# Woro-10. SALICYLIC ACID EFFECTIVENESS AS RESISTANCE INDUCER OF RICE

*by* 10. Salicylic Acid Effectiveness As Resistance Ind Woro

**Submission date:** 27-Feb-2023 02:36PM (UTC+0700)
**Submission ID:** 2024131009
**File name:** ._SALICYLIC_ACID_EFFECTIVENESS_AS_RESISTANCE_INDUCER_OF_RICE.pdf (792.21K)
**Word count:** 4155
**Character count:** 22547

Jurnal Pertanian Agros Vol. 25 No.1, Januari 2023: 614 - 623

# SALICYLIC ACID EFFECTIVENESS AS RESISTANCE INDUCER OF RICE PLANT AGAINST SHEATH BLIGHT PATHOGEN

## *EFEKTIVITAS ASAM SALISILAT SEBAGAI PENGINDUKSI RESISTENSI TANAMAN PADI TERHADAP PATOGEN SHEATH BLIGHT*

**Woro Sri Suharti[1], Feby Laelia Nur Hibah, Wiyantono)**
***Agrotechnology Study Program, Agricultural Faculty, Universitas Jenderal Soedirman***

***ABSTRACT***

*This study aims to determine the effectiveness of salicylic acid in inhibiting the growth of Rhizoctonia solani in vitro and to determine the effect of salicylic acid in increasing rice plants' resistance to rice sheath blight disease. In the in vitro research stage, the antifungal activity of salicylic acid was assayed with 5 levels of concentration. The observed variable was the percentage of R. solani mycelium growth inhibition. The next stage of research was carried out in planta. The observed variables in the resistance assay were the pathosystem, growth, morphological, and physiological components. Based on the observed variables of pathosystem components, salicylic acid can reduce the intensity of rice sheath blight both on an in vitro and in planta. Based on observations of morphological and physiological components, the salicylic acid was able to increase plant resistance by thickening of the leaf epidermis and increase the phenolic compounds.*

*Keywords: induction of resistance, salicylic acid, rice sheath blight, rice plant*

**INTISARI**

Penelitian ini bertujuan untuk mengetahui efektivitas asam salisilat dalam menghambat pertumbuhan Rhizoctonia solani secara in vitro dan mengetahui pengaruh asam salisilat dalam meningkatkan ketahanan tanaman padi terhadap penyakit hawar pelepah padi. Pada tahap penelitian in vitro, aktivitas antijamur asam salisilat diuji dengan 5 tingkat konsentrasi. Variabel yang diamati adalah persentase penghambatan pertumbuhan miselium R. solani. Tahap penelitian selanjutnya dilakukan in planta. Variabel yang diamati dalam uji resistensi adalah komponen patosistem, pertumbuhan, morfologi, dan fisiologis. Berdasarkan variabel komponen patosistem yang diamati, asam salisilat dapat menurunkan intensitas penyakit hawar pelepah padi baik secara in vitro maupun in planta. Berdasarkan pengamatan komponen morfologi dan fisiologis, asam salisilat mampu meningkatkan ketahanan tanaman dengan cara menebalkan epidermis daun dan meningkatkan senyawa fenolik.

Kata kunci: induksi ketahanan, asam salisilat, penyakit hawar pelepah padi, tanaman padi

## INTRODUCTION

Rice sheath blight disease is one of plant disease which reduce the production about 50-80%. The disease is caused by the soil-borne fungus *Rhizoctonia solani*. The fungal infections cause damage in the rice plant at any stages. The infection develops and expand to the stem part causes plant rot (Inagaki, 2001). Inoculum of *R. solani* can survive in the soil for several years (Ritchie et al., 2013). Various controls were carried out, including biological control with vegetable fungicides, synthetic fungicides, and resistant varieties. But all of them have their own advantages and disadvantages.

