EFFICACY OF ONION (Allium cepa L.) EXTRACT AS A BIOFUNGICIDE TO CONTROL SCAB DISEASE (Sphaceloma batatas) of SWEET POTATO (Ipomoea batatas)

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Received – June 11, 2014; Revision – August 07, 2014, Accepted – August 11, 2014
Available Online – August 21, 2014

ABSTRACT

Present study was carried out at Kendalpayak Experimental Station (ES), Indonesian Legumes and Tubers Crops Research Institute (ILETRI) in 2013. Total five treatments and one control were used for study. All the treatments were arranged in randomized block design with 4 replications. Results of study revealed that soaking of sweet potato with onion extract (50 g/liter) for an hour before planting followed by spraying once a week on 4 – 6 week after planting could inhibit the sweet potato scab disease intensity 70 to 80% and increased the weight and size of tubers by 46%, and prevent the yield loss up to 33%.
1 Introduction

Sweet potato is one of the important tuber crops in Indonesia. The annual production of sweet potato was 2,400,000 and 2,300,000 ton in 2012 and 2013 respectively (Statistics Indonesia, 2013). It was staple foods in Papua province of Indonesia, and consumed as an alternative food supplement during rice shortage (Zuraida, 2003). As a source of carbohydrate, sweet potato is suitable for making flour. It can be processed to make various types of foods such as noodles, pasta, cakes, chips, and juice. Orange tubers of sweet potato are rich in beta-carotene, which is source of vitamin A (Jaarsveld et al., 2005) and purple tubers which is contain a lot of anthocyanin (Kano et al., 2005) that is contains a lot of antioxidant compounds.

There are several obstacles in increase sweet potato production, one of them is disease and infection caused by plant pathogens. Scab is a major fungal disease in sweet potato (AVRDC, 1990; Semangun, 2004). Disease has widely spread in almost all parts of the world (Ams & O’Sullivan 2014), including Australia (Ramsey et al., 1988). In Indonesia, this disease has spread across all the sweet potato production centers such as Papua, Bali, and Java. The yield loss due to scab disease in Indonesia has been estimated up to 30 % (Mukelar et al., 1994), while the same has been reached up to 50 % in the case of USA (Clark et al., 1988).

Scab disease is caused by the fungus Sphaceloma batatas belongs to division Ascomycota and class Dothideomycetes. Earlier symptoms of disease appeared on the leaves vein but usually it occurred on the stems portion which is near soil. If the weather is favorable, the disease reaches to shoots, and shoots turn to curling. According to Quebral (2000), scab disease of sweet potato can be controlled by using various technique such as: use of resistant varieties, pathogen - free plant material, crop rotation, field sanitation, application of natural fungicides, application of chemical fungicides, crop rotation, and sanitation (Saleh & Rahayuningsih, 2013). Fungicides based on plant material can be use an alternative approach for the management of plant disease, these biofungicides are ecofriendly and cost effective.

Antimicrobial properties of onion (Allium cepa) have been reported by various researchers such as Sharma et al. (1979) reported a significant inhibition in multiplication of Aspergillus flavus, aflatoxin producing-fungus. Furthermore, efficacy of onion extract was tested against Staphylococcus aureus, Salmonella enteridis, Aspergillus niger, Penicillium cyclopium, and Fusarium oxysporum by Benkeblia (2004). The effect of onion and ginger extract against Escherichia coli, Salmonella typhi, and Bacillus subtilis was tested and found suitable inhibition in the multiplication of above mentioned microorganism by Azu & Onyeagba (2006). Garlic, onion, and leek extract inhibited the multiplication of Aspergillus niger was proved by Irkin & Korukluoglu (2007). Similarly, Carnago et al. (2011) reported the efficacy of onion bulb extract against Fusarium oxysporum and Colletotrichum. Presence of flavonoids from the onion extract was reported by Palomar et al. (2004) these flavonoids inhibit the growth of microorganisms. The results of experiment in 2012 found that out of nine natural plant fungicides, onion (Allium cepa) extract effectively inhibit the development of scab in sweet potato (Sumartini, 2013). The objective of the experiment to obtained methods of application of onion extract to control the scab disease.

