Survey of Cassava Anthracnose Disease Occurrence in Various Local Cultivars of Cassava Cultivated in Regency of Gunungkidul, Special Region of Yogyakarta

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Abstract. Cassava farmers in Regency of Gunungkidul prefer to cultivate local cultivars of cassava, hence allowing the region to have a high diversity of cassava germplasm. However, improper cultivation system applied by local farmers triggered the infection of several diseases, including cassava anthracnose disease (CAD) caused by Colletotrichum sp. This study was aimed to compare the disease occurrence of CAD infecting various local cultivars of cassava cultivated in Regency of Gunungkidul. This study was carried out through survey where samples were selected using purposive sampling method. Incidence of CAD was thoroughly observed from nine local cultivars (Gatotkaca, Adira, Jawa, Ketan Putih, Ketan Merah, Gambyong, Manalagi, Kirik and Bamban) cultivated in several sub districts in Regency of Gunungkidul. Each cultivars was represented by 18 plants. Cropping system applied in all cultivars was also observed. Statistical analysis was performed using a one-way analysis of variance and the significance among cultivars was further assessed using DNMRT with a p<0.05. Results showed high incidence and severity of CAD were recorded from bitter cassava cultivars (Gatotkaca, Kirik, Jawa, Gambyong, Bamban) where Gatot Kaca cultivar was assumed to be the most susceptible one. CAD infection in these bitter cassava cultivars was predicted to be transmitted through planting materials. The use of shady-stored stake from the previous planting season might be associated with this pathogen transmission, thus resulting in higher CAD severity.

Keywords: cassava, local cultivars, disease resistance, Gunungkidul, cassava germplasm

1. Introduction

Cassava production in several major producing countries is affected by various limiting factors, including disease infection. One of main disease commonly found in cassava cultivation and considered as serious problem affecting cassava yield is cassava anthracnose disease (CAD). This disease, caused by Colletotrichum gloeosporioides f. sp. manihotis [1], had caused significant loss in cassava main producing regions, such as Africa, South America and Asia [2-6]. Main characteristic of disease is noticed by the appearance of cankers symptom on stem, leaf necrotic spots and dieback on shoot tip [1, 6-8]. Severe infection may lead to leaf wilting, defoliation and induce the stem breakage, thus reducing the yield and high quality of cassava stem required as planting materials in the next season [9-11].
causal agent of CAD might be diverse among regions since this pathogen was known for its high genetic diversity [2, 5, 12-15]. Due to this characteristic, the CAD occurrence varied among countries and depended on the cultural practices applied in each region as well as its geographical condition [16].

Our previous work recorded the CAD incidence in several cassava plantations located in Regency of Gunungkidul, Special Region of Yogyakarta. Unlike other cassava producing regions, most local farmers in Regency of Gunungkidul cultivated this crop with a highly minimal input and improper management. Even, there was no specific treatment applied to manage the presence of cassava-infecting diseases, including CAD [17]. Due to this fact, the cassava production in Gunungkidul as well as Special Region of Yogyakarta contributed relatively small share only to the national cassava production compared to other cassava growing regions in Indonesia [18]. In addition, proper reference of cassava cultivation practice that fit to Gunungkidul geography was poorly documented, particularly related to diseases management. Therefore, most local farmers in this region were unable to perform optimal crop management, hence leading to low yield.

Apart from its improper cultivation practice applied, Regency of Gunungkidul had conserved highly diverse yet valuable cassava germplasm. Samidjo et al. [19] had recorded 28 cassava local cultivars commonly cultivated by the local farmers in Regency of Gunungkidul. The existence of these local cultivars should be managed in a correct way, not only to enhance the regional production, but also to ensure the nature of each cultivar. In addition, these local cultivars may contribute as powerful genetic materials required for breeding program to improve specific traits or develop new cultivar with certain properties. Therefore, it is very important to investigate the characteristics of each local cultivar comprehensively from various aspects, including its resistance against CAD infection. This present study was aimed to evaluate the CAD occurrence infecting several most widely cultivated local cultivars of cassava in Regency of Gunungkidul. The result of this study would provide a cultivar-specific reference regarding to the CAD resistance of each local cultivar, thus enabling the development of compatible CAD control strategy.