The control effort of rice sheath blight disease can be conducted by the induction of plant resistance using chemical compounds such as salicylic acid (Leiwakabessy et al., 2017). It is

[1] Corresponding author: Woro Sri Suharti. E-mail: woro.suharti@unsoed.ac.id

**e-ISSN 2528-1488, p-ISSN 1411-0172**

further stated that salicylic acid is an intermediate compound in plants as a physiological and morphological response during infection by pathogens. Salicylic acid can accelerate the activation of resistance signals to produce various hormones for suppressing the rate of infection. Based on this, the research was conducted to induce the resistance of rice plants to sheath blight disease using salicylic acid with the aim 1) determine the effectiveness of salicylic acid in suppressing the growth of *R. solani* in vitro, 2) determine the effect of salicylic acid application in the resistance induction of rice plants to *R. solani*.

## RESEARCH METHOD

This research was carried out at the Plant Protection Laboratory and Greenhouse, Faculty of Agriculture, Universitas Jenderal Soedirman from September to February 2021. The experimental design used was a Completely Randomized Design for the antifungal activity assay of salicylic acid in vitro and a Randomized Block Design for plant resistance assay in planta with 5 types salicylic acid concentration (0, 5 mM, 10 mM, 15 mM, 20 mM). Each treatment was repeated 5 times. The data obtained were analysed by the F test and continued with the Duncan Multiple Range Test (DMRT).

The isolate of *R. solani* from the exploration was used to the antifungal activity assay of salicylic acid in vitro. The antifungal activity of salicylic acid against *R. solani* was carried out by adding salicylic acid of various concentrations to 1 ml of potato dextrose agar (PDA) media and then inoculated by *R. solani*. The percentage of *R. solani* mycelia growth inhibition was calculated after 7 days with the formula according to El-Garhy *et al.* (2020).

$$\text{Percentage of the fungal colony inhibition} = \frac{\Delta d0 - \Delta d}{\Delta d0} \; x \; 100\%$$

Δd0 : The average of fungal colony diameter in control treatment,
Δd : The average of fungal colony diameter in treatment

The in planta induce resistance examination was carried out on rice plants of the IR-64 variety. IR-64 seeds were soaked in water for 1x24 hours and then sown in a nursery tray. After the nursery was 21 days old, the plants were transferred to a 0.3 m polybag filled with 9.6 kg of soil. Plants were watered regularly and fertilized with NPK fertilizer at 14 and 21 days.

The application of salicylic acid was carried out when the rice plants entered the early vegetative state (6 week after planting). Salicylic acid solution was prepared by dissolving powdered salicylic acid (C7H6O3) with 70% alcohol (Leiwakabessy et al., 2017). This solution will become a stock solution. The stock solution was diluted into salicylic acid concentrations as follows: 0 mM, 5 mM, 10 mM, 15 mM, and 20 mM.

The application of salicylic acid was carried out by spraying salicylic acid solution on the leaves to the base of the stem as much as 10 ml for each test plant. Inoculation of *R. solani* was carried out after 3 days of salicylic acid being applied to rice plants according to Wasano et al. (1983).

The observed variables were included growth components, pathosystems, morphology, and physiology. Pathosystem components consist of incubation period, disease intensity and Area Under Disease Progress Curve (AUDPC). Measurement of disease intensity was determined by the standard formula for evaluation of the International Rice Testing Program (IRTP, 1988):

$$\text{Disease intensity of RSB} = \frac{4N4 + 3N3 + 2N2 + 1N1 + 0N0}{4N} \text{ x } 100\%$$

N4 = Number of tillers with a score of 7,
N3 = Number of tillers with a score of 5,
N2 = Number of tillers with a score of 3,
N1 = Number of tillers with a score of 1,
N0 = Number of tillers with a score of 0,
N = Total Number (N4 + N3 + N2 + N1 + N0).

