGY BASED ON ITS ROLE (STUDY OF ECOPHYSIOLOGICAL CHARACTERISTICS ON THREE SPECIES OF WEED UNDER SHADE)

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ABSTRACT

The nature of tree ecophysiology is "autecology", which is "studying the ecology of a tree species or the influence of environmental factors on the life and growth of one or more tree species" and / or its role is to analyze and explain growth involving physiological processes that are influenced by environmental factors. The objectives of ecophysiological research cover a range from the tissue level to the individual species. Plant Ecophysiology is the science of the physiological response of plants to the environment. Physiology is the science that describes the physiological mechanisms that underlie ecological observations. Stress is a biotic and abiotic environmental factor that can reduce the rate of physiological processes. Plants compensate for the deleterious effects of stresses through various mechanisms operating over different time scales, depending on the nature of the stress and the physiological processes affected. Research on growth is partly the effect of acclimation by individuals and genetic differences between populations. Ten types of plants studied, each of which has a distinctive leaf anatomical structure. Some types have structures that are not shared by other types, including the sclerenchyma sheath, secretory channels and cells and oxalate crystals.

KEYWORDS: Ecology, Plants, Morphology, Adaptation.

INTRODUCTION

Indonesia, is one of the countries that has the richest diversity of plant species in the world. Plants as renewable biological resources have ecological and economic potential which are very beneficial for the welfare of society and the growth of the Indonesian economy in general. One of the potentials of biological resources is medicinal plants. Medicinal plants as the main raw material for traditional medicines have been used by the community, especially the people of Central Java in the form of herbal medicine. Knowledge of medicinal plants is a legacy that is passed down from generation to generation from generation to generation, as indigenous knowledge, where it is known and believed by the community to have properties that are able to overcome various kinds of diseases in humans.

In general, cultivation actions taken to increase the productivity of tea plants in plantations are through fertilization. In line with the principles of sustainable agriculture, now the planters generally use inputs that are more environmentally friendly, including using humic acid and consortium biofertilizers. The use of inorganic fertilizers on the soil is not fully absorbed by plants because these nutrients are leached, evaporated, or are bound by the soil. This causes low fertilization efficiency, has the potential to cause environmental pollution, and the accumulation of fertilizer residues can result in decreased soil quality, both physically, chemically and biologically. The use of organic fertilizers or other nutritional supplements such as humic acid (humic acid) is currently widely practiced, apart from being based on product safety reasons, it can also improve soil fertility.

The nature of tree ecophysiology is "autecology", which is "studying the ecology of a tree species or the influence of environmental factors on the life and growth of one or more tree species" and / or its role is to analyze and explain growth involving physiological processes that are influenced by environmental factors. The objectives of ecophysiological research range from the network level to the individual species.[1]

The Mount Merapi National Park (TNGM) is a National Park where the people still maintain Javanese culture with traditional wisdom values, including planting and using medicinal plants as traditional medicines. However, in 2010 there was a very large eruption of Mount Merapi which resulted in drastic changes in the ecosystem. According to Sufiantono,[2] the eruption of Mount Merapi resulted in severe damage (50-75% of fallen trees) in the Pronojiwo-Gandok area, Kaliurang, Sleman. Meanwhile, moderate damage (25-50% of damaged vegetation) occurred in Dukun and Srumbung sub-districts, Magelang. The eruption was quite powerful, showing symptoms of severe damage in the TNGM area, including shrubs, such as damage to medicinal plants is quite alarming. Judging from the type of damage, the ecosystem damage that occurs in TNGM has led to secondary succession, namely the process of growth / re-establishment of an ecosystem damaged by disturbances, which usually takes the form of natural disasters, such as forest fires, hurricanes, and volcanic eruptions, however The disturbance does not completely destroy the place where the organism grows, so that in the community the old substrate and life still exist.[3]

Many questions in the field regarding the prospect of Indigofera as a forage crop have recently begun to be discussed in many scientific forums. Ecophysiologically, I. zollingeriana is a plant that is very adaptive to relatively dry environmental conditions, because of the physiological mechanisms it builds on. In the plant body system through the excretion of proline is one of its characteristics, in addition there is an interaction mechanism with mycorrhizal hyphae which is very helpful for I. zollingeriana to maintain leaf production.[4] Indigofera can maintain a very low water potential compared to other legumes in drought conditions, as long as there are mycorrhizae interacting with it.