2. Materials and Methods

Occurrence of CAD was observed in 9 local cultivars of cassava cultivated in Gunungkidul Regency, namely Gatotkaca, Jawa, Gambyong, Kirik, Manalagi, Adira, Ketan Putih, Ketan Merah and Bamban. Sample collection and sampling location were determined using purposive sampling. Samples representing each cultivar were collected from three different locations in Gunungkidul Regency (sub districts of Ponjong, Ngawen and Nglipar) based on the availability of the cultivars. CAD symptom was carefully observed from the aerial parts of each cultivar. Its prevalence was monitored from 8-10 months aged plants where each cultivar was represented by 18 plants. The severity found in each cultivar was measured based on the scoring of severity level (ranging from 0 (no symptom) to 4 (>75% of plant area infected)) found in 20 representative leaves or stems. Severity index of CAD was further determined through this following formula:

\[
\text{Severity Index} \% = \frac{\sum_{i=0}^{n} (n_i \times v_i)}{N \times V} \times 100
\]

where \(n_i\) is the number of infected plants representing each severity score, \(v_i\) is severity score, \(N\) is the total number of plants observed and \(V\) is the highest severity score [20]. Secondary data were collected through the observation of the cultivation pattern applied for each cultivar. Data collected from disease monitoring were statistically analyzed using one-way analysis of variance with the support of SPSS version 23.0. Significant difference among cultivars was assessed using Duncan’s New Multiple Range Test (DNMRT) with a \(p<0.05\). Mean value obtained from each cultivar was presented in the form of histogram and complemented with standard deviation (SD) and statistical notation (if any).

3. Results and Discussion

3.1. Visual of CAD Symptom in Several Cassava Local Cultivars.
CAD symptom found in all local cultivars observed was spotted in a different part of the plant. Some cultivars showed CAD symptoms in the stem (Fig. 1) indicated by round lesions which potentially developed into stem canker at the severe infection. In contrast, the remaining cultivars exhibited CAD symptoms in the form of leaf spots (Fig. 2) which its visual was similar to brown leaf spot symptom caused by Cercospora henningsii. As presented in Fig. 2, the infected leaves displayed brownish spots with dark colored bull’s eye effect at the center of the lesions.

Figure 1. Visual of CAD symptoms detected in the cassava stems of several local cultivars.

Figure 2. Visual of CAD symptoms detected in the cassava leaves of several local cultivars.

CAD symptoms found in this present study was similar to those reported by the previous studies [1, 6, 8] emphasizing on the appearance of necrotic leaf spot and stem canker. However, the severe infection of CAD might also lead to the appearance of different symptoms, such as leaf wilt, defoliation and die-back at the shoot tip of cassava [11]. Other studies also mentioned that the symptom variation
of this disease was frequently found among cultivars. CAD infection in susceptible cultivars might trigger severe wilting and loss of stem firmness [21]. In contrast, some resistant cultivars were potentially recovered from the CAD through the emergence of new branches from the axillary buds underneath the infected parts [4].

3.2. Comparison of CAD Prevalence and Severity among Cassava Local Cultivars.

Cassava local cultivars observed in this study are categorized into 2 groups, namely bitter and sweet cassava types. Bitter cassava cultivars are represented by Gatot Kaca, Kirik, Jawa, Gambyong, and Bamban. Sweet cassava cultivars are represented by Adira, Manalagi, Ketan and Ketan Merah. As shown in Fig. 3, bitter cassava cultivars exhibited significantly higher CAD occurrence and severity indicating that this type of cassava conferred lower resistance against CAD infection. Of all bitter cassava cultivars, Gatot Kaca was predicted to be the most susceptible cultivar against this disease marked by the highest CAD severity up to 95% (Fig. 3). In contrast, all sweet cassava type showed relatively low CAD prevalence and severity. Even Ketan cultivar exhibiting the highest incidence compared to other sweet cassava cultivars, its CAD severity was recorded below 20% (Fig. 3). This result indicated that this sweet cassava type was possibly confer better resistance compared to the bitter type. However, further investigation was suggested to observe the CAD development among each type of cassava to confirm the difference of its resistance level in more accurate way.