The intensity of the disease observation used as the basic for calculating the Area Under Disease Progress Curve (AUDPC). According to Jeger & Rollinson (2001), AUDPC can be calculated by the formula as follows:

$$AUDPC = \sum_{n}^{i} \left(\frac{y+y_{i+1}}{2}\right) t_{i+1} - t_i$$

y : disease percentage at the time, t : days

The morphological component variables consisted of measuring the thickness of the leaf epidermis and calculating the stomatal density. The thickness calculation uses the formula according to Dewi et al. (2013).

$$TK = TKM \times K$$

TK : Thickness of cuticle and epidermis,
TKM : Thickness of cuticle and epidermis in micrometer,
K : Calibration (1mm = 0.0025 m)

Meanwhile, the observation of stomatal density was calculated using the following formula (Dama et al., 2020).

$$\text{Stomata density} = \frac{\text{number of stomata}}{\text{unit area of view}}$$

The physiological components observed consisted of a qualitative test of saponins and tannins, and a quantitative test of total phenol content and salicylic acid levels. The content of saponins and tannins was observed qualitatively. The saponin test was carried out according to Minarno et al. (2016). The tannin test was carried out according to Mainawati et al. (2017). The total phenol content test was carried out using the Follin-Ciocalteu method using a spectrophotometer at a wavelength of 725 nm according to Hapsari et al. (2018) is calculated by the formula:

$$\text{Total phenol} = \frac{x.V.FP}{BS}$$

Note: x : Concentration ppm,
V : Volume of extract solution (ml),
FP : Dilution factor of sample solution,
BS : Weight of extract (g)

The salicylic acid content test was carried out using the alkalimetric method according to Safitri (2017). Calculation of the percentage of salicylic acid using the following equation (Rambe, 2018):

$$\text{Salicylic acid (mg)} = \frac{V \times N}{0,1} \times 13,81$$

$$\% \text{ Salicylic acid} = \frac{Salicylic\ acid\ content\ (g)}{100\ g} \times 100\%$$

## RESULT AND DISCUSSION

### The antifungal activity of salicylic acid in vitro

In vitro antifungal activity assay showed that salicylic acid treatment with various concentrations (5 mM, 10 mM, 15 mM, and 20 mM) significantly affected the inhibition of *R. solani* mycelia (Table 1). The percentage of inhibition increased in accordance with the concentration of salicylic acid. According to Mondol et al. (2020), the application of salicylic acid (1-25 mM concentration) in PDA media was able to inhibit the mycelia growth of all types of pathogenic fungi. Salicylic acid has antifungal properties cause damage to the integrity and function of cell membranes, disrupt mitochondrial performance, and cell death. Furthermore, the growth of pathogenic fungal mycelia is inhibited (Kong et al., 2021).

Table 1. Percentage of inhibition of growth of pathogenic *R. solani* by salicylic acid in vitro

| Salicylic acid concentration | Inhibition percentage (%) |
|---|---|
| Salicylic acid 5 Mm | 0,02a |
| Salicylic acid 10 Mm | 0,08ab |
| Salicylic acid 15 mM | 0,17b |
| Salicylic acid 20 mM | 0,37c |

Note: Numbers followed by the same letter in the same column show no significant difference according to DMRT at an error level of 5%.

Table 2. Incubation period of rice sheath blight in salicylic acid treatment.

| Treatment | Disease Incubation period (days after inoculation) |
|---|---|
| Control | 6,60a |
| Salicylic acid 5 mM | 6,80ab |
| Salicylic acid 10 mM | 7,40b |
| Salicylic acid 15 mM | 7,00ab |
| Salicylic acid 20 mM | 6,60a |

Note: Numbers followed by the same letter in the same column show no significant difference according to DMRT at an error level of 5%.

**The resistance examination of plants infected with *R. solani* with salicylic acid**

**Pathosystem component**

The incubation period for rice sheath blight with various concentrations of salicylic acid shows longer than the control treatment (Table 2). This phenomenon is in line with the research conducted by Luo et al. (2012). Salicylic acid can induce plants through signalling and elicitation pathways. Resistance induction through salicylic acid signalling pathway expresses resistance genes on the cell wall, while the elicitor pathway can accelerate the necrosis response and mechanical damage. Furthermore, it prevents the pathogens infecting plants and reducing the incubation period of the disease (Nawangsih et al., 2014).

