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Agronomy Performance and Resistance of Shallots against Fusarium Wilt Disease under Various Salicylic Acid Treatments

Keragaan Agronomi dan Ketahanan Penyakit Layu Fusarium Bawang Merah pada Berbagai Perlakuan Asam Salisilat

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ABSTRACT

This study was conducted to determine the agronomic performance and resistance of shallots to fusarium wilt disease under various salicylic acid treatments. The research was conducted at the Greenhouse, Faculty of Agriculture, UGM using RAL experimental design with a one-factor, namely salicylic acid treatments (0 ppm, 15 ppm, 20 ppm, and 25 ppm). Each experiment was repeated 3 replications. Each treatment was grown on media that had been incubated with Fusarium acutatum inoculum, while control plants were grown on media without F. acutatum inoculum. The materials used in this experiment were shallot bulbs of Tajuk variety, synthetic salicylic acid, and Fusarium acutatum inoculum. Variables observed included plant height, number of leaves, fresh tuber weight, incubation period, and disease incidence. The data collected was then analyzed by analysis of variance (ANOVA) with a significance level of 95%, then the DMRT test (95%) was carried out to determine the difference in influence between treatments. Statistical test results showed that salicylic acid treatment had a significant effect on the character of plant height, fresh weight, and disease incidence, while the character of the number of leaves and incubation period of salicylic acid had no significant effect. Salicylic acid treatment at a concentration of 15 ppm showed the the highest plant height (34,26 cm), the highest number of leaves (24,46 strands), the highest fresh tuber weight (6,30 g), and the least disease incidence (14,55%).

Keywords: *Concentration of salicylic acid, Fusarium acutatum, incidence of disease, Tajuk variety*

ABSTRAK

Penelitian ini dilakukan untuk mengetahui keragaan agronomi dan ketahanan bawang merah terhadap penyakit layu fusarium pada berbagai perlakukan asam salisilat. Penelitian dilaksanakan di *Greenhouse*, Fakultas Pertanian UGM dengan rancangan percobaan RAL satu faktor, yaitu perlakuan asam salisilat (0 ppm, 15 ppm, 20 ppm, dan 25 ppm). Setiap percobaan diulang sebanyak 3 ulangan. Setiap perlakuan ditanam pada media yang sudah diinkubasi dengan inokulum *Fusarium acutatum*, sementara tanaman kontrol ditanam pada media tanpa inokulum *F.acutatum.* Adapun bahan yang digunakan pada percobaan ini berupa umbi bawang merah varietas Tajuk, asam salisilat sintetik, inokulum *Fusarium acutatum.* Variabel yang diamati meliputi tinggi tanaman, jumlah daun, bobot umbi segar, periode inkubasi, dan insidensi penyakit. Data yang terkumpul selanjutnya dianalisis dengan *analysis of variance* (ANOVA) taraf nyata 95%, selanjutnya dilakukan uji DMRT (95%) untuk mengetahui perbedaan pengaruh antar antar perlakuan. Hasil uji statistik menunjukkan bahwa perlakuan asam salisilat memberi pengaruh nyata pada karakter tinggi tanaman, bobot segar, dan insidensi penyakit, sedangkan pada karakter jumlah daun dan periode inkubasi asam salisilat tidak berpengaruh nyata.

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Perlakuan asam salisilat pada konsentrasi 15 ppm menunjukkan tinggi tanaman tertinggi (34,26 cm), jumlah daun terbanyak (24,46 helai), bobot umbi segar tertinggi (6,30 g), serta insidensi penyakit paling sedikit (14,55%).

Kata kunci: Konsentrasi asam salisilat, *Fusarium acutatum*, insidensi penyakit, varietas Tajuk

INTRODUCTION

Fusarium wilt disease or often called moler disease is one of the main diseases that attack onion crops. The results of research conducted by Lestiyani (2015) showed that based on the results of molecular identification associated with pathogenicity, it showed that this Fusarium wilt disease was caused by *Fusarium acutatum* and *Fusarium solani*.

Fusarium wilt disease is characterized by pale green or yellow leaves, the leaves grow longer and twist (twisted) (Lestiyani, 2015). Fadhilah, 2014 added, the symptoms of fusarium wilt disease include; root growth is disturbed and even rots so that the plant is easily uprooted, the tuber size of diseased plants is relatively smaller and less than that of healthy plants, and the base of the tuber has white fungus. Some of the efforts made include increasing the resistance of shallot plants with exogenous inducers, such as salicylic acid.

Salicylic acid is a compound that acts as a signal transduction molecule in the mechanism of plant resistance (Vlot et al., 2009). This is indicated by the accumulation of salicylic acid in the phloem tissue after pathogen infection. The accumulation of salicylic acid in plant parts infected with pathogens is a signal for plants which are then transduced to other uninfected plant parts and will activate pathogenesis-related genes (Ryals et al., 1996). In addition to plant resistance, another role of salicylic acid is as a growth hormone that can regulate plant growth, especially physiological activities such as photosynthesis, respiration, flowering, and germination (Vicente & Plasencia, 2011). So many roles of salicylic acid in plants that many researchers use salicylic acid as an exogenous inducer.