RESULTS AND DISCUSSION

Plant Ecophysiology

Plant Ecophysiology is the science of the physiological response of plants to the environment. Physiology is the science that describes the physiological mechanisms that underlie ecological observations. On the other hand, ecological or physiological scientists direct ecological problems regarding control of growth, reproduction, ability to survive, and geographic distribution of plants as processes caused by interactions between plants and their physical, chemical, and biotic environment mechanisms.[5]

Ecophysiology involves the descriptive study of the response of organisms to ambient conditions and analysis of physiological mechanisms that are ecologically appropriate depending on each level. The ecophysiological approach must take into account polymorphisms in individual responses, which are largely responsible for the adaptability of each group. In this regard, ecophysiological studies yield information that is fundamental to understanding the mechanisms underlying adaptation strategies. Ecophysiology studies will explore the physiological processes that affect plant growth, reproduction, survival, adaptation and evolution. Physiological processes include the relationship of water, mineral nutrition, solute transport, and energetics (photosynthesis and respiration). The influence of biotic and abiotic factors, physiological stress and ecological consequences for plant adaptation and evolution are also included in plant ecophysiology studies.[6]

Response of Plants to the Environment

Stress is a biotic and abiotic environmental factor that can reduce the rate of physiological processes. Plants compensate for the deleterious effects of stresses through various mechanisms operating over different time scales, depending on the nature of the stress and the physiological processes affected. These responses together allow the plant to maintain a relatively constant level of physiological processes, although the occurrence of periodic stresses can reduce the plant's performance. If a plant will be able to withstand a stressful environment, it will have a high resistance to stress. Examples of stresses are nitrogen deficiency, excess heavy metals, excess salt and shade by other plants.[5]

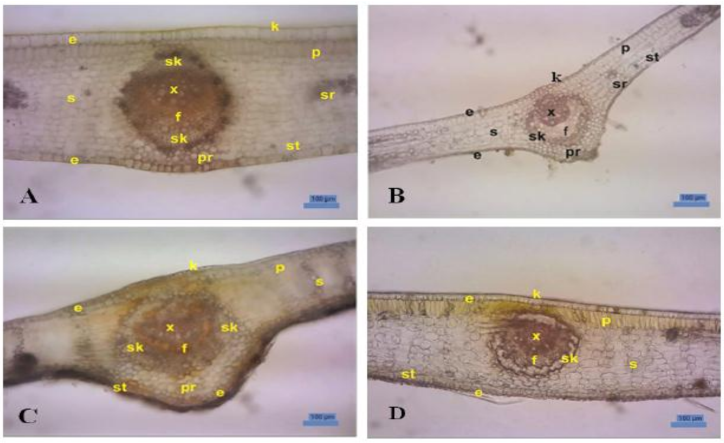
The compensation made by plants for stressful effects occurs differently in each plant for the time scale, because the mechanism varies depending on the natural stress and physiological processes. If plants are able to deal with environmental stress, they must have stress resistance. However, resistance to stress is very different in each species.[5]

An example is the response of plants to drought and salinity stress; Drought stress occurs when the availability of water in the soil decreases and atmospheric conditions cause water depletion due to transpiration and evaporation. Stress can occur on day-to-day crops or for long periods of time.[6] In drought stress conditions, the stomata will close in an attempt to curb the transpiration rate. When the stomata are closed, photosynthesis will not occur.[7] According to Jumin,[8] lack of water directly affects the vegetative growth of plants. This process in plant cells is determined by the turgor stress. Loss of turgidity can stop cell growth (multiplication and enlargement) which consequently stunted plant growth. Loss of water in plant tissue will reduce cell turgor, increase the concentration of macro molecules and compounds with low molecular weight, affect cell membranes and the potential for water chemical activity in plants. The very important role of water has a consequence that directly or indirectly lack of water in plants will affect all its metabolic processes so that it can reduce plant growth.[9]

