Carboxin: A Promising Systematic Agricultural Fungicide.

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ABSTRACT:

The in vitro activity of Carboxin were examined against pathogens viz., *Alternaria solani. Colletotrichum lindemuthianum, Curvularia lunata, Fusarium moniliforme, Fusarium oxysporum, Fusarium solani, Helminthosporium sativum, Rhizoctonia solani* causing different vegetable diseases. The MIC values of Carboxin fungicide against eight pathogenic fungi of different vegetables were varied and recorded in the range of 4000 µg/ml to 6000 µg/ml. The effect of fungicide on the growth rate of mycelium of eight fungal pathogens of different vegetables was most significant ranging from 57.3 to 79.1%. The in-vitro results clearly indicate that, Carboxin was most effective as it completely inhibited the radial growth averagely 71.59%.

KEYWORDS: Carboxin, Antifungal activity, fungal pathogens, MIC.

INTRODUCTION:

Agriculture is the backbone of nation's economy, growth and development. India grows the largest number of vegetables from temperate to humid tropics and from sea level to snowline (Shaikh and Sahera.,2013). Vegetable are the rich source of all essential component of balance diet, which includes carbohydrates, fat, minerals, vitamins which help in growth, development, and reproduction of human being. Vegetables occupy 38.9% of area and 61% of total horticultural area and production of country respectively (National Horticulture Board 2014-15). China, India, and Indonesia showed the highest agricultural productivity among Asian countries (FOASTAT,2018). Fungal phytopathogens affecting agricultural crops lead to a decrease in their quality and production (Shupind and Eloff.,2017). They act as a threat to crops (Doehlemann et al.,2017) through various mechanisms of pathogenesis that compromise the immune system of the plants. Not all fungal species attack plants but plant fungal pathogens attack every group of plants (Knogge, 1996). These fungi collectively are responsible for 80% of plant diseases (El Hussein et al., 2014). About 8000 fungal species cause nearly 100 000 diseases in plants (Agrios, 2005). Even though the Per capita consumption of vegetables in India is increased, but alone the fungal pathogens are responsible to cause losses in agricultural yield all over the world including India. It is important to control those devastating fungal pathogens. The use of fungicides against fungal plant diseases improves crop yield, quality, and shelf-life (Lucas et al.,2015). Some examples of antifungal agents include benzimidazoles, dithiocarbamates, strobilurins, and azoles (Hof.,2001), with azoles, especially triazoles, being widely used in fields (Ribas et al.,2016). Application of fungicides is the most convenient and predominant way for disease control. Their use has made it feasible to enhance crop yields and food production. Despite of all the health hazards of fungicides, it has been proved to be the effective control strategy (Maitlo et al., 2014). The efficacy of fungicides is influenced by many biological and environmental factors that directly influence the metabolic activities of fungal cells (Reinprecht 2010). Sometimes critical concentrations are not effective long-term, as the fungus can become resistant to the fungicide (Neely 1969, Brent & Hollomon 2007). The present work aimed to evaluate the in vitro sensitivity of *A. solani, C. lindemuthianum, C. lunata, F.moniliforme, F. Oxysporum, F. solani, H. sativum* and *R. solani* towards carboxin fungicides currently used on several crops, since it is representative of different modes of action .

MATERIAL AND METHODS:

For the purpose of *in vitro* evaluation of fungicides poisoned food technique was used (Ilyas *et al*., 1982). Prepare 1 lit PDA by using 1000ml water, 200gms potatoes, 20gms Dextrose and 2gms Agar-Agar. 200gm of peeled were cut into 2-3 cm cubes and then were thoroughly washed with tap water twice to remove the dirt. Then equal quantity of water was added and kept on gas burner to extract the starch, after the extract of the starch it was filtered through muslin cloth and was made upto 1 litres by adding distilled water, then 20gm of dextrose and 20gm of Agar-Agar was added until a homogenous solution was formed. After autoclaving the media, this media was used for further studies, using desired concentration of the fungicides *in vitro* studies (10ml of the sterile PDA+ 2ml of different concentration of fungicide). Control treatment was maintained without adding any fungicide to the medium. For fungal inoculation agar plugs having fungal isolates with 6 mm diameter taken from 7days old cultures were placed in the centre of each petriplate. Three replications were maintained for each concentration. These plates were incubated at 25±1°C. After incubation for nine days at room temperature, radial growth was measured when fungus attained maximum growth in control plates. The efficacies of the fungicides were expressed as percent inhibition of mycelial growth over control, which was calculated by using the formula of Vincent (1927).

$$I = \frac{C - T}{C} \times 100$$

Where, I = per cent inhibition

C = Colony diameter in control

T = Colony diameter in treatment.

