Resistance of several wheat varieties grown at the medium altitude of East Lombok to leaf blight disease

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Abstract. Wheat is a subtropical plant that can only be cultivated in tropical highlands of Indonesia at an altitude of >800 m above sea level. When planted at a lower altitude, the wheat need to adapt to different climate conditions (the adaption getting a lot harder due to climate change issues), especially to the disease they will face in warmer conditions. The research aimed to determine the resistance of several wheat varieties grown at medium altitude to leaf blight disease had been conducted in East Lombok, Indonesia. The research applied a Randomized Completely Block Design (RCBD) with 12 wheat varieties, namely: Nias, Dewata, Axe, Gladius, Correll, Cobra, Espada, Scout, Mace, Sunstat, Janz, and Westonia. The incidence of natural infection of Bipolaris sorokiniana, the causal agent of leaf blight disease of wheat, was observed weekly. The wheat yield was also measured after harvest. The results showed that the highest average percentage of disease incidence (35.97%) was found in the Axe variety which is categorized as susceptible to leaf blight disease, while the lowest (11.37%) was found in the Janz variety which is categorized as resistant variety. The highest yield of wheat (3.16 ton/ha) was found in the Nias variety with the disease incidence of 13.21%, and the lowest (0.68 ton/ha) was found in the Cobra variety with the disease incidence of 20.96%.

1. Introduction

There was an increase in household needs for wheat-based food products in Indonesia [1], with almost all wheat to fulfill this needs is imported, mainly from Australia. The increasing demand for wheat poses a challenge to be able to produce large amounts of wheat so that it can reduce dependence on imports. In Indonesia, wheat has long been cultivated in several areas such as Pasuruan (East Java), Salatiga (Central Java), and Berastagi (North Sumatra). However, wheat production in these areas is still on a small scale, so it is unable to meet domestic demand for wheat [2].

Therefore, it is needed to find suitable areas to cultivate wheat. Wheat, which is a subtropical plant, can be grown in tropical highland of Indonesia, i.e. an altitude of > 800 m above sea level (asl) with temperatures of 10-28°C. But in the highlands, the availability of land for cultivation is very limited and also wheat crops will not be able to compete with high economic value crops such as horticulture [3]. Efforts had been made to find suitable areas for wheat development such as at medium altitude [4], and it is found that wheat can still be cultivated at the medium altitude of Indonesia [5].

However, when planted at a lower altitude, the wheat need to adapt to different climate conditions (the adaption getting a lot harder due to climate change issues), especially to the disease they will face on warmer conditions. In warmer conditions, foliar fungal diseases usually will increase and become more prevalence to plants [6]. One important fungal foliar disease is Helminthosporium leaf blight caused by Helminthosporium sp. syn. Bipolaris sorokiniana which can cause yield losses of about 20% at the farm level [7], and even higher loss of up to 80-90% in areas that have never been planted
with wheat [8]. Perian village is located in medium altitude of East Lombok Indonesia and has never been planted with wheat. In addition, the information on the response of wheat varieties to leaf blight disease is very limited; therefore, it important to know the resistance of wheat varieties to leaf blight disease when planted at the medium altitude.

2. Materials and methods
The experiments were conducted in the field and in the laboratory. This research was conducted from May to October 2018. Observations and sampling were carried out on the research area in Perian Village (8°34'31" S, 116°23'35" E with the altitude of 490 meter above sea level), Montong Gading Sub-district, East Lombok, Indonesia. Disease identification is carried out at the Microbiology Laboratory, Faculty of Agriculture, the University of Mataram.

This research applied a Randomized Completely Block Design (RCBD) with 12 wheat varieties, namely: Nias, Dewata, Axe, Gladius, Correll, Cobra, Espada, Scout, Mace, Sunstate, Janz, and Westonia. Each wheat variety was repeated 3 times, so that the experiment consists of 36 experimental units. Wheat seeds were planted in 4 rows of the prepared raised beds with the size of 1x3 m² each, with a population of 150 seeds in one row (a population of 600 plants per bed/plot).

Replanting was done when the plants were not growing well at the age of 14 days after planting. The seedlings used for replanting were the same variety of the plants that did not grow or die. Weeding is done every 2 weeks by removing weeds that grow around the planting area.

Fertilization is carried out twice, namely the first fertilization and subsequent fertilization. The first fertilization is carried out simultaneously at planting. The fertilizers used were NPK 90 g/plot, and Urea 30 g/plot. Subsequent fertilization was carried out at the age of 3 weeks after planting and 6 weeks after planting by using Urea at the rate of 30 g/plot. Irrigation is carried out 3 times, simultaneously at the time of applying fertilizers.

The observed variables include: (a) Pathogens that cause leaf blight of wheat, (b) Disease incidence and resistance of wheat to leaf blight, and (c) Wheat crop yields. Disease incidence is the percentage of plants attacked by pathogens of the total plants observed regardless of the severity of the disease. Disease incidence data were used to classify the resistance of each variety. The criteria for plant resistance to late blight are based on Puri et al. [9] and are grouped as in Table 1.

| Disease incidence | Category          |
|-------------------|-------------------|
| 0%                | Very resistant    |
| 1% - 15%          | Resistant         |
| 15.1% - 30%       | Moderately resistant |
| 30.1% - 50%       | Susceptible       |
| 50.1% - 100%      | Very susceptible  |

Harvesting is done when the wheat kernels are physiologically ripe, which is indicated by the hardening of the seeds. Harvesting is done by cutting the wheat stalks using a sickle and threshing the seeds. Measurement of wheat yield was carried out by weighing the seed weight in the sample plot measuring 0.5 m x 0.4 m in each treatment.