If there is little rainwater, salt will not be released from the soil volume, where the yield will decrease as the amount of salt increases. The main effect of salinity is reduced leaf growth which directly results in reduced plant photosynthesis. The plant's first response was to reduce turgor pressure. This decrease in turgor pressure results in a decreased ability to develop and increase in cell size. This turgor reduction is thought to be the most sensitive process in plants in response to drought stress conditions. The result of this decrease in turgor can have an effect on a decrease in growth, which includes increased stem length, leaf expansion and stomata constriction,[7] Another response given by plants when salt stress occurs is by increasing levels of the hormone abscisic acid (ABA). ABA endogenous concentrations increase in plant tissue as long as the plant is exposed to stress, either salt stress, drought or cold.[10]

Ecophysiological Adaptation to Dry Tropical Climates

Ten types of plants studied, each of which has a distinctive leaf anatomical structure. Some types have structures that are not shared by other types, including the sclerenchyma sheath, secretory channels and cells and oxalate crystals. All plant species studied did not have a bundle sheath, which is a layer of cells that is usually large around the transport bundle.



Epidermal cells in the ten plant species studied had quite a lot of variations in shape, from flattened to rounded (Figure 1). Hypodermis are the cells that are located on the inner side of the epidermal tissue.

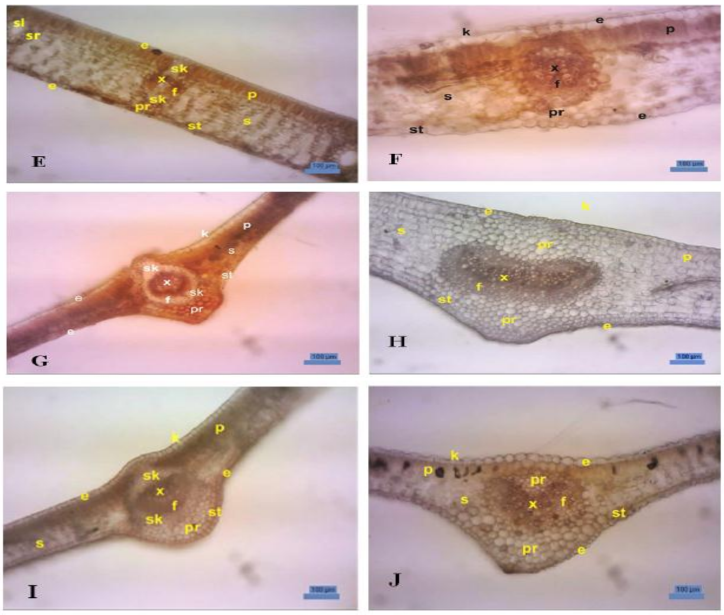


Figure 1: Cross section of the branches of the leaves: A) Barringtonia asiatica, B) Dracontomelon dao, C) Heritiera littoralis, D) Diospyros discolor, E) Calophyllum inophyllum, F) Antidesma bunius, G) Schleichera oleosa, H) Syzygium cumini, I) Madhuca longifolia, J) Adenanthera pavonina. Information: k = cuticle, e = epidermis, st = stomata, p = palisade, s = spongy tissue, x = xylem, f = phloem, sk = sclerenchyma sheath, pr = parenchyma, sr = secretory cells, sl = secretory channels. Bar = 100 µm.

Of the ten plant species studied, only Heritiera littoralis has a hypodermis on the adaxial side with an elongated to a rounded shape (Figure 1C). Eight types of plants studied had a sclerenchyma sheath consisting of cells that experienced wall thickening (lignification) and had a lumen. Two other types, Syzygium cumini and Adenanthera pavonina do not have a sclerenchyma sheath. According to Carlquist,[11] the sclerenchyma network shows the character of woody plants that have non-succulent leaves so that both species are indicated as having succulent leaves. In addition, the greater the number of layers of sclerenchyma cells, the harder the wood density, for example in Heritiera littoralis, Schleichera oleosa, and Diospyros discolor.[12]

The shape of the epidermis, thickness of the epidermis, leaf thickness and related characteristics of the mesophyll palisade and mesophyll sponge are related to shade-adapted plants.[13] The Barringtonia asiatica, Antidesma bunius and Syzygium cumini species have thick leaves and specialized mesophyll tissue so they are adapted to a sun-adapted environment. Meanwhile, the Dracontomelon dao and Schleichera oleosa types have thin leaves and narrow spaces between cells. This indicates that the two types were shade-adapted.