The success of the application of salicylic acid to increase plant disease resistance has been widely reported. In tomato plants, exogenous salicylic acid applied by spraying on the leaves can increase resistance and reduce the intensity of attack by Fusarium oxysporum f.sp lycopersici (Ojha & Chatterjee, 2012). Likewise for date seedlings, spraying salicylic acid can inhibit the growth and distribution of Fusarium on date palm roots, as well as increase the activity of enzymes related to resistance such as peroxidase, synthesized ammonia lyase (PAL) (Dihazi et al., 2011). In vitro, the application of salicylic acid can increase the resistance status of Bima Brebes cultivar from susceptible to moderate (Juwanda et al., 2016). In shallot callus, salicylic acid can reduce the percentage of dead callus after being tested for resistance with fusaric acid and increase callus regeneration into plantlets (Khotimah et al., 2017).

The application of exogenous salicylic acid as growth regulation has been widely reported, such as in garlic (Bideshki & Arvin, 2011), orchids (Sulistiana & Sukma, 2012), and Brasica species (Muhal et al., 2014). Thus the application of exogenous salicylic acid is quite effective in growth and induces disease resistance in some plants. From the explanation above, it is hoped that salicylic acid can be used to improve agronomic characters and induce onion resistance as an effort to increase resistance to fusairum wilt disease. This study was conducted to determine the agronomic performance and resistance of shallots to fusarium wilt disease under various salicylic acid treatments.

METHOD

The research was conducted from December 2015 to February 2016 at the Greenhouse, Faculty of Agriculture, UGM. The experimental design used was a completely randomized design with a single

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factor, namely the concentration of salicylic acid. The salicylic acid treatments used included 0 ppm, 15 ppm, 20 ppm and 25 ppm where each treatment was inoculated with inoculum *of Fusarium acutatum*. Treatment of 0 ppm as a positive comparison (positive control) was inoculated with inoculum *of Fusarium acutatum*, while for negative comparison (negative control) it was not inoculated with inoculum *of Fusarium acutatum*.

The materials used were shallot bulbs of the Tajuk variety, synthetic salicylic acid, pure isolate of the fungus *Fusarium acutatum*, a mixture of soil and compost planting media (1:1), NPK fertilizer and other supporting materials.

Data from the results of the study were analyzed by analysis of variance (ANOVA) at a 95% significance level, then Duncan Multiple Range Test (DMRT) was conducted to determine the effect of differences between treatments.

Research methods include: 1) Preparation of planting media and inoculation; The planting medium used is a mixture of soil and compost (1:1). The planting media mixture was sterilized for 2 hours. Furthermore, the planting media mixture was put into polybags (20 x 30 cm) and inoculated with inoculum *of Fusarium acutatum* 1 week before planting by watering the growing media with 5 ml polybag-1 suspension of *Fusarium acutatum* (density 10^6 conidia ml^{-1} distilled water) (Lestiyani , 2015). 2) Salicylic acid treatment; much as bulb shallot 100 g with an average size of 5 g were soaked in 200 ml of salicylic acid solution with the appropriate concentration of treatment for 30 minutes. For comparison, the shallot bulbs were soaked in distilled water. Furthermore, the soaked tubers are dried for 30 minutes before planting. 3) Planting and maintenance; Shallot bulbs were planted 1 bulb/polybag in a mixture of growing media that had been inoculated with F.acutatum. Then do watering every day or adjust to conditions.

The variables observed were plant height, number of leaves, fresh tuber weight, incubation period and disease incidence. Variable incidence of disease (IP) using the formula = $\frac{\text{Number of symptomatic plants}}{\text{Number of all plants}}$ x 100%

RESULTS AND DISCUSSION

The application of salicylic acid can be done by contact (directly) such as spraying, soaking, or watering and indirectly by adding it to in vitro culture media. In this study, the application of salicylic acid was carried out by soaking the onion bulbs before planting in the planting medium. This immersion is intended to cause the accumulation of salicylic acid in the onion bulb tissue to activate the plant resistance system.

The agronomic performance in this study was indicated by plant height, number of leaves, and weight of fresh bulbs. The results of the analysis of variance showed that there was a significant difference between the control (0 ppm) and salicylic acid treatment at all concentrations (15, 20, and 25 ppm) for the character of plant height and weight of fresh bulbs, while for the number of leaves there was no difference between the treatment and control.