Salicylic acid concentrations of 15 mM and 20 mM had no significant effect on plant resistance compared to salicylic acid concentrations of 5 mM and 10 mM (Table 3). This is presumably because the high concentration of salicylic acid cannot give a significant effect in suppressing plant diseases. This statement is in line with the research results of Sillero et al. (2012) on faba beans (*Vicia faba* L.) infected with rust and Aschochyta blight pathogens. It is possible that high concentrations of salicylic acid have no effect on suppressing the intensity of the disease because it can cause phytotoxicity. This is consistent with the generalization of Sillero et al. (2012). Barilli et al. (2010) added that salicylic acid concentration >10 mM can cause phototoxicity symptoms and does not increase the systemic resistance of legumes to leaf rust.

A good concentration of salicylic acid to increase plant resistance to a disease based on a number of studies is in the range of 2-10 mM, according to research conducted on potato plants infected with Rhizoctonia solani Hadi & Balali (2010), citrus fruits infected with *Penicillium digitatum* Sacc. and *P. italicum* (Iqbal et al., 2012), and tomato plants infected with wilt-causing pathogens (Jabnoun-Khiareddine et al., 2015).

Table 3. Intensity of rice sheath blight on salicylic acid treatment.

| Treatmen | Disease Intensity (%) | | | | |
|---|---|---|---|---|---|
| | 5 dai | 10 dai | 15 dai | 20 dai | 25 dai |
| Control | 0,21b | 0,27c | 0,33c | 0,40c | 0,45c |
| Salicylic acid 5 mM | 0,16a | 0,21ab | 0,29bc | 0,33b | 0,37ab |
| Salicylic acid 10 mM | 0,14a | 0,18a | 0,22a | 0,28a | 0,32a |
| Salicylic acid 15 mM | 0,14a | 0,20ab | 0,25ab | 0,29ab | 0,32ab |
| Salicylic acid 20 mM | 0,16a | 0,21b | 0,28b | 0,33b | 0,38b |

Note: Numbers followed by the same letter in the same column show no significant difference according to DMRT at an error level of 5%.

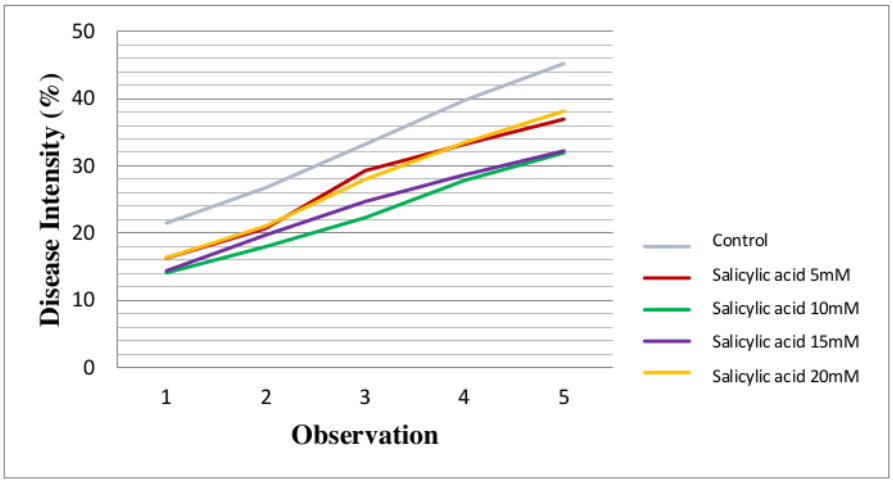


Figure 1. AUDPC of leaf sheath blight

The Area Under Disease Progress Curve (AUDPC) shows that the highest AUDPC value is in the control treatment and the lowest is in the 10 mM salicylic acid treatment. This is in accordance with the results of research by Leiwakabessy et al. (2017) that 10 mM concentration of salicylic acid in Ciherang variety produced the lowest AUDPC value against bacterial leaf blight (BLB) pathotype VIII.