Types of Adenanthera pavonina have relatively thin leaves, but have large intercellular spaces. The space between cells supports the exchange of gases in the photosynthetic process. This is thought to support this type of having a fast growth rate (fast growing plant) because by having a large photosynthetic capacity, plant productivity increases. However, the spatial relationship between cells and growth rate needs to be tested through adaptation patterns of anatomical characters with photosynthetic rates and relative growth rates in all studied plant species.

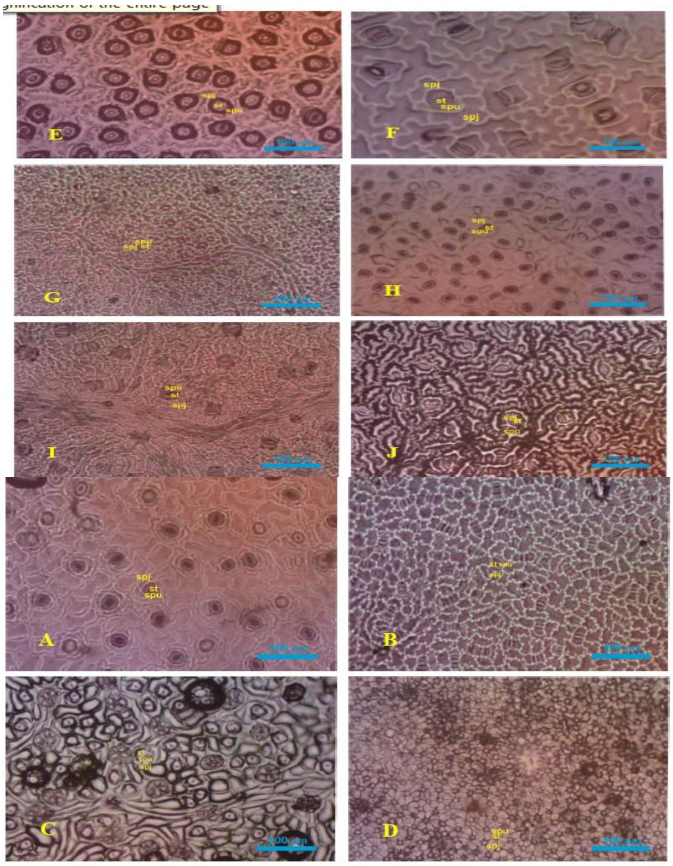


Figure 2: Character stomata: A) Barringtonia asiatica, B) Dracontomelon dao, C) Heritiera littolaris, D) Diospyros discolor, E) Calophyllum inophyllum, F) Antidesma bunius, G) Schleichera oleosa, H) Syzygium cumini, I) Madhuca longifolia , J) Adenanthera pavonina L. Description: spj = guard cell, spu = cover cell, st = stomatal gap. Bar = 100 µm.

Leaf stomata structure

The leaf stomata of the ten plant species studied were hypostomatic, only on the underside of the leaves / abaxial (Figure 2). In this species, drowning and prominent stomata are not found. The stomata types of the ten plant species studied had high variations (Figure 2) because they came from various tribes (Table 1). Barringtonia asiatica has anisocytic stomata type, Dracontomelon dao anomocytic, Heritiera littoralis anisocytic, cyclocytic Diospyros discolor, anomocytic Calophyllum inophyllum, Antidesma bunius parasitic, Schleichera oleosa anomocytic, Syifzyolia cumini anisositik, and Pavenantuca longanisosytic Syifzyolia cumini anisositik. The stomata type shows genetic and evolutionary characteristics. Plant species within a plant family have certain types of stomata, although some exceptions are found in plants that have a variety of stomata types within one species.[14,15]

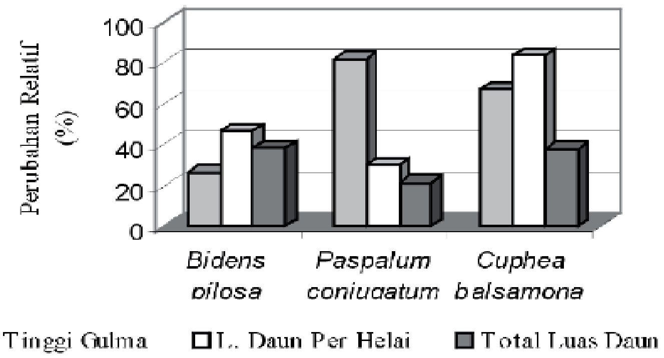
Observation and Analysis of Parameters

Plant height

Increased height of weed B. compared to B. pilosa and C. balsamona, pilosa, P. conjugatum, and C. 81.84, and 66.19% (Figure 1).

