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Comparative Study of Selected Cucumber Cultivars Resistant To Powdery Mildew Caused BY *Podosphaera xanthii*

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Abstract

Genetic resistance is one of the most suitable strategies to control cucurbit powdery mildew (CPM) on cucumber, incited by Podosphaera xanthii or Golovinomyces orontii. Annual surveys of the screening of germplasm for new sources of genetic resistance provide a vital support to cucumber breeding programs. The objective was to determine whether resistance to powdery mildew which has been bred into most commercial resistant cucumber cultivars, was continuing to provide suppression of the pathogen. In this study eight genotypes in greenhouse condition and six genotypes in open field condition were evaluated for resistance to the pathogen by a visual scale for leaf lesions of disease symptoms. This study was conducted at Horticultural crop research and development Institute, Gannoruwa, Sri Lanka (Agro ecological zone WU1). Powdery mildew species differ in host range, ecological requirements, and geographic distribution. But, in here causal agent of the powdery mildew of cucumber was identified as Podosphaera xanthii based on microscopic observation as oval shape, presence of fibrosin bodies in the conidia and size of conidia. These observations are compatible with published data. There was a considerable variation among cucumber cultivars in terms of resistance to powdery mildew resulting in the identification of five tolerant cultivars (R2 x M2 self, Big white self, White Jade self, Kalpitiya white x G17 and White Jade self long) belonging to greenhouse class and three resistant varieties (Big white self, G17 x Kalpitiya White self and Kalpitiya white x G17) belonging to open field condition. Big White Self variety is suggested to be used in both greenhouse cultures and open field cultures to control powdery mildew caused by Podosphaera xanthii.

Key words: *Cucumber, Powdery mildew, Resistant varieties*

1. Introduction

Powdery mildew is one of the most prevalent and aggressive diseases that affect leaves in cucurbits (McGrath 2017). The infection is evident by the development of white mycelia and conidia, mainly on leaves and stems, but it can also affect fruits and floral structures. Severely infected leaves may become chlorotic, or even necrotic and brittle. Consequently, it decreases the photosynthetic potential, and concomitantly lower the fruit quality and yield [1]. *Podosphaera xanthii* [syn. *Sphaerotheca fuliginea* (Schlecht) Pollacci] and G*olovinomyces orontii* (syn. *Erysiphe cichoracearum* DC. Ex Mérat) are the most important CPM pathogen species of cucurbits [2]. *P. xanthii* occurs in a higher frequency in tropical and subtropical regions, whereas *G. orontii* is most observed in temperate climate [3], [4]. Physiological races and pathotypes are well documented for both species [5]. The chemical control of CPM may be ineffective due to development of resistance (insensitivity) of CPM to some fungicides [6], [7], [8]. In light of the high cost of pesticides and their negative effects on the environment and human health, the most appropriate alternative for disease control is the use of resistant cultivars [9]. Cucumber (Cucumis sativus) is a widely grown and economically important vegetable throughout the world. Cucumber productivity depends upon various biotic and abiotic stresses and their timely control. Powdery mildew, caused by

Podosphaera xanthii (formerly *Sphaerotheca fuliginea*) and *Golovinomyces cichoracearum* (formerly *Erysiphe cichoracearum*) is a widely distributed disease of cucurbits affecting most cucumber cultures in greenhouse and field conditions [10], [11], [12]. Additionally, development of greenhouse cultures has provided a favorable condition for the pathogen to maintain over the year and spread with a high severity. Breeding and application of powdery mildew resistant germplasm are among the best methods used to control cucumber powdery mildew [13] because of avoiding the use of environmentally unsafe chemicals and other costly methods. Since fifties to now, many studies on powdery mildew infected cucumber germplasm have reported a considerable variation in terms of resistance to the pathogen and have identified several resistant genotypes [14], [15], [16], [17] as well as genetic factors controlling resistance to the pathogen. Nevertheless, there may currently exist a notable variation among cucumber cultivars present in the market in terms of resistance to powdery mildew particularly if they be compared in the pathogen favorite conditions. The objective was to determine whether resistance to powdery mildew which has been bred into most commercial resistant cucumber cultivars, was continuing to provide suppression of the pathogen.

2. Methodology

2.1 Identification of pathogen

Podosphaera xanthii [syn. *Sphaerotheca fuliginea* (Schlecht) Pollacci]and *Golovinomyces orontii* (syn. *Erysiphe cichoracearum* DC. Ex Mérat) are the most important CPM pathogen species of cucurbits [2]. *P. xanthii* occurs in a higher frequency in tropical and subtropical regions, whereas *G. orontii* is most observed in temperate climate [3]. Powdery mildew affected cucumber leaves were collected from farmers' field in different locations in the central region and mycelia parts and conidia of all diseased samples were microscopically observed to identify the morphological features of pathogen.