2 Materials and Methods

2.1 Experimental site and setup

A series of experiments were conducted at Kendalpayak Experimental Station, Indonesian Legumes and Tubers Crops Institute (ILETRI), in the dry season of 2013. The experiments have total six treatments viz (i) T1 - Sweet potato stems were soaked into onion extract for one hours before planting + spraying of onion extract on weekly basis at 4-6 week after planting (ii) T2 - Sweet potato stems were soaked onion extract for one hours before planting + spraying of onion extract on weekly basis at 4-9 week after planting (iii) Sweet potato stems were soaked into 50 g/l water onion extract for one hours before planting + spraying of onion extract on weekly basis at 4-12 week after planting (iv) T4 - Sweet potato stems were soaked into onion extract for one hours before planting + spraying of onion extract on weekly basis at 4-15 week after planting (v) T5 - Sweet potato stems were soaked into onion extract for one hours before planting + spraying of onion extract on weekly basis at 4-15 week after planting (vi) T6 - Absolute check (without treatment). Each treatment was replicated four times and was arranged in Randomized Block Design.

Sweet potato stems of Ayamurasaki variety (scab susceptible variety) were planted in beds with five meters in long, and one meter width. Each treatment consisted of 4 beds (Yusuf & Sumartini, 2012). Distance between plants in beds were 20 cm. One week after planting, Furadan was applied (3 g/l of water) to eliminate pests. Furthermore, to eliminate mites attacks the infected leaves were cut, collected, and it embedded into the ground.

2.2 Preparation of Onion extract

Onion extract was prepared in the Mycology Laboratory of ILETRI, for this onion were washed, sliced into small pieces and 50 g onion pieces was grinded in a blender and added water up to one liter. The solution was incubated overnight and filtered (Priyono, 1999). The supernatant was sprayed onto the sweet potato crops (Sumartini, 2013). Before planting the sweet potato stems were soaked in onion extract (remove the inoculums) for one hour. Five hundred pieces of sweet potato stems were soaked into 10 liters of onion extract. Spraying of onion extract was conducted by “knapsack sprayer” in the afternoon to avoid UV radiation that can damage the extract.
Inoculation was performed by spraying *S. batatas* spore suspension (10^7* spores/ml) (Anggijani & Amir, 1988) at 21 days after planting. Spore suspension of *S. batatas* was obtained by removing the spores from leaves and stems of sweet potato from the field and incubated them overnight in a moist chamber (RH ± 95%) in the laboratory at room temperature (Sumartini & Rahayuningsih, 1996). Scab disease intensity was recorded at 42, 56 and 70 days after planting. Yield component were observed at harvest time.

### 3 Results and Discussion

Results of the present study revealed that disease intensity of scab increased with the increase of the plant age. Highest disease intensity was reported at 70 DAP (42%), in rest of the treatments shows 12% inhibition in the same extract (5gr of onion/l water). According to Nath et al. (2010) onions contain diallyl disulfide, S-allyl cysteine and S-methyl cysteine which were effective to inhibit the gram-positive bacteria, fungi which cause skin disease in humans, and it also inhibited the growth of *A. flavus* and *A. niger*. Other researchers proved that onion, garlic, and ginger can effectively inhibit the development of *Cladosporium herbarum*, (Tagoe et al., 2011).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Scab disease intensity (%)</th>
<th>Inhibition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>42 DAP</td>
<td>56 DAP</td>
</tr>
<tr>
<td>T1</td>
<td>3.00±0.65 ab</td>
<td>7.50±1.05 ab</td>
</tr>
<tr>
<td>T2</td>
<td>3.37±1.0 ab</td>
<td>6.25±1.05 ab</td>
</tr>
<tr>
<td>T3</td>
<td>2.75±0.67 ab</td>
<td>5.0±1.05 ab</td>
</tr>
<tr>
<td>T4</td>
<td>1.25±0.23 b</td>
<td>3.50±0.75 c</td>
</tr>
<tr>
<td>T5</td>
<td>2.25±0.55 ab</td>
<td>6.0±1.65 b</td>
</tr>
<tr>
<td>T6</td>
<td>6.00±1.14 a</td>
<td>20.75±1.5 a</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>5.08</td>
<td>11.05</td>
</tr>
</tbody>
</table>

Values followed by the same letters were not significantly different (LSD a = 0.05), DAP = days after planting; data given in table are mean of four replicates

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biomass weight/5 plants(kg)</th>
<th>Number of tuber/10m^2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
<td>Medium</td>
</tr>
<tr>
<td>T1</td>
<td>5.68 ± 1.46 a</td>
<td>12.00 ± 3.44 b</td>
</tr>
<tr>
<td>T2</td>
<td>4.98 ± 1.09 ab</td>
<td>14.50 ± 2.39 b</td>
</tr>
<tr>
<td>T3</td>
<td>5.34 ± 1.16 a</td>
<td>13.00 ± 6.01 a</td>
</tr>
<tr>
<td>T4</td>
<td>5.30 ± 2.26 a</td>
<td>27.00 ± 6.28 a</td>
</tr>
<tr>
<td>T5</td>
<td>4.66 ± 0.33 ab</td>
<td>17.50 ± 4.00 ab</td>
</tr>
<tr>
<td>T6</td>
<td>4.71 ± 2.99 ab</td>
<td>17.25 ± 5.86 ab</td>
</tr>
</tbody>
</table>