Leaf area

The response of the three types of weeds to providing shade causes the leaves to expand. The highest increase in leaf area per blade in C.balsamona was 83.64%, whereas B. pilosa and P. conjugatum were 46.22 and 2.92%, respectively (Figure 1). The large increase in leaf area is a response to shade to obtain more light or to optimize the light reception of each leaf, so that these weeds can grow well without experiencing the stress of lack of light.



Leaf Thickness

The adaptation mechanism for light deficiency through reducing leaf thickness is an effort made to be more efficient in using light energy for its development. The leaves become thin because there is a reduction in the palisade layer and leaf mesophyll cells. The reduction in leaf thickness of P. conjugatum was higher than that of B. Pilosa and C. Balsamona, namely 13.12, 5.12 and 7.04%, respectively (Figure 2).

These morphological and anatomical changes aim to increase light transmittance and reduce the amount of light transmitted.[7] Changes in leaf anatomy and morphology to become thinner and wider is an adaptation planted at low light intensity and vegetation under the canopy of trees in natural forests.[16]

Number of Stomata

One mechanism for adapting plants to lack of light is increasing the number of stomata per leaf blade. The results of the analysis of changes in the number of shaded stomata of the weed species showed an increase in the number of B. pilosa, P. conjugatum, and C. Balsamona stomata, respectively 15.91, 22.61, and 10.98% (Figure 2). The increasing number of stomata of the three types of weeds that were given shade was a form of relative change in the anatomical properties of the 3 types of weeds that were given 50% shade.

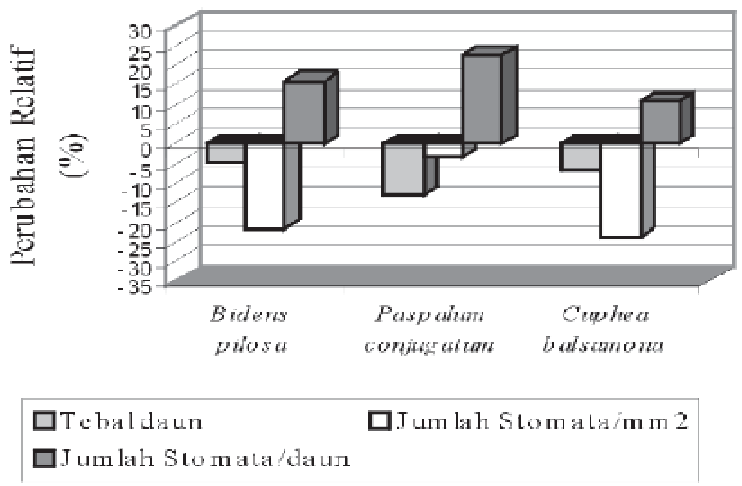


Figure 2: Relative changes in the anatomical traits of 3 weed species given 50% shade.

The amount of CMC had a significant effect on the texture of dragon fruit jam sliced (Figure 2). The best texture of dragon fruit jam sliced was given 2.0% CMC (C4), and the poor texture of dragon fruit jam sliced was given 0.5% CMC (C1). The increase in the value of the texture score is because the viscosity of the jam increases so that the resulting texture is more solid and thick. CMC functions as a stabilizer that is able to bind water, the higher the amount of CMC, the more supple and preferred by the panelists. This is consistent with the statement of,[17] which states that CMC which is hydrophilic will absorb water that was previously outside the granule and is free to move, cannot move freely anymore so that the solution is more stable and there is an increase in viscosity. The higher the number of CMC, the higher the viscosity of the solution.

CONCLUSION

It can be seen that both Biotic and Abiotic environments greatly affect the physiology or morphology of a plant, where the environment also plays a role in the growth of a plant. To get good plants and high production, the environment must also support as a condition for growing a plant.

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