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Management of late blight of potato through inorganic copper compounds under organic system

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Abstract

Attempt has been made to evaluate three different copper compounds viz. copper hydroxide copper sulphate and copper oxy-chloride against late blight of potato under single spray schedule. All the copper fungicides gave significantly effective control against the disease and were able to delay the disease appearance by three days in comparison to the unsprayed control. However, none of them able to arrest the disease incidence and intensity below 50 % as recorded at 15 days after first appearance of symptoms. Lowest disease intensity (77.77%) with comparatively high healthy tuber (4.48t/ha) was recorded in plots sprayed with copper hydroxide @ 0.2 % as one prophylactic spray at the time of canopy closure subsequent two at seven days intervals.

Keywords: *Phytophthora infestans*, late blight, potato, copper sulphate, copper oxy-chloride copper hydroxide

Introduction

Organic farming helps in the sustainable development of the agriculture sector and provides food security with least negative impact on the environment. Worldwide growing concerns about the environmental degradation, uncontrollable cost of chemical intensive crop management measures have promptly elevated the popularity of organic system of crop production. Observing the escalating demand India also leaping forward towards the organic agriculture sector and was able to secure respectable position. During the year 2012-13, India produced around 1.34 million metric tons of certified organic products from 5.21 mha of land and ranked 10th position among the top ten organic growing countries in terms of cultivable land under organic certification. The total export volume of organic products during 2012-13 was 165262 metric tons with total export value of 374 million US dollar (Anonymous, 2016) [1]. The introduction of the National Programme of Organic Production (NPOP) in 2001 by the government has brought a new impetus into organic farming in India. The remote states of India especially the North East region have been practicing organic agriculture from time immemorial. A vast patch of agricultural land of the region has remained untouched by synthetic agro-chemicals hence these fields are organic by default. This holds promise for the organic producers to tap the market which is growing steadily in the domestic and export market. In Assam, the total certified area has observed steady increase to reach 2299 ha from 2047 ha in the 2010-11 (Anonymous 2012-13) [2].

Potato (*Solanum tuberosum*) is an important food crop of the world which ranks fourth in production after cereals, cultivated worldwide for its tubers (FAO, 2010; Rhodes, 1982) [4, 7]. In Assam, the potato cultivation occupies an area of 99.77 thousand hectares with an annual production of 975.27 thousand metric tons (2012-13). This crop has higher market value if produced organically. Although, the yields in organic production are observed to be approximately 40% lower than in conventional crop cultivation system and the losses often due to the occurrence of late blight (co *Phytophthora infestans* (Mont.) de Bary) disease in a severe form (Tamm *et al.*, 1999). In Assam also, the disease occurs every year in epidemic form contributing to heavy yield losses which go as high as 90% in unsprayed crop (Bhattacharya *et al.*, 1990) [3]. In organic agriculture, synthetic fungicides are not allowed, with the exception of copper products which may be used in limited quantities as protectant under the supervision of inspection and certification agency. Presently the copper in the form of Bordeaux mix, copper hydroxide are on the list of National Center of Organic Farming,

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Department of Agriculture and cooperation, Ministry of Agriculture, Government of India for use as disease management tools. However, their use is restricted to 8 kilograms per hectare per year depending upon the crop. So, it is quite essential to evaluate the comparative efficacy of these copper containing compounds against *P. infestans* under the high inoculum pressure in the potato growing season of the state. In the present investigation, efforts have been made to find out the efficacy of different forms of copper against late blight of potato under same spray schedule with a view to select the most effective copper containing compound for the management of the disease.