**Morphology Component**

The salicylic acid treatment on the thickness of the upper and lower epidermis showed a significantly different response between treatments (Table 4). The results obtained that the largest leaf epidermis thickness was found in the 15 mM concentration of salicylic acid treatment.

Nurcahyani & Lindawati (2014) stated that salicylic acid can accelerate plant resistance signals in forming anatomical resistance, such as thickening of the epidermis, as a structural resistance response to pathogen infection. In contrast to the results of the analysis of leaf epidermal thickness, the results of the analysis of stomatal density variance showed that it was not significantly different from the control (Table 4). This is presumably because stomata density does

not affect plant resistance to disease, but as a way of entry for pathogens to infect plants. This is in accordance with research conducted by Hasanah & Sembiring (2018).

**Physiology component**

The results of the qualitative test showed that the administration of salicylic acid influenced the levels of saponins and tannins in rice plants (Table 5). This is indicated by the formation of foam in the saponin test and brown colour in the tannin test (Figure 2). The saponin test on the salicylic acid treatment with concentrations of 10 mM, 15 mM, and 20 mM had foam with the same thickness but thicker than the treatment with 5 mM concentration of salicylic acid and control. These results are in accordance with the research of Jirakiattikul et al. (2021) that the application of salicylic acid can increase the saponin content in plants.

In a qualitative test to determine the tannin content, it was found that the highest tannin content was found in the 10 mM concentration of salicylic acid treatment with a darker brown colour than the other treatments, while the lowest tannin content was found in the control test solution which had a light brown colour. Godghate & Gogle (2018) stated that salicylic acid affects the tannin content in plants.

Table 4. Leaf epidermis thickness and stomata density

| Treatment | Leaf epidermis thickness ($\mu$m) | | Stomata density (sel/mm$^2$) |
|---|---|---|---|
| | Adaxial | Abaxial | |
| Control | 20,86a | 41,14a | 16,46a |
| Salicylic acid 5 mM | 31,05ab | 51,43ab | 15,91a |
| Salicylic acid 10 mM | 26,29ab | 46,19ab | 14,77a |
| Salicylic acid 15 mM | 32,38b | 59,33b | 14,60a |
| Salicylic acid 20 mM | 25,33ab | 48,19ab | 16,54a |

Note: Numbers followed by the same letter in the same column show no significant difference according to DMRT at an error level of 5%.

Table 5. Qualitative test for saponin and tannin levels on rice plants treated by salicylic acid

| Treatment | Saponin | Tanin |
|---|---|---|
| Control | + | + |
| Salicylic acid 5 mM | + | + |
| Salicylic acid 10 mM | ++ | +++ |
| Salicylic acid 15 mM | ++ | ++ |
| Salicylic acid 20 mM | ++ | ++ |

Note: The + sign in the saponin test means foaming, ++ thick foaming, and +++ very thick foaming. The + sign in the tannin test means brown, ++ dark brown, and +++ blackish brown.

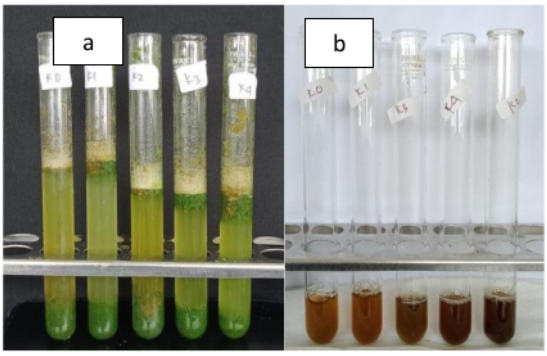


Figure 2. The results of the qualitative test of saponin (a) and tannin (b) levels on rice plants.

