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Non-conventional approach for the management of early blight disease in potato

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Abstract
In the present study, the efficacy of non-conventional chemicals along with commonly used fungicide and biocontrol agent were tested against *Alternaria solani*, which causes Early blight disease in Potato. The treatments were Trichoderma 5g/l (T1), Lithium Sulphate 1 g/l (T2), Hexaconazole 5% (T3), Oxalic acid 5 ppm (T4), Neam leaf extract (T5) and control (T6). Under *in-vitro* condition, the maximum suppression of pathogen was found in Hexaconazole 5% (T3), followed by Trichoderma 5g/l (T1), Oxalic acid 5 ppm (T4), Neem Leaf Extract (T5) and Lithium sulphate 1 g/l (T2), as compared to control. Similar trend was also observed in field condition when the treatments were analyzed for Disease Incidence (%) and yield (t/ha) after 75 days of planting.

Keywords: Chemicals, early blight, management, potato

Introduction

Potato (*Solanum tuberosum* L.) after maize, wheat and rice is the world's fourth-largest food crop, which is used as vegetable, stock feed and industrial crop for fulfillment of starch, alcoholic beverages and other processed foods requirement all over the world. India ranked second in the potato production worldwide (Anonymous, 2017) [1] with a production of about 45 million tons of potatoes, by the states like Assam, Bihar, Chhattisgarh, Gujarat Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Uttar Pradesh and West Bengal which account for more than 12% of global production with a productivity of 23 tons per hectare (2013-14), second only to China. (Hussain, 2016) [5]. Potato plants are susceptible to a variety of fungal diseases, which includes Anthracnose (*Colletotrichum phomoides*), Early blight (*Alternaria solani*), Fusarium wilt (*Fusarium oxysporum*), Late blight (*Phytophthora infestans*), Leaf blight (*Alternaria alternate*) etc. (Sharma *et al*., 2020) [10]. Early blight disease caused by *Alternaria solani* is currently one of the most serious concerns in potato production in irrigated heavy dew forming areas (Rotem, 1994) [8]. The disease can be easily identified as dark brown to black lesions along with concentric rings, which usually appears like a target board which however, reduces its market quality. Affected leaves develop circular to angular dark brown lesions ranging in diameter from 3–4 mm. The disease typically affects stressed or senescing plants, as the oldest foliage is the first to show symptoms. Leaves that have been severely affected turn yellow and starts drooping which also seems like a dark, corky dry rot appears on infected tubers. Brown, round to irregular, depressed lesions appear on the tuber, with the beneath flesh turning dry, brown, and corky (Sharma *et al*., 2020) [10]. *A. solani* is a plant pathogenic fungus, increases its number by asexual production of conidia, which can be easily transmitted by air or rain water that makes the pathogen to infect a large number of plants easily. The pathogen is capable of surviving in soil, diseased crops, and on a variety of weed hosts (Shukla and Ratan, 2019) [11]. The pathogen was initially described in all potato-growing locations, and it appears after crop blossoming or during early crop senescence, contrary to its name (Stevenson, 1993) [12]. A warm and humid season, on the other hand, aids in the early development of the disease, which has a significant impact on yield (Wale *et al*., 2008) [13]. However, the disease can also develop in a variety of climates and is largely dependent on the frequency of foliage soaking from rain, fog, dew, or irrigation, as well as the nutritional quality of foliage and cultivar susceptibility. The fungus overwinters in the soil on potato tubers or on the dead plant detritus. The disease can be managed by various methods, among them use of agrochemical have been recommended by the experts to contest with the pathogen.

Several effective fungicides that were used to treat late blight were also employed to control early blight in recent decades, such as mancozeb, chlorothalonil, and triphenyl acetate, but they are not regarded long-term remedies due to their high cost, danger of exposure, residues, and other health and environmental problems. Some efforts have been undertaken and a study has been conducted to manage early blight of potato using non-conventional chemicals in an attempt to modify this condition.

Materials and Methods

The experiment was conducted to study the potentiality of different non-conventional chemicals along with some commonly used agrochemical and biocontrol agent to study their effect on Early blight disease of potato caused by *A. solani.* Trichoderma 5g/l (T1), Lithium Sulphate 1 g/l (T2), Hexaconazole 5% (T3), Oxalic acid 5 ppm (T4), Neam leaf extract (T5) and control (T6) treatments were used for evaluation of their efficacy on mycelial growth of *A. solani* by poisoned-food technique method (Chaurasia *et al*., 2014) [2]. The fungal pathogen was grown on 90 mm petri-plate on Potato Dextrose Agar (PDA) medium against various treatments as described earlier. Mycelial growth was measured after 7 days of incubation at 28 °C. The growth of fungus was measured by averaging the bisecting assessments of the radial growth from back of the petri-plate (Das *et al*., 2014) [3].

For field level evaluation, twenty-four plots were made of each about 3m × 2m having 4 replications in each treatment using Randomized Block Design (Gomez and Gomez, 1984) [4]. The spray was done at an interval of 15 days after the onset of disease in the fields. The assay was done on the basis of Disease Incidence (DI) and yield (t/ha) after 75 days of planting of the crop. All the data were taken in a replicates of four and Duncan's Multiple Range Test (DMRT) ($P< 0.05$) was performed to delineate treatment mean for suppression of radial growth by different treatments using statistical software IBM SPSS Statistics 20.

