Fernando MSW, et al., J Agron Agri Sci 2024, 7: 060
DOI: 10.24966/AAS-8292/100060

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HSOA Journal of Agronomy & Agricultural Science

Research Article

Potential chemical control for target spot disease of tomato caused by *Corynespora cassiicola*

Fernando MSW[1]*, Alahakoon AMKD[1], Rathnayaka RMAT[2], Ranasinghe WMAM[2], Weerarathna WPR[3], Kumudumali K[1], Wijenayaka TMN[2] and Jayawardhana KGNL[2]

[1]Horticultural Crops Research and Development Institute, Department of Agriculture, Gannoruwa, Sri Lanka

[2]Kandy, Sri Lanka

[3]CIC Holdings PLC, Colombo, Sri Lanka

Abstract

Tomato (*Solanum lycopersicum*) is affected by several fungal and bacterial diseases such as bacterial wilt, fungal foot rot, early blight, late blight. The target spot of tomato is one of the economically important diseases that is severely attacked to the tomato plants. It is a fungal disease caused by *Corynespora cassiicola* and was having a wide range of diversity when it infected the plant species. Target spot is one of the most serious tomato diseases in tropical and subtropical areas. It is a worst pathogen to Sri Lankan tomato cultivation since 2019. In in-vitro testing for controlling the target spot of tomato was studied at the Horticultural Crop Research and Development Institute, Gannoruwa, Sri Lanka by using different fungicides. The objective is to determine its chemical control measures. The best treatments were Azoxystrobin 250g/l SC (10 ml/10l), Mancozeb 80% WP (20g/10l), and Two combination products of Pyraclastrobin 5% + Metiram 55% WG (20g/10l) and Azoxystrobin 11% + Tebuconazole 18.3% W/W SC (3.5ml/10l) in-vitro tested in this study (P= 0.05) in both trails. Those fungicides can be recommended for an alternative application for tomato target spot disease control. Maintaining of field sanitation must take place.

Keywords: Chemical Control; *Corynespora Cassiicola*; Fungal Diseases; Tomato Target Spot

***Corresponding author:** Fernando MSW, Horticultural Crops Research and Development Institute, Department of Agriculture, Gannoruwa, Sri Lanka. E-mail: sobashinifernando@gmail.com

Citation: Fernando MSW, Alahakoon AMKD, Rathnayaka RMAT, Ranasinghe WMAM, Weerarathna WPR (2024) Potential chemical control for target spot disease of tomato caused by Corynespora cassiicola. J Agron Agri Sci 7: 060.

Received: February 26, 2024; **Accepted:** March 18, 2024; **Published:** March 25, 2024

Introduction

Many limitations influence tomato quality and productivity, with diseases caused by fungi, bacteria, viruses, and phytoplasma playing a significant role. One of the major limiting factors in tomato production is fungal diseases. The tomato target spot is caused by the fungus *Corynespora cassiicola*, which was discovered in Florida in 1972. C. cassiicola is a diverse fungus that infects over 500 plant species, including tomatoes, papaya, cucumbers, legumes, and possibly weeds [1]. Brinjal, cowpea, gingelly, soybean, cotton, and tobacco are some of the other hosts of C. cassiicola. C. cassiicola is the organism responsible for the most devastating leaf disease that affects several plants in Sri Lanka. The fungi have been found in rubber, soybean, winged bean, tomato, cocoa, papaya, sweet potato, and casava in Sri Lanka [2]. Target spot of tomato was first molecularly identified samples from commercial cultivation in Kimbissa, Sri Lanka, in 2019 and this disease caused considerable foliage loss, with disease severity ranging from 50-70 percent in diseased tomato fields. [3].

When C. cassiicola infected the tomato plant, symptoms appeared on all above-ground plant parts. Most seriously, it appears on foliar parts and spreads upwards, beginning with small, pinpoint, and water-soaked lesions on the upper surface of older leaves. These lesions grew moderately in size, from pale brown irregular shapes to circular and ringed shapes with yellow halos [3,4]. In addition, brown oblong-shaped thin and long spots are appearing on stems and petioles. Tomato target spots must be correctly identified and managed before they can spread into productive parts of the plant. Small lesions with darker margins and light brown spots can be seen in the young fruits as it spreads. The centers of these lesions are sunken and dry. When looking at the ripened fruits, large circular lesions with cracked brown centers are developing. The critical fruit infection resulted in significant yield loss [4]. The target spot is mostly difficult for seedlings and mature plants just before and after bear fruits. Mature leaves seem to be more vulnerable than younger leaves, and fruits can also be affected whether they are green or ripe.