Table 7. Total phenol content on rice plants treated by salicylic acid

| Treatment | Total Phenol (mg GAE/g sample) |
|---|---|
| Control | 123,04 |
| Salicylic acid 5 mM | 76,67 |
| Salicylic acid 10 mM | 112,89 |
| Salicylic acid 15 mM | 163,62 |
| Salicylic acid 20 mM | 194,06 |

The quantitative test to determine the total phenol content (Table 7) showed that 5 mM and 10 mM salicylic acid treatment could not increase the phenol content in rice plants, while the 15 mM and 20 mM salicylic acid treatments were able to increase the phenol content of rice plants when compared to the control treatment. The increase in total phenol levels in the 15 mM and 20 mM salicylic acid treatment was in accordance with Ali's (2020) statement that exogenous application of salicylic acid was able to increase the activity and gene expression of the phenylalanine ammonia-lyase (PAL) enzyme. The increased activity of these enzymes causes the accumulation of phenolics. Preciado-Rangel et al. (2019) adds that the higher the concentration of salicylic acid, the higher the total phenol content, but the response of plants to various concentrations of salicylic acid is different due to the influence of plant species, application method, and environmental conditions.

The content of salicylic acid in rice plants (Table 9) shows that salicylic acid treatment with concentrations of 5 mM, 10 mM, 15 Mm, and 20 mM had an effect on increasing levels of salicylic acid in rice plants when compared to the control treatment. The content of salicylic acid increases as the concentration of salicylic acid increases. According to Tajik et al. (2019), exogenous application of salicylic acid can increase the content of phenolic compounds such as jasmonic acid and salicylic acid. Endogenous salicylic acid increases with increasing concentration of salicylic acid given. Khan et al. (2015) added that spraying salicylic acid on leaves plays a role in regulating biochemical and physiological processes that can increase the accumulation of secondary metabolites, especially phenolic compounds such as salicylic acid.

Table 9. Salicylic acid levels in rice plants

| Treatment | Salicylic acid content (mg) | Percentage of salicylic acid content (b/b) |
|---|---|---|
| Control | 8,286 | 8% |
| Salicylic acid 5 mM | 15,191 | 15% |
| Salicylic acid 10 mM | 15,8815 | 16% |
| Salicylic acid 15 mM | 16,572 | 17% |
| Salicylic acid 20 mM | 17,953 | 18% |

## CONCLUSION

The conclusions obtained from this research are as follows:

1. Salicylic acid is effective in suppressing the growth of *R. solani* in vitro.
2. Application of salicylic acid affects the components of the pathosystem and can increase the resistance of rice plants morphologically and physiologically.

## ACKNOWLEDGMENT

Sincere gratitude to LPPM Unsoed for providing research funds through Competency Scheme 2020.

## REFERENCES

Ali B. 2020. Salicylic acid: an efficient elicitor of secondary metabolite production in plants. *Biocatalysis and Agricultural Biotechnology*.101884 : 1-32.

Barilli E., J. C. Sillero & D. Rubiales. 2010. Induction of systemic acquired resistance in pea against rust (*Uromyces pisi*) by exogenous application of biotic and abiotic inducers. *Journal of phytopathology*. 158(1) : 30-34.

Dama H., S.I. Aisyah, A.K. Dewi & S. Sudarsono. 2020. respon kerapatan stomata dan kandungan klorofil padi (*Oryza sativa* L.) mutan terhadap toleransi kekeringan. *Jurnal Ilmiah Aplikasi Isotop dan Radiasi*. 16(1) : 1-6.

Dewi, I. M., Cholil, A., & Muhibuddin, A. 2013. Hubungan karakteristik jaringan daun dengan tingkat serangan penyakit blas daun (*Pyricularia Oryzae* Cav.) pada beberapa genotipe padi (*Oryza Sativa* L.). *Jurnal Hama dan Penyakit Tumbuhan*. 1(2) : 10-18.

El-Garhy, H.A.S., Rahman, F.A.A., Shams, A.S., Osman, G.H., & Moustafa, M.M.A. 2020. Comparative analysis of four chemicals used to control black mold disease in tomato and its effects on defense signaling pathways, productivity and quality traits. *Plant*. 9 (808) : 1-20.