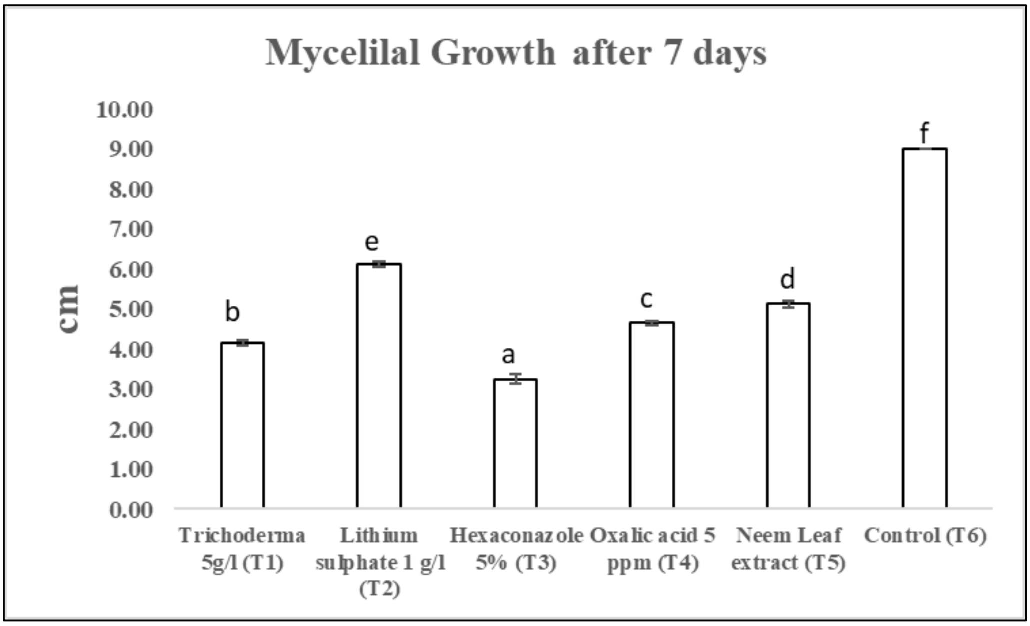

Fig 1: Mycelial growth of *Alternaria solani* in PDA medium against different treatments after 7 days

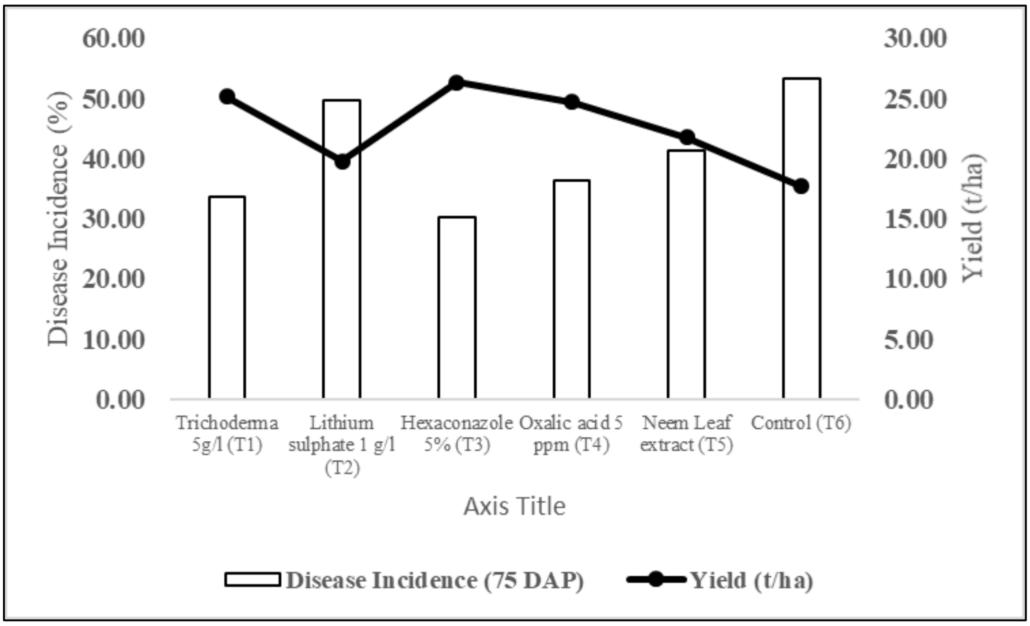

Fig 2: Disease Incidence (%) and yield (t/ha) of potato crops in different treatments

