BRAZILIAN JOURNAL OF MICROBIOLOGY

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Microbial Physiology

Management of blight of bell pepper (*Capsicum annuum* var. *grossum*) caused by *Drechslera bicolor*

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ARTICLE INFO

Article history:
Received 2 July 2015
Accepted 7 April 2016
Available online 31 August 2016

Associate Editor: Rosana Puccia

Keywords:
Plant extracts
Bio-control agents
Trichoderma
PGPR
Botanicals
Neem oil
Zatropin
Fungicides

ABSTRACT

Sweet or bell pepper is a member of the Solanaceae family and is regarded as one of the most popular and nutritious vegetable. Blight, in the form of leaf and fruit blight, has been observed to infect bell pepper crops cultivated at the horticulture farm in Rajasthan College of Agriculture, Udaipur, India. Based on disease severity, we attempted to curb this newly emerged problem using different fungicides, plant extracts, bio-control agents, and commercial botanicals against the fungus in laboratory and pot experiments. Bio-control agent *Trichoderma viride* and plant growth promoting Rhizobacteria (PGPR) isolate Neist-2 were found to be quite effective against bell pepper blight. All evaluated fungicides, botanicals, commercial botanicals, and bio-control agents *in vitro* were further studied as seed dressers and two foliar sprays at ten days interval in pot experiments. The combinations of Vitavax, PGPR isolate Neist-2, and Mehandi extract were found to be very effective against bell pepper blight followed by Vitavax, *T. viride*, and *Mehandi* extract used individually. All treatments in the pot experiments were found to significantly reduce seedling mortality and enhance plant biomass of bell pepper. Thus, these experimental findings suggest that a better integrated management of bell pepper blight could be achieved by conducting field trials in major bell pepper- and chilli-cultivated areas of the state. Besides fungicides, different botanicals and commercial botanicals also seem to be promising treatment options. Therefore, the outcome of the present study provides an alternate option of fungicide use in minimizing loss caused by *Drechslera bicolor*.

Introduction

Sweet or bell pepper [*Capsicum annuum* var. *grossum* (L.) Sendt.], a member of the Solanaceae family, is regarded as one of the most popular and nutritious vegetable. It is native to tropical South America, especially originating from Brazil, and is widely cultivated in central and south America, Peru, Bolivia, Costa Rica, Mexico, Europe, China, and India. In India, it is commercially cultivated in Tamil Nadu, Karnataka, Himachal Pradesh, and in some parts of Uttar Pradesh. In North India, it is commonly known as "*Shimla Mirch*" and is an

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http://dx.doi.org/10.1016/j.bjm.2016.04.032