3. Result and discussion

3.1. The causal agent of wheat leaf blight
The results of field observations show that wheat plant leaves infected with pathogens that cause leaf blight show initial symptoms of small spots on the leaves and later this spots will widen and cause the leaves to become dry and brown. Symptoms caused by pathogens that cause leaf blight on wheat in the field are the same as those caused by the fungus Bipolaris sorokiniana. This is in accordance with the
results of research by Widodo [10] that *Helminthosporium* sp. (syn.) *B. sorokiniana* can attack the leaves and panicles of wheat. The affected leaves show brown symptoms that expand irregularly with yellowish edges with the advanced symptoms show the leaves become dry and brittle.

The identification in the laboratory also show that the pathogen that causes leaf blight in wheat plants isolated from the diseased part of the leaves is the fungus *B. sorokiniana* (see Fig 1). According to Barnett and Hunter [11], the colony of *B. sorokiniana* is brown with fibrous surface. The fungus has a single conidiophore, tall, upright, insulated, and conidia develop laterally from the pores under the septa.

![Figure 1](image)

**Figure 1.** Symptom of leaf blight (A), colony of *Bipolaris sorokiniana* at 7 days after isolation (B), conidiophore of *B. sorokiniana* (x40) (C), and conidia of *B. sorokiniana* (x40) (D).

### 3.2. Disease incidence and categories of wheat resistance to leaf blight

The Tukey test (HSD) at the 5% level showed that the Axe variety has the highest percentage (35.97%) which is significantly different from all other treatments. The Axe variety was categorized as susceptible to leaf blight (Table 2).

| Varieties | Disease incidence | Resistance category | Wheat yield (ton/ha) |
|-----------|-------------------|---------------------|----------------------|
| Nias      | 13.21 bc          | Resistant           | 3.16 a               |
| Dewata    | 12.97 bc          | Resistant           | 2.75 ab              |
| Mace      | 16.59 bc          | Moderately resistant| 2.62 ab              |
| Scout     | 17.66 bc          | Moderately resistant| 2.59 abc             |
| Janz      | 11.37 c           | Resistant           | 2.35 abc             |
| Gladius   | 18.00 bc          | Moderately resistant| 2.33 abc             |
| Sunstate  | 20.57 b           | Moderately resistant| 2.13 abc             |
| Espada    | 18.62 bc          | Moderately resistant| 2.05 abc             |
| Westonia  | 14.93 bc          | Resistant           | 1.88 bc              |
| Correll   | 20.72 b           | Moderately resistant| 1.67 bcd             |
| Axe       | 35.97 a           | Susceptible         | 1.45 cd              |
| Cobra     | 20.96 b           | Moderately resistant| 0.68 d               |
| HSD 5%    | 8.01              |                     | 1.13                 |

Note: Figures followed by the same letter within the same column are not significantly different according to HSD test at 5% significant level.

Table 1 showed that the 12 varieties of wheat used as treatments have different responses to the incidence of late blight. Leaf blight caused by *Bipolaris sorokiniana* is one of the main disease of wheat plants [12]. The percentage of disease incidents caused by this fungus in Axe variety is quite hight (35.97%). According to Widodo [10] this pathogen was also found in Cisarua and Kuningan,
West Java. The average disease incidence occurred in these areas to introduce wheat could reach 45.68% and 69.26%, respectively. During this time, the wheat fields in Kuningan are inundated by water which increases the humidity of the environment so that pathogens easily develop. The difference in response to disease incidence in several treatments was caused by differences in environmental conditions at the medium altitude where wheat was planted compared to their area of Origin (subtropical), in this case temperature and humidity, which caused the growth of wheat plants to be poor so that they were susceptible to pathogens that caused leaf blight. The temperature at the research location is around 28°C, where this condition is less than optimal for the growth and development of wheat. In addition, humidity also causes a difference in response to the incidence of leaf blight. The humidity at the study site is high (90-95%), which causes pathogens to develop properly and can trigger the occurrence of leaf blight in wheat plants.

The difference in the level of resistance that occurs in each treatment is caused by differences in the degree of adaptation of the wheat plant varieties to the environment. Of the ten introduced varieties used, the Axe variety is susceptible to leaf blight. The Axe variety is the shortest variety among all varieties used, both introduced and local varieties. The short size of this variety makes it easy for the fungus to infect the leaves, because the distance between the leaves and the ground (as the source of inoculum of Bipolaris sorokiniana) is not too far away, so that at any time if there is a splash of water, either from raindrops or conidial dew from a fungus that causes leaf blight to easily pass to the leaves. The highest incidence of shorter plants has also been reported by Fauzi and Paulitz [13].

The highest wheat yield (3.16 ton/ha) is produced by Nias variety and the lowest (0.68 ton/ha) is produced by Cobra. The high yield of Nias may resulted from the lower disease incidence of leaf blight disease and also due to the ability of this variety to adapt to the medium altitude of Indonesia, while the low yield of variety Cobra is mainly due to its incapability to adapt the medium altitude of Indonesia.

4. Conclusion
The highest average percentage of disease incidence (35.97%) was found in the Axe variety which is categorized as susceptible to leaf blight disease, while the lowest (11.37%) was found in the Janz variety which is categorized as resistant variety. The highest yield of wheat (3.16 ton/ha) was found in the Nias variety with the disease incidence of 13.21%, and the lowest (0.68 ton/ha) was found in the Cobra variety with the disease incidence of 20.96%. The results implied that when planted wheat varieties in warmer areas due to a lower altitude or due to the effect of climate changes, it is important to choose wheat varieties that have a good adaptation to the environmental conditions of medium altitude.

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