![Figure 3](image-url)
CAD has been reported as one of main threats affecting the cassava production. Its occurrence in several main producing regions, such as South America, Africa, China and Thailand, had caused destructive yield loss [2, 3, 7, 12-14, 22]. However, little is known about the occurrence of this disease found in cassava cultivated in Indonesia. Moreover, the effect of CAD infection in cassava cultivation might be undetectable since the yield loss caused by this disease seemed to be insignificant. Difference in geographical location and cropping system among cassava producing regions (including Indonesia) was assumed to be the reason of variation in CAD occurrence. In addition, characteristic of the causal agent also played an important role in determining the disease distribution among regions. As mentioned by Weir et al. [16], the causal agent of CAD was known to form a species complex consisting of 22 species with similar morphological visual to *C. gloeosporioides sensu stricto*. This previous study highlighted that the species of *Colletotrichum* infecting cassava in certain regions might be genetically different compared to the one found in other regions. The occurrence of CAD in Brazil was reported to involve five different *Colletotrichum* species within the *C. gloeosporioides* species complex [5, 12-14]. Other studies reported that CAD infection in cassava plantation in Thailand was also associated with five different species of *Colletotrichum* with different composition [3] compared to those found in Brazil. Several studies mentioned the involvement of *C. gloeosporioides* and *C. graminicola* as the pathogen causing the CAD in some cassava plantations in China [23]. High diversity of *Colletotrichum* species involved in causing CAD contributed to the variation in pathogenicity level, thus leading to variation in CAD severity among regions.

Cropping system is also known to have remarkable contribution in disease occurrence, thus affecting its severity in the infected plants. Considering the cropping pattern applied in the cultivation of Gunungkidul local cultivars (Table 1), all cultivars were grown under intercropping system with various intercrops (legumes, cereals and horticulture). Due to this system, local farmers did not apply any crop rotation since each plant intercropped might be harvested in different time period. According to Table 1, the factors of this cropping pattern that triggered higher CAD occurrence and severity might be associated with the planting time and the pre-treatment applied to the cassava stake. Local farmers in Gunungkidul mostly starts to grow cassava in the beginning of rainy season to ensure sufficient water availability to support the plant during its early growth phase. In the other hand, this practice might trigger the CAD development easily due to its high humidity. As widely reported in previous studies, the causal agent of CAD favored humid condition compared to dry one [2, 14, 24]. Oliveira et al. [14] also highlighted that the humidity level was positively correlated with CAD severity. Unlike those previous studies, Gunungkidul is considered as arid zone with relatively low intensity of annual rainfall. Cassava cultivated in this area tends to experience long period of drought due to this climatic feature. However, referred to Fig. 3, the high incidence and severity of CAD found in several cultivars might not primarily associated with the climate condition of this region. This result was in agreement with Oliveira et al. [14] mentioning that conidia dispersal and inoculum availability also become the key determinant in triggering the CAD infection.

Despite being planted in the same period, bitter cassava cultivars exhibited severe CAD infection compared to the sweet cassava ones (Fig. 3). This result might be associated with the type of planting materials used suggesting that the pathogen was transmitted through the infected stake from the previous season. Since the stake was stored in shady condition before planting, it might promote the pathogen growth during the storage with no visible symptoms. Once it was planted in the beginning of rainy season, the humidity level contributed more favorable condition for the CAD symptom development, then leading to more severe infection during the plant growth. In contrast, the lower CAD severity found in sweet cassava cultivars (Fig. 3) was assumed to be associated with the use of sun-dried stake as the planting materials as well as fallow system applied (Table 1). The sun-drying treatment applied on the cassava stake could help to minimize the pathogen growth before planting, thus resulting in less contaminated planting materials. Since the majority of cassava cultivation in Gunungkidul are propagated vegetatively through stem cutting (stake), so the stake itself is potential to be the main entrance of pathogen to infect the plant. CAD-infected stake would facilitate the growth of fungal hyphae and the development of symptom [25]. Severe infection might trigger conidia dispersal
throughout the plantation, then resulting in more destructive impact to the crop. Therefore, ensuring the stake to be pathogen-free before planting would determine the cassava performance and potential yield.