Godghate, S., & Gogle, D. 2018. The effect of foliar application of salycylic acid on growth and secondary metabolites production of *Biophytum sensitivum* L. *Advance and Innovative Research*. 5(3) : 67.

Hadi, M. R., & Balali, G. R. 2010. The effect of salicylic acid on the reduction of Rhizoctonia solani damage in the tubers of marfona potato cultivar. *American-Eurasian Journal of Agricultural and Environmental Sciences*. 7(4) : 492-496.

Hapsari, A. M., Masfria, M., & Dalimunthe, A. 2018. Pengujian kandungan total fenol ekstrak

etanol tempuyung (*Shoncus arvensis* L.). *Tropical Medicine*. 1(1) : 284-290.

Hasanah, Y., & Sembiring, M. 2018. Role of elicitors in chlorophyll content and stomatal density of soybean cultivars by foliar application. *Journal of Agronomy*. 17(2) : 112-117.

Inagaki, K. 2001. Outbreaks of Rice Sclerotium Diseases in Paddy Fields and Physiological and Ecological Characteristics of this Causal Fungi. *Science Replications Agricultures*. 37: 57−66.

Iqbal, Z., Singh, Z., Khangura, R., & Ahmad, S. 2012. Management of citrus blue and green moulds through application of organic elicitors. *Australasian Plant Pathology*. 41(1) : 69-77.

IRTP. 1988. *Standard Evaluation System for Rice*. International Rice Testing Program, Los Banos, Philippines.

Jabnoun-Khiareddine, H., El-Mohamedy, R. S., Abdel-Kareem, F., Abdallah, R. A. B., Gueddes-Chahed, M., & Daami-Remadi, M. 2015. Variation in chitosan and salicylic acid efficacy towards soil-borne and air-borne fungi and their suppressive effect of tomato wilt severity. *Journal of Plant Pathology and Microbiology*. 6(11) : 325.

Jirakiattikul, Y., Rithichai, P., Songsoem, K., & Itharat, A. 2021. Elicitation of salicylic acid on secondary metabolite production and antioxidant activity of in vitro *Musa acuminata* L. cv.'Gros Michel'Shoots. *current applied science and technology*. 569-578.

Khan, M.I.R., Fatma, M., Per, T.S., Anjum, N.A., Khan, N.A. 2015. Salicylic acid-induced abiotic stress tolerance and underlying mechanisms in plants. *Frontiers in Plant Science*. 6 : 462

Kong, J., Xie, Y., Yu, H., Guo, Y., Cheng, Y., Qian, H., & Yao, W. 2021. Synergistic antifungal mechanism of thymol and salicylic acid on *Fusarium solani*. *LWT : International Journal of Food Science and Technology*.140 : 110787.

Leiwakabessy, C., Sinaga, M. S., Mutaqin, K. H., Trikoesoemaningtyas, T., & Giyanto, G. 2017. Asam Salisilat sebagai penginduksi ketahanan tanaman padi terhadap penyakit hawar daun bakteri. *Jurnal Fitopatologi Indonesia*. 13(6) : 207-215.

Luo, Z., Wu, X., Xie, Y., & Chen, C. 2012. Alleviation of chilling injury and browning of postharvest bamboo shoot by salicylic acid treatment. *Food Chemistry*. 131(2) : 456-461.

Mainawati, D., Brahmana, E. M., & Mubarrak, J. 2017. Uji Kandungan Metabolit Sekunder Tumbuhan Obat yang terdapat di Kecamatan Rambah Samo Kabupaten Rokan Hulu. *Disertasi*. Fakultas Keguruan dan Ilmu Pendidikan, Universitas Pasir Pengaraian.

Minarno, E. B. 2015. Skrining fitokimia dan kandungan total flavanoid pada buah *Carica pubescens* Lenne & K. Koch di Kawasan Bromo, Cangar, dan Dataran Tinggi Dieng. *Jurnal el-Hayah*. 5(2) : 73-82.