2.2 Variety evaluation under greenhouse and open field condition

The seeds of 06 cucumber cultivars were grown in open field located in Gannoruwa (WU1- Wet Zone area in Central Province, 80% Relative Humidity and 28 ^{0}C - 29 ^{0}C Temperature) Sri Lanka on randomize complete block design under natural infection and 08 cucumber cultivars (Table 1) were grown in 15 cm-diameter plastic pots in five replicates and randomly arranged on greenhouse benches based on the completely randomized design under artificial infection. The plant growth was conducted under controlled conditions (relative humidity was above 85% and temperature 25^{0}C-28^{0}C). The soil was a composition of 1:1compost and top soil. Once every two days, plants were watered to saturation and standard crop management practices were done throughout the study.

2.3 Pathogen Inoculation in green house

For pathogen inoculation, 15-days old plants with 4 fully-expanded true leaves were chosen with a 28 ^{0}C temperature and

85% relative humidity in the greenhouse. Thereafter, *P. xanthii* inoculum suspension was prepared from freshly sporulating leaves by immersing a few pieces of the leaves in 200 ml distilled water and adjusted to the number of 3-5*10^4 conidia ml-1 with the aid of a haemocytometer. The upper surface of the leaves was inoculated by spraying uniformly with a hand sprayer until tiny water droplets covered the leaf surface but not flawed.

2.4 Data collection and analysis

About 10 days after inoculation and when powdery mildew symptoms were well-appeared, disease evaluation and measurements on plants were performed and repeated 20 and 30 days after inoculation of plant house experiment and field trail at flowering stage. The severity of cucumber powdery mildew was recorded by using 0-9 scale developed by Mayee and Datar [18]. as given below. Per cent disease index (PDI) was calculated by using formula given by Wheeler [19].

Table 1. Rating scale for DSI of CPM on leaves

Rating Scale	Description
0	No symptom of powdery mildew on leaves.
1	Small scattered powdery mildew specks covering 1 % or less leaf area.
3	Small powdery lesions covering 1-10 % of leaf area.
5	Powdery lesions enlarged covering 11-25 % of leaf area.
7	Powdery lesions coalesce to form big patches covering 26-50 % leaf area.
9	Larger powdery patches covering 51 % or more of leaf area and defoliation occur

Formula where in PDI = [Sum of numerical values/(number of leaves rated maximum rating)]100. Based on the mean PDI, cultivars were clustered into three resistant, tolerant and susceptible groups. Mean PDI between 0 and15 was grouped as resistant, 15 and 30 as tolerant and above 30 as susceptible [20].

Data Analysis

The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS) 9.1 software. Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05.

Results and Discussion

1. Pathogen identification

Morphological characters of powdery mildew isolates on cucumber plants under greenhouse and open field were as follows: powdery mildew fungi were found on the living leaves, on the upper side and underside. Colonies were white to brown, irregular. Hyphae were hyaline, septate. Conidiophores hyaline, straight, unbranched. Conidia formed singly at the apex of the conidiophores. Fibrosin bodies were observed in conidia. Based on the morphological characteristics especially on the presence of fibrosin bodies in conidia, the identity of powdery mildew fungi in up country wet zone in Sri Lanka was *Podosphaera xanthii*. Fibrosin bodies in

conidia were an important characteristic for identification of *Podosphaera xanthii* [21] and were found in this study.

2. Variety evaluation under greenhouse condition

Table 2. Estimated mean values of percent disease index (PDI) for cucumber cultivars infected with powdery mildew caused by *P. xanthii* in greenhouse condition

Cucumber Varieties	Percent Disease Severity Index			
	10 Days after innoculation (Before Flowering)		20 Days after innoculation (At Flowering)	
R2 x M2 self	28.58 (32.01)^{a}	Tolerent	24.2 (28.24)^{b}	Tolerent
Big white self	13.3 (19.82)^{b}	Resistant	20.1 (26.5)^{b}	Tolerent
Shani x White Jade	13.6 (20.84)^{b}	Resistant	41.4 (39.87)^{a}	Suseptible
White Jade self	10.62 (17.81)^{b}	Resistant	20.24 (26.52)^{b}	Tolerent
G17 x Kalpitiya White self	16.84 (23.79)^{ab}	Tolerent	32.22 (34.23)^{ab}	Suseptible
Kalpitiya white x G17	21.46 (26.03)^{ab}	Tolerent	20.76 (26.96)^{b}	Tolerent
White Jade self long	8.68 (16.53)^{b}	Resistant	18.88 (25.41)^{b}	Tolerent
Kalpitiya White (control)	18.04 (24.13)^{ab}	Tolerent	30.16 (32.43)^{ab}	Suseptible