Table 1. Plant height in the treatment of salicylic acid concentration at 4 weeks after planting (MST)

Salicylic acid concentration	Agronomic character		
	Plant height (cm)	Number of leaves (leaf blade)	Fresh bulbs weight (g)
0 ppm	29,68 b	25,65 a	2,99 b
15 ppm	34,26 a	24,46 ab	6,30 a
20 ppm	32,81 a	23,81 ab	6,16 a
25 ppm	33,56 a	22,36 abc	6,22 a

Note: Numbers with the same letter in the same column and row show no significant difference based on the results of the DMRT test at a 95% significance level

The application of salicylic acid at concentrations of 15, 20, and 25 ppm

showed a significantly better effect on plant height characters than controls under biotic stress conditions. Plant height in salicylic acid treatment ranged from 32.81 - 34.26 cm, while plant height without salicylic acid treatment only reached 26.72 cm.

Plants that were given salicylic acid at all concentrations produced significantly higher fresh bulb weights than controls. The weight of fresh bulbs in plants treated with salicylic acid at concentrations of 15, 20, and 25 ppm ranged from 6.16 to 6.30 g, while the weight of fresh bulbs of plants without salicylic acid treatment was only 2.99 g. The highest fresh bulbs weight was found in the 15 ppm treatment, which was 6.30 g. It is suspected that salicylic acid affects the generative growth process of the tested shallots. Although the plants were grown under biotic stress conditions in the form of fusarium fungus infection, plants treated with salicylic acid were able to produce shallot bulbs and the yields obtained were relatively higher than plants without salicylic acid treatment (0 ppm).

In this study, salicylic acid treatment did not affect the number of leaves (Table 1). Control plants (without salicylic acid treatment) showed a higher number of leaves, namely 25.65 strands, but the number of leaves in the salicylic acid treatment was less and the number of leaves decreased with the addition of the concentration of salicylic acid given, which ranged from 22.36. – 24.46 strands.

Fusarium fungi enter through the cortex, endodermis, and vascular stele. The invasion of pathogens causes massive damage to the xylem and phloem cells. As a result, the absorption of water and mineral nutrients is disrupted, so that it can inhibit plant growth and development (Dihazi et al., 2011). The results showed that plants treated with salicylic acid showed a better phenotypic appearance even though they were infected with the Fusarium fungus. Treatment of salicylic acid on shallot plants can increase plant height, and increase the weight of fresh bulbs. These results are consistent with those reported by Bideshki & Arvin (2011) which showed that the application of exogenous salicylic acid could increase plant height (13%), increase the number of leaves (24%), increase plant fresh tuber weight (50%), and increase yields. tubers (48%) in garlic plants under drought stress.

Table 2. Incubation period and disease incidence in treatment with salicylic acid concentration at 4 weeks after planting (MST)

Salicylic acid concentration	Disease components	
	Incubation period (days)	Disease incidence (%)
Negative control	28,00 ab	10,00 c
Positive control	28,00 ab	75,00 a
15 ppm	27,75 ab	14,55 b
20 ppm	28,67 b	23,75 b
25 ppm	27,25 ab	22,50 b

Note: Numbers with the same letter in the same column and row show no significant difference based on the results of the DMRT test at a 95% significance level

In relation to plant resistance, the effect of salicylic acid treatment was indicated by the time of appearance of disease symptoms (incubation period) and disease incidence. Treatment of salicylic acid on onion bulbs can prolong the incubation period of fusarium wilt disease. In this study, salicylic acid treatment had a significant effect on disease incidence, but had no significant effect on the disease period after being inoculated with fusarium fungus (positive control). On average, plants showed early symptoms of disease at the age of 27.93 days after inoculation. The time for the appearance of disease symptoms from the results of this observation is quite long, usually symptoms of the disease will appear more quickly about 14 days (Lestiyani, 2015). It is suspected that the Thai variety is classified as a resistant variety to fusarium wilt disease.

The incidence of disease in plants treated with salicylic acid at concentrations of 15, 20 and 25 ppm was significantly

lower, ranging from 32.41% to 40.39%, compared to controls after being inoculated with *F. acutatum*. Control plants (positive control) showed the highest disease incidence of 75%. In this study, plants without resistance induction treatment and not inoculated with Fusarium fungus (negative control) also showed symptoms of the disease, although the incidence of disease was relatively low, which was only 10% (Table 2). It is suspected that Fusarium fungus is present in the shallot seeds used in this study. Agrios (2005) stated that *Fusarium* spp. is a soil-borne fungus that can spread through water, air, and seeds.

The application of exogenous salicylic acid compounds in shallots serves as an inducer of disease resistance which plays an important role in induced systemic resistance. Induction of resistance is intended to improve plant conditions so that they have resistance to certain diseases (Agrios, 2005). Salicylic acid treatment on shallot plants was able to increase the resistance of shallot plants by reducing the incidence of disease attacks. As reported by Faradilla (2011) that induction with salicylic acid can reduce the attack rate of *Fusarium oxysporum* f.sp *cubense* on banana plants as a result of in vitro selection. Thus, salicylic acid can be used to improve agronomic character and resistance to fusarium wilt in shallots.

CONCLUSION

The application of salicylic acid had a significant effect on the character of plant height, fresh tuber weight, and disease incidence, while the number of leaves and incubation period had no significant effect.

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