According to MacKenzie [5], no commercial tomato varieties are currently recognized as resistant to the disease tomato target spot. As a result, management practices were mainly responsible for maintaining the disease under control. Because the fungus C. cassiicola has a diverse host range, it can survive on a wide range of alternative host plants, including papaya, cucumbers, legumes, and weeds [5]. As a result, if it is critical to spray a protectant fungicide as soon as a symptom appears, it is difficult to identify correctly in the early stages. It forms in the same way as bacterial spot and early blight in the early stages of symptom emergence [4,5]. Host-plant resistance and cultural methods have not proven to be effective management strategies for this disease [6]. The use of the most readily available fungicides in the area is preferable for achieving continuous disease control. Thus, removing affected remains and maintaining a sufficient crop rotation period is an important practice when considering disease accumulation into the next crop [4]. When controlling the disease target spot in large-scale cultivation, synthetic fungicides are commonly used on a large scale. The greenhouse experiment, which was carried out at the Southwest Purdue Ag Center, discovered that the majority of mancozeb products were effective in reducing the disease severity of tomato target spot [7]. Since the pathogen can be difficult to manage when climatic conditions prefer fast development of the disease, many cultural management techniques involve rotating tomato fields with non-solanaceous crops, begin with strong and hygienic transplants, and removing weeds (particularly those in the Solanaceae family), volunteers, and plant residues which may contain inoculum is use as IPM in Florida and also benzovindiflupvr fluopyram, fluxapyroxad (FRAC group 7, SDHI fungicides, inhibitor of respiration in complex II at SDH), chlorothalonil (FRAC group MO5, Multi-site contact activity), cyprodinil, pyriethanil (FRAC group 9, AP fungicides, inhibition of methionine biosynthesis), difenoconazole, flutriafol (FRAC group 3, SBI class I: DMI - fungicides), fludioxonil (FRAC group 12,) and mancozeb (FRAC group MO3, Multi-site contact activity) were successfully used as chemical control methods [5].

Therefore, this study focused on five synthetic fungicides, and a combination of these fungicides was used to determine whether the pathogens were effectively controlled.

Materials and Methods

In vitro fungicide evaluation: Subsequently, fungi were grown on fungicides amended Potato Dextrose Agar (PDA) as a food poison technique [8] used for the screen of suitable fungicide. Those fungicides and the rate of application are shown in Table 1. The trials were carried out in duplicate with five replicates. All of the plates were kept in the dark at room temperature (25-27 °C), and colony diameters were taken three, seven, and ten days after inoculation.

Treatment	Fungicide	Concentration	FRAC code
T1	Azoxystrobin 250g/l SC	10 ml/10l	11
T2	Mancozeb 80% WP	20 g/10l	MO3
T3	Pyraclastrobin 5% + Metiram 55% WG	20 g/10l	11+ MO3
T4	Azoxystrobin 11% + Tebuconazole 18.3% W/W SC	3.5 ml/10l	11 + 3
T5	Control	-	

Table 1: Different concentrations used to treat fungicides.

Collected data/parameters: Radial growth of each fungus was measured and relative inhibition of colony growth (%) was calculated for each isolate by using the growth data values measured after three, seven, and ten days on control plates and plates amended with fungicides [9].

Data analysis: Percentage of inhibition calculated according to the formula: [10, 11].

$$\text{Percentage of inhibition} = \frac{\text{(Colony diameter (mm) of control – Colony diameter (mm) of test plate)}}{\text{Colony diameter (mm) of control}} * 100$$

The growth inhibition by fungicides was compared by mean separation using the Duncan Multiple Range Test (DMRT). The significance of the data was determined at p = 0.05.

Results and Discussion

In the complex of fungal foliar diseases, target spot is one of the most serious threats to tomato production. The highest average diameter value was observed in T5 (2.91cm) since even the fungal colony had not grown on fungicide amended PDA mediums of T1 (Azoxystrobin 250g/l SC), T2 (Mancozeb 80% WP), T3 (Pyraclastrobin 5% + Metiram55% WG) and T4 (Azoxystrobin 11% + Tebuconazole 18.3% w/w SC) respectively. According to the results, all the tested fungicides were very effective in controlling the pathogen of *Corynespora cassiicola* with 100% inhibition growth rate in Figure 1. Similarly, mancozeb products helped reduce disease severity in greenhouse experiments at the Southwest Purdue Ag Center [7].

In-vitro Fungicide evaluation: In both trails shows the similar results as follows.