Note: Means followed by the same letter/s along the column are not significantly different at p=0.05 level. (Values within parenthesis are Arcsine values)

3.Variety evaluation under open field condition

Table 2. Estimated mean value of percent disease severity index (PDI) in 20 plants for cucumber cultivars infected with powdery mildew caused by *P. xanthii* in open field condition at flowering stage

Cucumber variety	Mean value of disease severity index in 20 plants	CPM resistance

R2 x M2 self	35.19a	Suseptible
Big white self	9.09c	Resistant
Shani x White Jade	24.44b	Tolerent
White Jade self	24.07b	Tolerent
G17 x Kalpitiya White self	11.11c	Resistant
Kalpitiya white x G17	3.33d	Resistant

Note: Means followed by the same letter/s along the column are not significantly different at p=0.05

The disease symptoms appeared 7-10 dpi (days post inoculation) primarily in the susceptible and gradually in other cultivars with respect to the susceptibility rate. A considerable variation between the cultivars was observed based on the percent disease index (PDI) measurements and plants were classified into resistant, tolerant and susceptible.

The four greenhouse cultivars Big white self, Shani x White Jade, White Jade Self and White Jade self-long with the lowest PDI of 13.3, 13.6, 10.62 and 8.68 showed resistance and other varieties showed tolerant at the stage of before flowering.

The resistance rate of the greenhouse cultivars at the stage of flowering was lower than that of the outdoor ones so that, from 8 greenhouse cultivars, 0 appeared resistant, 3 susceptible and 5 others tolerant (Table 2). But among 6 outdoor cultivars, 2 were tolerant, 1 other susceptible and 3 varieties were resistant (Table 3). The five greenhouse cultivars R2 x M2 Self, Big White Self, White Jade Self, Kalpitiya White x G17 and White Jade Self long with the lowest PDI of 24.2, 20.1, 20.24, 20.76 and 18.88 showed tolerant and Shani x White Jade, G17 x Kalpitiya White Self and Kalpitiya White were identified as most susceptible cultivars. The three outdoor Big white self, G17 x Kalpitiya white self and Kalpitiya White x G17 with the lowest PDI of 9.09, 11.11 and 3.33 showed the resistant. R2 x M2 Self was identified as most susceptible cultivar in open field condition.

Genetically heritable control of resistance to cucumber powdery mildew has previously been reported in several investigations and related genetic control elements e.g. genes [22], [23], [24], [13] and Quantitative traits loci [25], [26] have been identified and have been exploited to develop resistant plants. Also, the investigations published during past 7 decades have reported a considerable variation in terms of resistance to powdery mildew among cucumber germplasm so that many resistant genotypes have been identified [14], [15], [16], [17]. According to above mentioned studies, a considerable part of the variation observed in the present study is expected to be controlled by genetic factors. On the other hand, the

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controlled environmental conditions used in the present study were based on the pathogen needed conditions. Hence the resistance rate identified in some cultivars e.g. R2 x M2 self, Big White Self, White Jade Self, Kalpitiya White and White Jade Self as tolerant verities under greenhouse condition and e.g. Big white self, G17 x Kalpitiya White self and Kalpitiya white x G17 varieties as resistant varieties under open field condition would be reliable and applicable for powdery mildew resistance breeding or for growing purposes. However, Big White Self variety can be recommended for both greenhouse and open field conditions.

Data at the open field and the greenhouse population level can contribute to elucidating temporal and spatial pathogen variation and dynamics, as well as to clarifying host-pathogen interactions and variety-race interaction. It is also important to consider the practical application of these data in resistance breeding, studies of fungicide effectiveness and disease management [27].

Conclusion

The cucumber powdery mildew of central province wet zone (agro ecological zone WL_1) isolated in the present study was confirmed to be caused by *Podosphaera xanthii*, based on microscopic observation and characteristics of pathogen. These observations are also compatible with published data.

In conclusion, there was a considerable variation among cucumber cultivars in terms of resistance to powdery mildew resulting in the identification of five tolerant cultivars (R2 x M2 self, Big white self, White Jade self, Kalpitiya white x G17 and White Jade self long) belonging to greenhouse class and three resistant varieties (Big white self, G17 x Kalpitiya White self and Kalpitiya white x G17) belonging to open field condition. Big White Self variety is suggested to be used in both greenhouse cultures and open field cultures to control powdery mildew caused by *Podosphaera xanthii*. In contrast growing of the susceptible cultivars should be avoided or be done with high attention, especially in humid regions.

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