Mondol, M. N., Sultana, A., Tumpa, F. H., Kashem, M. A., & Khokon, M. A. R. 2020. In-vitro suppression of wheat blast pathogen: *Magnaporthye oryzae* patothype *Triticumby* elicitors. *Bangladesh Journal Plant Pathology*. 34 (1-2) : 53-58.

Nawangsih, A. A., Widjayanti, T., & Anisa, Y. 2014. Kelimpahan bakteri rizosfer pada sistem PHT-Biointensif serta kemampuan antagonismenya terhadap *Sclerotium Rolfsii* Pada Kedelai. *Jurnal Hama dan Penyakit Tumbuhan Tropika*. 14(2) : 110-120.

Nurcahyani, E., & Lindawati, L. 2014. Analisis lignin dan struktur anatomi planlet tomat (*Lycopersicum esculentum* MILL) hasil seleksi asam salisilat secara *in vitro*. *Jurnal Ilmiah Biologi Eksperimen dan Keanekaragaman Hayati*. 2(2) : 77-81.

Preciado-Rangel, P., Reyes-Pérez, J. J., Ramírez-Rodríguez, S. C., Salas-Pérez, L., Fortis-Hernández, M., Murillo-Amador, B., & Troyo-Diéguez, E. 2019. Foliar aspersion of salicylic acid improves phenolic and flavonoid compounds, and also the fruit yield in cucumber (*Cucumis sativus* L.). *Plants*. 8(2) : 1-8.

Rambe, S.S.I.S. 2018. Analisa asam salisilat pada bedak anti jerawat secara alkalimetri. *Karya Tulis Ilmiah*. Jurusan Farmasi, Politeknik Kesehatan Kemenkes Medan.

Ritchie, F., bain, R.A., & Mcquilken, M.P. 2013. Survival of Sclerotia of Rhizoctonia solani AG3PT and Effect of Soil-Borne Inoculum Density on Disease Development on Potato. *Journal of Phytopathology 161(3):180-189*

Safitri, H. 2017. Kajian Implementasi Ekstrak ubi jalar ungu (*Ipomoea batatas* (l.) lam.) sebagai indikator alami pada analisis asam salisilat dalam produk bedak tabur. *Karya Tulis Ilmiah*. Program Studi D III Farmasi, Sekolah Tinggi Ilmu Kesehatan Nasional Surakarta.

Sillero, J. C., Rojas-Molina, M. M., Ávila, C. M., & Rubiales, D. 2012. Induction of systemic acquired resistance against rust, ascochyta blight and broomrape in faba bean by exogenous application of salicylic acid and benzothiadiazole. *Crop Protection*. 34 : 65-69.

Tajik, S., Zarinkamar, F., Soltani, B. M., & Nazari, M. 2019. Induction of phenolic and flavonoid compounds in leaves of saffron (*Crocus sativus* L.) by salicylic acid. *Scientia Horticulturae*. *257* (108751) : 1-6.

Wasano, K., Oru, S., & Kido, Y. 1983. The syringe inoculation method for selecting rice plants resistant to sheath blight, *Rhizoctonia solani* Kuhn. *Japan Journal Tropical Agriculture*. 27(3) : 131-139.

# Woro-10. SALICYLIC ACID EFFECTIVENESS AS RESISTANCE INDUCER OF RICE

ORIGINALITY REPORT

| 7% | 2% | 8% | 0% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | D. R. WALTERS, A. F. MITCHELL, J. HAMPSON, A. McPHERSON. "The induction of systemic resistance in barley to powdery mildew infection using salicylates and various phenolic acids", Annals of Applied Biology, 1993<br>Publication | 3% |
| 2 | W S Suharti, N W A Leana. "Induce resistance of rice plants against bacterial leaf blight by using salicylic acid application", IOP Conference Series: Earth and Environmental Science, 2021<br>Publication | 2% |
| 3 | ojs.uma.ac.id<br>Internet Source | 2% |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 2% |
| Exclude bibliography | On | | |