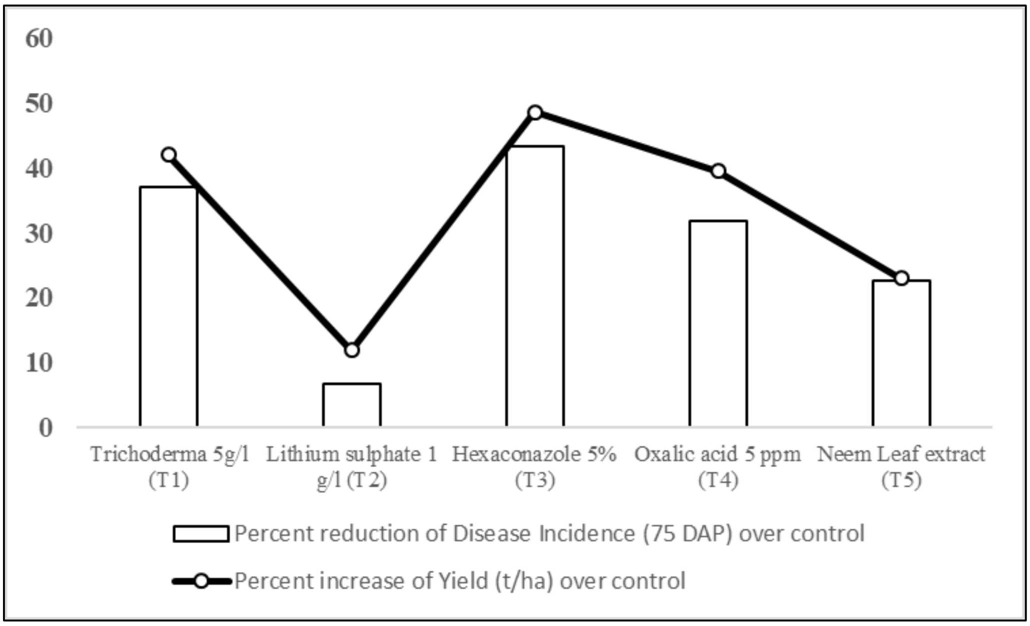

Fig 3: Percent reduction of Disease Incidence (DI) and increase of yield over control in different treatments

Results and Discussion

All the treatments were tested for their potentiality to control the early blight disease under *in-vitro* condition as well as in field condition. Under *in-vitro* condition, it was found that the effect of different treatments was significant ($P< 0.05$) on the mycelial growth of *A. solani*. Based on Duncan's Multiple Range Test (DMRT) ($P< 0.05$) analysis, Hexaconazole 5% (T3), allowed the pathogen to grow only up to 3.25 cm in the petri plate of 9 cm diameter, and thereby suppressed 63.89% of the pathogen growth, Trichoderma 5g/l (T1), was found able to suppress the pathogen up to 53.89% which allowed only 4.15 cm radial growth of the pathogen. The pathogen was observed to be suppressed up to 48.33% by Oxalic acid 5 ppm (T4), and thus allowed the pathogen to develop 4.65 cm radially. Neem Leaf Extract (T5) was reported to suppress the pathogen up to 43.06%, allowing the pathogen to grow 5.13 cm radially. The pathogen was recorded to be suppressed up to 31.94% by Lithium sulphate 1 g/l (T2), which allowed the pathogen to develop 6.13 cm radially and in the control one (T6) the pathogen growth was seen in full plate up to 9 cm radially (Fig. 1).

In the field condition also, Hexaconazole 5% (T3) exhibited best result in terms of percent disease incidence (%) which was found to be 11.23% as well as yield (t/ha) of 26.32 t/ha after 75 days of planting, which was followed by Trichoderma 5g/l (T1) (13.62% DI and 25.15 t/ha), Oxalic acid 5 ppm (T4) (16.31% DI and 24.72 t/ha), Neam leaf extract (T5) (21.26% DI and 21.77 t/ha) and Lithium Sulphate 1 g/l (T2) (25.05% DI and 19.81 t/ha). In the control treatment the DI was found to be 33.34% and the yield was recorded 17.71 t/ha. The Percent reduction of Disease Incidence (75 DAP) over control and percent increase of Yield (t/ha) over control in Hexaconazole 5% (T3) treated plot was 66.33% and 48.61% respectively followed by Trichoderma 5g/l (T1) (59.15% and 42.03%), Oxalic acid 5 ppm (T4) (51.07% and 39.56%), Neam leaf extract (T5) (36.23% and 22.94%) and Lithium Sulphate 1 g/l (T2) (24.86% and 11.83%) (Fig. 3).

The current findings demonstrate that using non-chemical compounds at low concentrations can also give effective and long-lasting protection as a dynamic defense mechanism against the plant pathogens. This finding is similar to Maity *et al*., (2005) [6], who found that dipping groundnut seedlings in metal salts, amino acids, and growth regulator solutions at low concentrations yielded disease-free plants and was cost-effective. Similarly, Olivier *et al*. (1998) [7] found that several organic and inorganic salts considerably decreased the radial development of *Alternaria solani*. Trichoderma and leaf extracts of *Elettaria cardamomum* were tested by Sarfraj *et al*. (2018) [9] and showed up to 100% inhibition of *A. solani*, compared to control. Data obtained in present work showed that non-conventional chemicals may also become an alternatives of the hazardous agrochemicals, the only need is to give emphasis on their development in terms of ingredients and formulations.

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