Values followed by the same letters were not significantly different (LSD a = 0.05), Small tuber: <100 gram/tuber, medium tuber: >100 – 150 gram/tuber, and big tuber: > 150 gram/tuber.
In this study, no significant difference in biomass was reported between treated and untreated plots, although there was a trend which shows lower biomass in the untreated crop than the treated crops (Table 2). The number of large tubers was the highest at the treated crops that was soaking sweet potato stems into onion extract before planting and spraying at 4-6 weeks after planting. The number of medium-sized tubers was not different between all treatments, on the other hand, the plot that have stems treated with onion extract before planting and spraying at the age of 4-12 weeks after planting had the highest number of small-sized tubers (Table 2).

The tuber weight of medium sized was not significantly different among all treatments; whereas most small-sized tubers were found in plots treated with onion extract before planting followed by spraying at the age of 4-9 weeks was the highest (Table 3). In the plots treated with the onion extract before planting followed by spraying at the age of 4, 5, and 6 had the largest total weight of tubers, and significantly different from the untreated plots (Table 3), in these an average increase in tuber weight was 49% compared to untreated plot. These tuber weights were in line with observations of the scab intensity, which the highest intensity had the highest yield loss. Increasing the scab intensity, would losses the tubers weight, but their correlation was not significant (r = -0.18 ns). Although the correlation was not significant, the total tubers in T4 was 12.96 kg/10m² equal with 13 t/ha, means it was increasing 3 t/ha tubers. Ayamurasaki is a common variety cultivated by farmer, the average of the yield was 10 tons/ha, and the crop has potential yield up to 20 tons/ha (Yusuf et al., 2011).

The inhibition of scab intensity (70 – 80%) in this study was higher than reported by Priyono (1999) and Kardinal (1998). They concluded that the inhibition of biofungicides were not more than 50%. The result of this experiment, especially report of application of onion extract in the field was the first report. Report previously, efficacy of onion extract inhibited microorganism caused plant disease limited in medium on the petridish only (Sharma et al, 1979; Benkeblia, 2004; Azu & Onyeagba, 2006; Irkin & Korukluoglu, 2007; Carnago et al., 2011; Palomar et al., 2004).

Total tuber weight was highest in plots treated in onion extract followed by spraying three times. In the sprayed plots less or more than 3 times the total weight of tubers obtained lower (Table 3). The onion extracts was also contained plant growth hormones such as gibberelin, auxin and cytokinin (Thomas 1968; Shiraiawa et al., 2011) which positively influenced the growth and biomass of the sweet potato. Purwitasari (2012) proved that onion juice acted as a hormone regulator of root growth and plant height of chrysanthemum, it was induced by the application of 80% and 60 % of onion juice.

The application of onion extract of this research is not so difficult to apply. Onion extract is easy to make because of the soft tissue of onion, but it need much water for the application. In Indonesia, paddy is the main crop, mostly with water irrigation system. Some food crops used to plant after paddy, sweet potato is one of crop after paddy. Water that comes from irrigation can use for application.

The yield loss (total tuber weight) in this study was saved up to 33%. This result was almost the same as the experiment conducted Amir et al. (1994) those who reported 30% yield loss because of scab disease while Floyd (1988), estimated 34% yield losses by scab.

Conclusion

Application of the onion extract (50 gr/l) by soaking sweet potato stems for an hour and spraying the plant at 4, 5, and 6 week after planting inhibited the scab disease on sweet potato of Ayamurasaki from 70% to 80%, and increasing the weight of large tubers by 46%, and prevent the yield losses due scab disease by 33%.

Table 3 Effect of the various treatments on the sweet potato tuber weight.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tuber weight (kg)/10m²</th>
<th>Total tuber weight (kg/10m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
<td>Medium</td>
</tr>
<tr>
<td>T1</td>
<td>2.21±0.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.25±1.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T2</td>
<td>3.20±1.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.01±0.8&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T3</td>
<td>2.68±0.68&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.84±0.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>T4</td>
<td>6.39±0.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.38±1.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T5</td>
<td>3.88±1.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.81±0.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T6</td>
<td>3.45±0.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.21±0.7&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values followed by the same letters were not significantly different (LSD α = 0.05)
Small tuber: <100 gram/tuber, medium tuber: >100 – 150 gram/tuber, and big tuber: > 150 gram/tuber.
References