Table 1. Comparison of cropping system applied for the cultivation of various cassava local cultivars in Regency of Gunungkidul.

| Parameters of cropping pattern | Cassava Local Cultivars |  |  |  |
|--------------------------------|------------------------|---|---|---|
|                                | Gatot Kaca, Kirik, Jawa, Gambyong, Bamban | Adira | Manalagi | Ketan | Ketan Merah |
| Location                       | Sub district of Ponjong | Sub district of Nglipar | Sub district of Nglipar | Sub district of Ngawen |
| Planting time                  | Beginning of rainy season |  |  |  |
| Planting materials             | Shade-stored stake from previous planting season | Sun-dried stake from previous planting season | Sun-dried stake from previous planting season | Shade-stored stake from previous planting season |
| Cropping system                | Intercropping          |  |  |  |
| Details of intercrops (if any) | Rice, maize and peanut | Peanut and soybean | Peanut and pea | Peanut, soybean, maize, and wild cosmos |
| Fertilizer applied             | Manure applied at 35 DAP* | Manure | Manure | Manure and TSP |
| Weeding cycle                  | Once at 20 DAP          | None |  |  |
| Harvest age                    | 365 DAP                | 270 DAP | 270 DAP | 270 DAP |
| Crop rotation applied          | None                   |  |  |  |
| Fallow system applied          | None                   |  | During dry season |  |
| Pest and disease control       | None                   |  |  |  |

Besides the choice of planting materials, the use of fallow system during the dry season seemed to provide significant contribution in reducing the CAD occurrence in sweet cassava cultivars. Interestingly, Ketan Merah used the shade-stored stake as the planting material (Table 1) but the CAD occurrence and severity were remarkably lower compared to the bitter cassava (Fig. 3) indicating the possible contribution of fallow system in minimizing the CAD prevalence. Fallow system has been a common practice applied in semiarid to arid regions where it functions as the strategy to maintain the soil water in the soil profile and reduces the precipitation rate [26]. In addition, bare fallow system allowed significant changes in soil properties due to the absence of N fertilizer applied thus resulting in remarkable changes in the activity of microbial community [27]. In other studies, Enwall et al. [28] emphasized that the diversity of soil microbial community was driven by soil pH and fertilizer applied. It also suggested that bare fallow-treated soil was known to confer similar microbial fingerprints to cropped soil with no fertilizer added. Since the soil was kept uncovered for certain period, it also potentially disrupting the life cycle of soil-borne pathogen due to loss of host crop and crop residues [26]. Direct exposure of environmental factors (such as sun light, rain and wind) towards the bare fallow soil might be helpful to kill the pathogen inoculum infested within the soil. According to these previous studies, the bare fallow system applied in sweet cassava cultivation had allowed the soil to be exposed by high temperature during the dry season as well as eliminated pathogen residues from the previous planting season. This system thus provided a better quality of soil for the next planting season.
4. Conclusion
This present study highlighted the comparison of CAD occurrence among cassava local cultivars commonly cultivated in Regency of Gunungkidul. Remarkable difference in CAD severity between bitter and sweet cassava cultivars suggested that the cultural practices applied had contributed in different way, thus resulting in resistance variation of each cultivar against this disease. However, the effect of CAD towards the yield of each cultivar observed had not been thoroughly observed, thus questioning the importance of this disease for the cassava plantation in Regency of Gunungkidul. Moreover, further investigation should also focus on the characteristic of CAD causal agents found in this region. Such comprehensive information regarding the importance of CAD and its pathogen identity may serve as key knowledge for the local farmers to perform better management on their cassava cultivation.

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