Materials and Method

The field experiment was carried out in organic Block of the Instructional cum Research farm of Assam Agricultural University (AAU), Jorhat during the potato growing season (Nov to March) of 2014-15 with susceptible variety Kufri Jyoti. The healthy and certified organic potato seed tubers were obtained from the AICRP on potato, of the same university. The crops were raised as per the standard organic practices. Three different forms of copper containing compound viz. copper sulphate (as Bordeaux mixture @ 1%), copper oxy-chloride (Blitox 50 @ 0.2%) and copper hydroxide (Kocide @ 0.2%) were evaluated for their comparative disease containing efficacy against late blight of potato. The experimental pots were laid out in randomized block design with four treatments and five replications. Each pot measures (4 x 3) m. The fungicides were sprayed as one prophylactic spray at the time of canopy closure (35 days after planting) followed by another two sprays at an interval of seven days starting at just after appearance of the late blight symptom in control pot.

Percent Disease Incidence (PI), Percent Disease Intensity (PDI) and Percent Disease Control were recorded at three days interval starting from first appearance of the disease till the complete death of the plants in the control (unsprayed treatment). The yield of potato tubers harvested from the different plots along with the percent tuber infection was also

recorded. The disease intensity (%) was calculated using 1 to 9 scale given by Wheeler (1969). The grading scale used in this experiment is given below-

Score	% foliage affected	Description
1	0	None or very few lesions on the leaflets
2	3	More than 0% but less than 10%
3	10	More than 10% but less than 25%
4	25	More than 25% but less than 50%
5	50	Half of the foliage destroyed
6	75	More than 50% but less than 75%
7	90	More than 75% but less than 90%
8	97	Only very few green areas leaf (Much less 10%)
9	100	Foliage completely destroyed.

Results

Perusal of the data reveal that the treatment comprising of 0.2 % copper hydroxide was found most effective in delaying incidence of late blight and reducing the severity of the disease. This treatment, delayed the incidence of the disease by 3 days from first appearance of the disease in unsprayed control and the disease intensity was recorded lowest (77.77 %) after 15 days from first appearance of late blight in the unsprayed control. In this experiment the remaining two treatments comprising copper oxychloride @ 1% and copper sulphate @ 1% exhibited statistically at par result. It was observed that all the copper containing compound was able to delay the disease appearance by 3 days but none of them able to arrest the disease incidence and intensity below 50 % as recorded at 15 days after first appearance of symptoms (Table 1 and 2). However, these treatments have produced significantly high healthy tuber yield with low tuber infection (%). The highest healthy tuber yield (4.48t/ha) with minimum tuber infection (12.74%) was recorded in the plots treated with copper hydroxide @ 0.2 % among the different forms of copper fungicide which were applied under the same spray schedule (Table 3).

Table 1: Effect of different forms of copper fungicide on progress of late blight incidence

Treatments	Percent incidence of late blight at different intervals					
	(Days after first appearance of symptoms)					
	0 day	3 Days	6 Days	9 Days	12 Days	15 Days
T1: Copper Sulphate @ 1%	0 (0)	0 (0)	18.83 (25.68) ^b	40.67 (39.60) ^b	94.51 (76.94) ^b	100 (90.00) ^a
T2 : Copper oxychloride @ 0.2%	0 (0)	0 (0)	17.49 (24.71) ^b	39.27 (38.79) ^b	92.62 (74.46) ^b	100 (90.00) ^a
T3 : Copper hydroxide @ 0.2%	0 (0)	0 (0)	11.65 (19.90) ^c	35.39 (36.47) ^c	87.48 (69.43) ^c	100 (90.00) ^a
T4 : Control (Unsprayed)	5.69 (13.73) ^a	35.15 (36.33) ^a	100 (90.00) ^a	100 (90.00) ^a	100 (90.00) ^a	100 (90.00) ^a
S. Ed (±)	0.507	0.741	0.571	0.880	2.181	N/A
CD	1.116	1.633	1.258	1.938	4.806	N/A

Values in the parentheses are angular transformed values

Values superscripted with same letter are not significantly different (P=0.05)