RESULTS AND DISCUSSION:

The fungicide Carboxin (Systemic), was selected for the assessment of fungicidal efficacy and determination of their Minimum Inhibitory Concentration (MIC) against eight different pathogenic fungi of vegetables such as *Alternaria solani, Colletotrichum lindemuthianum, Curvularia lunata, Fusarium moniliforme, Fusarium oxysporum, Fusarium solani, Helminthosporium sativum, Rhizoctonia solani.* For the assessment of fungicidal efficacy, food poisoned technique was used. Required concentration of fungicides in part per million (ppm) in the ratio as µg/ml were used. The radial growth of the fungal pathogens was recorded as a mean of three replicates at each tested concentration and percent inhibition of mycelia growth over control was tabulated. The lowest concentration which showed complete inhibition of mycelia growth was considered as Minimum Inhibitory Concentration (MIC) of fungicide to particular pathogen.

The MIC values of Carboxin fungicide against eight pathogenic fungi of different vegetables were varied from 4000 µg/ml to 6000 µg/ml (Table.1). The pathogen *C. lindemuthianum* was found to be most resistant and showed MIC value at 6000 µg/ml. While all other pathogens *A. solani, C. lunata, F. moniliforme, F. oxysporum, F. solani, H. sativum, R. solani* were inhibited significantly at MIC value- 5000 µg/ml (Fig.1). On contrary, A. solani inhibited at MIC value 4000 µg/ml.

The effect of Carboxin fungicide on the growth rate of mycelia of eight pathogenic fungi of different vegetables was most significant ranging from 57.3 to 79.1% (Table.2). The percent inhibition of mycelia growth of *F. solani* and *A. solani* were found to be maximum, 79.12% (5000 µg/ml) and 77.35% (4000 µg/ml) respectively. While the percent inhibition of mycelia growth of *C. lindemuthianum, F. moniliforme, C. lunata, R. solani* and *F. oxysporum* were found to be significant as 75.93%, 74.74%, 70.60%, 69.12% and 68.60%. On contrary, *H. sativum* revealed minimum percent inhibition of mycelia growth to 57.93% (Table 2; Fig 1).

Fungicides are important tools for managing diseases in many crops. Unlike insecticides and some herbicides which kill established insects or weeds, fungicides are most commonly applied to protect healthy plants from infection by fungal plant pathogens. Chemical control measures have been tested and found effective in the control of diseases (Ogundana and Denis, 1981; Plumbley, 1985). Certain protective fungicides although hazardous to environment are still used for the control of fungal diseases (Vaish and Sinha, 2003). Fungicides may act on or interrupt the metabolic system of the pathogen (Bilgrami & Dube, 1976).

Table 1: MIC of Carboxin against plant pathogenic fungi in µg/ml.

Pathogens	**Carboxin**
Alternaria solani	4000
Colletotrichum lindemuthianum	6000
Curvularia lunata	5000
Fusarium moniliforme	5000
Fusarium oxysporum	5000
Fusarium solani	4000
Helminthosporium sativum	5000
Rhizoctonia solani	5000

Table 2: Inhibitory effect of Carboxin on the mycelial growth of targeted fungi.