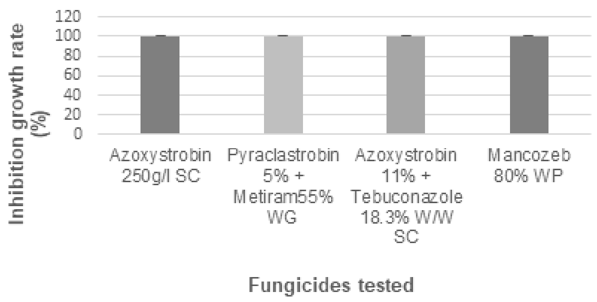

Figure 1: Tested fungicides vs inhibition growth rate percentage.

The strobilurin fungicides, azoxystrobin and Pyraclastrobin providing admirable control. Azoxystrobin, a natural extract of mushroom with low mammalian toxicity and environmental safety, has rapidly developed fungicide resistance. Since that, it provided excellent control of the target spot earlier and later did not provide adequate control [1]. And Pyraclastrobin was an excellent control agent [12].

This result proven that the both Azoxystrobin 250g/l SC and Pyraclastrobin 5% + Metiram55% WG have an excellent control under in-vitro condition. Equally, Azoxystrobin 11% + Tebuconazole 18.3% W/W SC has a commendable pathogen control. C. cassiicola from soya beans was found to be HNS or resistant to pyraclostrobin, azoxystrobin, trifloxystrobin, and picoxystrobin in Brazil [13]. Quinone outside inhibitors (QoI) (QoI, FRAC code 11) resistance in C. cassiicola isolates from tomato was explained in Florida, causing a reduction in QoI fungicide applications in tomato cultivations [14]. In this study it shows 100% control of C. cassiicola in laboratory conditions from both mixtures of pyraclostrobin and azoxystrobin.

Up to this point, no resistance to demethylation inhibiting fungicides has been noted in C. cassiicola [15]. Azoxystrobin 11% + Tebuconazole 18.3% W/W SC contains a FRAC group 3 DMI fungicide, which is Tebuconazole. It may be the reason for the best control of C. cassiicola by Azoxystrobin 11% + Tebuconazole 18.3% W/W SC in this study. Multisite fungicides have a low risk of fungicide resistance development [16]. To control C. cassiicola in tomato fields, multisite or protectant fungicides have been used [17]. Mancozeb 80% WP is a good examples of multisite fungicides [16, 18]. Such fungicides recommended to be used in combination with fungicides with different modes of action, typically a systemic fungicide, to decrease the selection pressure of one fungicide and prevent the emergence of resistant strains [18, 19]. Pyraclastrobin 5% + Metiram55% WG also contains a FRAC group MO3 type fungicide which is Metiram. That may be the reason for the success in control of C. cassiicola by Pyraclastrobin 5% + Metiram55% WG in this study.

For further control of the disease, the affected remaining and host plants (weeds) should be removed to improve crop hygiene. It was important to maintain a sufficient crop rotation period to break down the life cycle of the pathogen. Moreover, by introducing a correct identification method by observing disease symptoms, farmers can control the disease at the early stages of the disease spreading without misunderstanding with tomato early bight disease. Nowadays, large-scale crop yields is highly depended on effective fungicide uses since, in favorable conditions, the pathogen has such a stronger potential to cause damage if no precautions are used [20]. However, present a significant risk of resistance development [16,18, 21]. Because novel modes of action of fungicides are difficult to discover, it is important to follow recommendations for fungicide use and avoid the development of resistance [22]. To maintain the most effective available fungicides, it is recommended to use a high-risk resistance fungicide in combination with low resistance fungicide, as well as rotate with different fungicide groups [23]. Chlorothalonil is a broad-spectrum, protectant fungicide that has been widely used to control target spot disease in other countries that can be tested in future. Although, IPM is more stable method for a disease management chemical control is essential with a disease outbreak.

Conclusion

The research finding proved that the pathogen of Corynespora cassiicola which infected to target spot disease of tomato was successfully controlled by Azoxystrobin 250g/l SC (10 ml/10l), Mancozeb 80% WP (20g/10l), and Two combination products of Pyraclastrobin 5%+ Metiram 55% WG (20g/10l) and Azoxystrobin 11%+ Tebuconazole 18.3% w/w SC (3.5ml/10l). If the pathogen *Corynespora cassiicola* was effectively controlled by the above fungicides, the use of manually controlling methods is more important in the reduction of disease spreading. However, further studies should have to be done for the confirmation of effective concentrations to control the disease in different stages of disease spreading. Field validation should be done.

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