Observations are mean of five replications

Table 2: Effect of different forms of copper fungicide on late blight intensity

Treatments	Percent intensity of late blight at different intervals					
	(Days after first appearance of symptoms)					
	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days
T1: Copper Sulphate @ 1%	0 0	0 0	12.44 (20.60) ^b	25.33 (30.19) ^b	72.88 (58.62) ^b	100 (90) ^a
T2 : Copper oxychloride @0.2%	0 0	0 0	9.77 (18.13) ^b	22.66 (28.40) ^b	70.22 (56.92) ^b	99.55 (88.28) ^a
T3 : Copper hydroxide (Kocide) @ 0.2%	0 0	0 0	6.66 (14.87) ^c	16.44 (23.90) ^c	63.99 (53.14) ^c	77.77 (61.94) ^b
T4 : Control (Unsprayed)	5.33 (13.73) ^a	18.22 (25.22) ^a	64.44 (53.39) ^a	94.22 (76.65) ^a	100 (90.00) ^a	100 (90.00) ^a
SEd (±)	0.507	0.578	1.227	1.635	0.929	1.780
CD	1.116	1.274	2.702	3.602	2.047	3.921

Values in the parentheses are angular transformed values

Values superscripted with same letter are not significantly different (P=0.05)

Observations are mean of five replications

Table 3: Effect of late blight on tuber infection and total yield of potato due to different forms of copper fungicide

Treatments	Tuber infection (%)	Healthy tuber yield (t/ha)
T1 Bordeaux mixture @ 1 %	22.40 (28.23) ^b	3.65 b
T2 Copper oxy-chloride @ 0.2%	21.86 (27.86) ^b	3.81 b
T3 Copper hydroxide @ 0.2%	12.74 (20.88) ^c	4.48 a
T4 Control (Unsprayed)	41.40 (40.03) ^a	2.23 c
SEd (±)	0.767	0.087
CD (0.05)	1.690	0.192

Values in the parentheses are angular transformed values

Values superscripted with same letter are not significantly different (P=0.05)

Discussion

The results of the study indicated that all the copper containing compounds could significantly delay the development of the late blight and reduce the disease severity compared to the untreated control. The treatment with one prophylactic spray of 0.2 % copper hydroxide at canopy closure followed by two more sprays after appearance of late blight has shown comparatively better efficacy against late blight in comparison to other two copper fungicides viz., copper oxychloride and copper sulphate in the form of Bordeaux mixture. These results were in conformity with the findings of Hermeziu and his coworkers (2014) ^[6] who reported that copper fungicides can effectively control late blight if applied prophylactically with complete coverage of all plant surfaces. They also reported that copper hydroxide formulations work better than copper oxy-chloride in reducing late blight on potato which confirms the findings of the present investigation. The higher efficacy of copper hydroxide against late blight might be attributed to the higher release of copper ion, excellent suspensibility and even coverage on the foliage due to the smaller particle size of copper hydroxide than other two fungicides (Copper oxy-chloride and Bordeaux mixture). Torgeson (1967) ^[9] also suggested that, by reducing the particle size the efficacy of copper fungicide can be considerably improved. On the other hand the increase in healthy tuber yield in copper hydroxide (@ 0.2%) treated plots may be correlated to lowest infection of foliar blight (lower disease intensity) and subsequent reduction in infection on tubers since, potato tubers in soil usually get infected by the spores washed out from blighted foliage. Singh *et al.* (1993) mentioned the there is a direct correlation between increased tuber infection and degree of intensity of late blight on foliage.

Conclusion

Potato late blight, caused by *P. infestans* (Mont.) de Bary, is one of the most devastating potato diseases responsible for lower potato production. Currently, it causes substantial economic losses in both organic and inorganic potato production systems. In the light of the findings obtained from the present investigation, it can be concluded that among different copper containing compounds copper hydroxide can be recommended for management of late blight disease in potato crop under organic cultivation system. Further research on development of an effective spray schedule out of this compound is necessary for management of late blight.

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