important summer vegetable grown extensively in the mid hills of Himachal Pradesh, which is then supplied to regions in the plains. It is also grown in Rajasthan especially in Jaipur, Tonk, Sawaimadhopur, and Udaipur districts. It is not only rich in nutrients but also added as a natural colorant in food preparations. It has a wonderful combination of sweetness and tanginess with a crunchy texture. This may be eaten raw (sliced in salads) or cooked. In stews, bell peppers are also used for pickling in brine, baking, and in stuffing. Diced green or red bell peppers are sometimes mixed with sweet corn and other vegetables. The fruits are large with basal depression, inflated, red or yellow in color, with a thick flesh and a mild taste. Bell peppers are a rich source of vitamins, even more so than tomatoes, especially vitamins A, B_6, and C, calcium, and folic acid. The production of sweet pepper is very low in India as compared to the US, Holland, Italy, France, and other capsicum-growing countries over the world. This low production is mainly attributed to the infection of bell pepper crops with diseases caused by fungi, bacteria, viruses, and mycoplasmas, which drastically reduce potential yields. These pathogens also infect the fruits during transit and storage.[1] The major fungal diseases of capsicum crops are damping off (*Pythium aphanidermatum* and *Phytophthora* spp.), leaf spots (*Cercospora capsici* and *Alternaria solani*), anthracnose and ripe rot (*Colletotrichum capsici*), fruit rot and leaf blight (*Phytophthora* spp.), powdery mildew (*Erysiphe cichoracearum* and *Leveillula taurica*), early blight (*A. solani*), wilt (*Fusarium oxysporum*), frog eye rot (*Phaeoramularia capsicicola*), leaf spot (*Septoria lycopersici*), fruit spot (*Phoma destructiva*), stem rot (*Macrophomina phaseoli*), dry rot (*Sclerotium rolfsii*), and fruit rot (*Phomopsis* spp.). The post-harvest rots are caused by *Aspergillus terreus*, *A. candidus*, *A. niger*, *F. moniliforme*, *F. sporotrichoides*, *Paecilomyces variotii*, and *Penicillium corylophilum*.[1–3] Sharma and Sohi reported a new disease in a chili cultivar NP-46A caused by *Drechslera* sp. during kharif season of 1977–78 causing leaf blight and fruit rot.[4] They found symptoms on margins of leaf lamina, spots on stem, branches and fruits; and the symptoms on fruits were water soaked brown black areas. Seeds from the infected fruit have very poor germination capacity. In Varanasi (Uttar Pradesh) *D. bicolor* has been found on seeds of *C. annuum*.[5,6] In Udaipur, Bell pepper blight, on the leaves and fruits (cv. Bombay red and Nun 3020 yellow), was first time noticed in August 2006 at Hi-tech Horticultural Polyhouse Farm, Rajasthan College of Agriculture (RCA).[7] *D. bicolor*, the causative agent for this disease, infects the fruits of chilies, tomatoes, and brinjals.[7] The initial symptoms of the disease include yellowing of young leaves near the tip. As the disease progresses, large straw or brown blight patches appear throughout the leaf thereby resulting in coalescence and drooping of leaf. The apical portion of the bell pepper fruit gets rotted with rapid discoloration, ultimately progressing to internal decay and complete deformation of fruits. The morphological features of *D. bicolor* are well defined by Ellis,[8] which include conidiophores emerging singly or in small groups, straight or flexuous, sometimes swollen at the base, the upper part often repeatedly geniculate with large, dark sears, golden brown, up to 400 μm long, 5–10 μm thick, straight conidia or rarely curved slightly, cylindrical or rather broader in the middle and tapering toward the ends, rarely obclavate, rounded at the apex, often truncated at the base, with 3–14 pseudosepta, 20–135 × 12–20 μm, mostly 40–80 × 14–18 μm with 5–9 pseudosepta, central cells of mature conidia often dark brown or smoky brown and sometimes quite opaque but each cell remains hyaline or very pale and is frequently cutoff by a very dark septum; hilum flat, dark, 3–5 μm wide. The taxonomy of "*Helminthosporium*" species is well studied by Alcorn.[9] According to Misra et al., the *D. bicolor* grows well on PDA medium and produces profuse bottle green to whitish-gray colored aerial mycelium with a smooth and circular colony surface, which becomes brownish when aged.[10] In another study, *D. bicolor* grown on PDA medium produced gray-black fluffy mycelium with maximum growth and sporulation observed at 25 ± 2 °C, and at hydrogen ion concentration of 6.5.[7] In addition, the maximum mycelial growth of *D. bicolor* was recorded at 100% relative humidity followed by that at 80%, whereas an abundant sporulation was obtained only at 100% humidity level. The maximum spore germination was observed at 100% humidity followed by that at 80%.[7]

When the crop loss is high due to the pests and diseases, then intense efforts are needed avoid such a damage. The plant diseases are controlled to a great extent through scientific approaches such as the development of several potent pesticide/fungicide chemicals and ecofriendly management by biocontrol agents, phytoextracts, and botanicals. Moreover, continuous initiatives are being taken in an effort to obtain better and more specific agents against pathogens responsible for many uncured plant diseases. Of the seven fungicides tested, Vitavax was most effective against *D. bicolor* followed by thiram, mancozeb, and thiophanate methyl.[7] The ecofriendly and cheap plant protection measures are essential for a sustainable crop production. As an alternative to fungicides, various plant extracts can be helpful in protecting crops and farm production from harmful diseases. In the same study, Didvaniya[7] evaluated the antifungal activities of 15 different plant extracts against *D. bicolor* (blight of bell pepper). The maximum fungal growth inhibition was obtained with the extracts of neem leaves followed by that of lantana leaves and garlic cloves. Yadav and Gour[11] studied reduction in disease index of leaf stripe by barley using fungicides (carboxin, thiram, captan, mancozeb, carbendazim, and thiophanate methyl), botanicals (*Lantana camara* and *Azadirachta indica*), and bio-control agents (*Trichoderma harzianum* and *T. aureoviride*) as seed treatments and foliar sprays both in pot and field experiments. Maximum disease control was observed by carboxin (0.15%) in both pot and field experiments, followed by botanicals and bio-control agents. The use of carboxin (Vitavax) at concentration of 0.15% to treat seeds and for two foliar field applications (at day 35 and 56 after sowing) showed maximum efficacy in controlling disease control and increasing in the grain and fodder yield. Several studies have found better plant disease management using different approaches.[12–16] In view of its recurrence in the emerging vegetable crops in Udaipur (Rajasthan), it was decided to conduct an experiment to manage the disease. For efficient management of recurring bell pepper blight, an *in vitro* study was conducted earlier.[17] However, the efficacy of bio-control agents were not investigated; therefore, this study was undertaken to evaluate the *in vivo* effects of these