Pathogen	Control	Growth rate in (mm) and percent inhibition of mycelial growth at various concentration in (µg/ml)						Mean of % inhibition
		III						
		1000	2000	3000	4000	5000	6000	
A. s	89.6	32.6 (63.1)	23.3 (73.9)	17.3 (80.6)	7.33 (91.8)	-	-	77.35±0.65
Col. l	89.6	38.6 (56.9)	28.6 (68)	22 (75.4)	18 (79.9)	16 (82.1)	06 (93.3)	75.93±0.24
Cur. l	89.6	44.6 (50.2)	34.3 (61.7)	30.6 (65.8)	15 (83.2)	07 (92.1)	- -	70.60±0.97
F. m	89.6	32 (64.2)	26 (70.9)	24 (73.2)	18 (79.9)	13 (85.4)		74.74±0.44
F. o	75.3	36 (52.1)	26 (65.4)	24 (68.1)	20 (73.4)	12 (84)		68.60±0.90
F. s	89.3	30 (66.4)	27 (69.7)	24 (73.1)	06 (93.2)	06 (93.2)		79.12±0.84
H. s	89.6	64.4 (28.1)	52.6 (41.2)	48 (46.4)	14 (84.3)	12 (86.6)		57.32±1.65
R. s	89.6	38 (57.5)	34 (62.0)	28 (68.7)	25 (72.0)	13 (85.4)		69.12±0.64

Mean diameter of mycelial growth in mm at varied concentration (µg/ml) and figure in parenthesis represents percent inhibition of mycelia growth at varied concentration. Where *A. s= Alternaria solani, Col. l= Colletotrichum lindemuthianum, Cur. l= Curvularia lunata, F. m= Fusarium moniliforme, F. o= Fusarium oxysporum, F. s= Fusarium solani, H. s= Helminthosporium sativum, R. s=Rhizoctonia solani*.

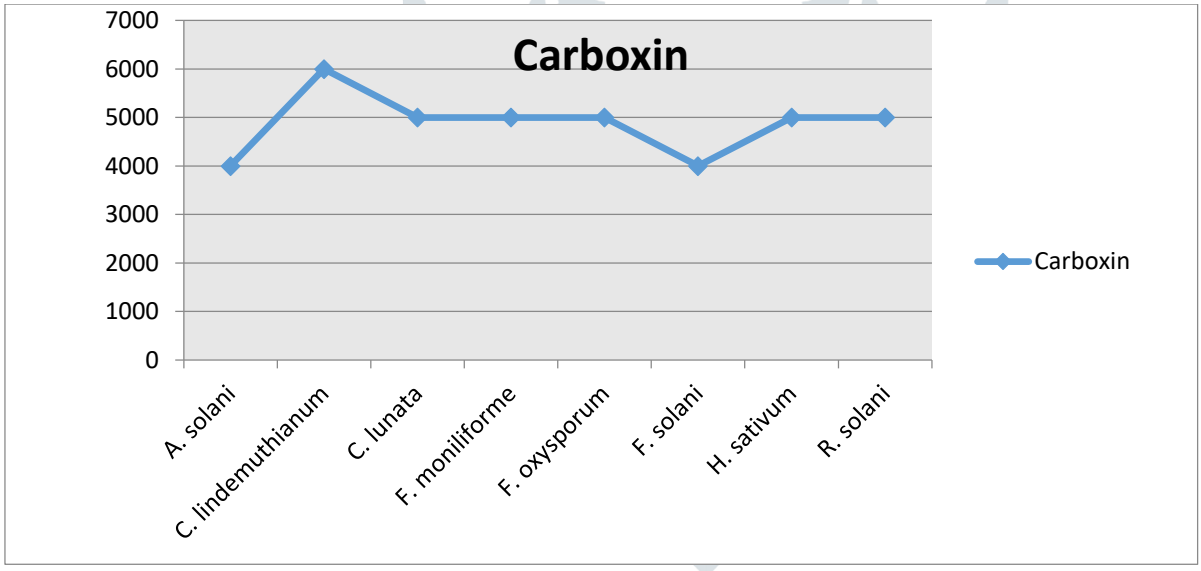

Fig 1: MIC of fungicide carboxin against pathogens of vegetables.

CONCLUSION:

The aim of the study is to determine the antifungal activity of Carboxin. We have observed that, the MIC values of Carboxin fungicide against eight pathogenic fungi of different vegetables were varied from 4000 µg/ml to 6000 µg/ml. The Carboxin holds the place of promising systematic agricultural fungicides from so many years.

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