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Effect of Borax for the Control of *Phytophthora* Leaf Blight of Taro (*Colocasia esculenta* (L.) Schott)

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Abstract

Effect of borax on sporangial germination as well as leaf blight severity caused by *Phytophthora colocasiae* and corm/cormel yield of taro were studied. Under *in vitro* conditions, borax (200 ppm) treatment totally inhibited both direct (sporangial germination) and indirect (zoospore germination) germination. Leaf blight of taro was completely controlled by spraying 500 ppm of borax under polyhouse conditions. In a field experiment involving 10 taro genotypes, foliar spraying of borax (500 ppm) significantly reduced the leaf area damage per plant by leaf blight disease and the treated plants produced greater corm/cormel yield than untreated plants. The highest corm/cormel yield (0.986 kg plant^{-1}) was recorded in "Muktakeshi" followed by "Kalasaru" under field conditions.

Keyword: Borax, disease severity, Phytophthora colocasiae, sporangial germination, taro

Introduction

Taro (*Colocasia esculenta* (L.) Schott) is one of the major tropical tuber crops grown in several countries (Chandra, 1984). The major area under taro cultivation lies in Eastern and Northern States of India. The corm/cormel serves as staple or subsistence food in many developing countries. The leaves and petiole are also cooked and eaten. It has higher mineral contents and medicinal values compared to other tuber crops. Corm and cormels are also rich in starch and protein. Taro is affected by number of fungal diseases of which *Phytophthora* leaf blight caused by *Phytophthora colocasiae* Raciborski is the most important one. This disease was recorded for the first time by Butler and Kulkarni (1913) from India. It occurs regularly in moderate to severe form on this crop in India causing 25 to 50% yield loss every year (Misra, 1997; Misra and Chowdhury, 1997; Gadre and Joshi, 2003). In addition, this pathogen causes a serious post-harvest decay of taro corms (Jackson and Gollifer, 1975; Misra, 1997). The disease starts with the onset of monsoon and continues till the end of monsoon. It appears as small spots on the taro leaves that later coalesce and whole leaf is destroyed. Under favourable weather, the entire filed is devastated within few weeks. Even though, the chemical control of this disease is possible by fungicides, metalaxyl and mancozeb based fungicides have proved effective in controlling the disease but waxy leaf surface and occurrence of disease during rainy season makes fungicidal spray ineffective (Misra, 1999). Furthermore, the fungicide sprays are too costly to be afforded by marginal farmers. Soil microorganisms rapidly degrade metalaxyl and release into water and soil system. Development of resistance against the systemic fungicides is another major threat. Boron is the constituent of borax and boron is an essential element for plants. It is required in developing leaves, stems and flowers (Blevins and Lukaszewski, 1998). Plants can take up boron through root system and leaves. The foliar applications and soil dressings of boron are often used by growers to limit boron deficiencies and improve fruit set. Use of boron in management of fungal plant disease has been reported (Bowen and Gauch, 1966; Rolshausen and Gubler, 2001). In view of this, the present study was aimed at investigating the effect of borax on sporangial germination of *P. colocasiae* and corm and cormel yield taro plants, in an attempt to explore its potential in controlling taro leaf blight disease.

Materials and Methods

Effect of Borax on sporangial germination

Effect of borax (Sodium tetraborate, Sigma) on sporangial germination in *Phytophthora colocasiae* was studied. Borax was dissolved in sterile distilled water in aseptic condition under laminar flow to obtain a stock solution of 200 ppm and from this 100 and 50 ppm solutions were prepared in sterile distilled water. Spores of *P. colocasiae* were collected in petri plates from taro leaves infected with leaf blight and spores were mixed in 50, 100 and 200 ppm concentrations of borax, separately with five replications. One set of spores suspension mixed in sterile distilled water without borax was maintained as control. The entire set of replicates as well as control was incubated at 28 °C for 6-8 h for sporangial germination. The germinated sporangia (both direct and indirect) were counted under low magnification (20X) in a compound microscope.

Borax spray and disease development

Growth chamber Experiment

Taro plants grown in pots were placed in an illuminated growth chamber (300 μE m^{-2} s^{-1}) with 12 h photoperiod at 28 °C for 4 days. After 4 days, taro leaves of same age were inoculated on their abaxial surfaces with 50 m*l* of sporangial suspension containing approximately 500 sporangia. Taro plants with inoculated leaves were further incubated at 28 °C with 85% humidity under the same light conditions, to allow the symptoms to develop. Then the pots were transferred to the polyhouse and the diameters of disease-lesion were recorded. The diseased leaves were sprayed with different concentrations of borax (100, 200 and 500 ppm) or water (control) twice at 15 days interval. Disease development on taro leaves was assessed by careful examination of increase in the lesion size.

Field Experiment

Ten taro genotypes as mentioned in Table 1 were planted in the first week of June at spacing of 60 x 45 cm in plots of 3 x 2.25 m size with three replications. The crop was sprayed with borax (500 ppm) twice at 15 days interval and corm/cormel yield per plant was recorded in all the genotypes.

Leaf area damaged on a maximum disease intensity day was calculated using the following equation (Melinda et al., 1991).

$$L = [(D/2)^2 - (d/2)^2]$$

Where L = leaf area damaged; D = final average diameter of necrotic leaf area (cm); d = initial average diameter of necrotic leaf area.

Results and Discussion

The present study revealed an important role of borax as a potent inhibitor of spore germination of *Phytophthora colocasiae* on taro plants and under *in vitro* conditions. The effect of borax on sporangial germination under *in vitro* conditions is presented in Fig. 1. The inhibition of spore germination of *P. colocasiae* was found to be dependent on concentration of borax. Both, the direct spore germination (sporangial germination) and indirect spore germination (zoospore germination) were found to be suppressed by borax. Our results clearly demonstrated that borax had more prominent effect on direct sporangial germination than indirect germination. However, under *in vito* conditions, borox at 200 ppm completely inhibited both direct and indirect sporangial germination of *P. colocasiae*.

Under *in vivo* (polyhouse and field) conditions, the rate of development of *Phytophthora* leaf blight disease was significantly reduced in leaves treated with 100 and 200 ppm of borax as compared to control. This effect was concentration dependent and borax at 500 ppm

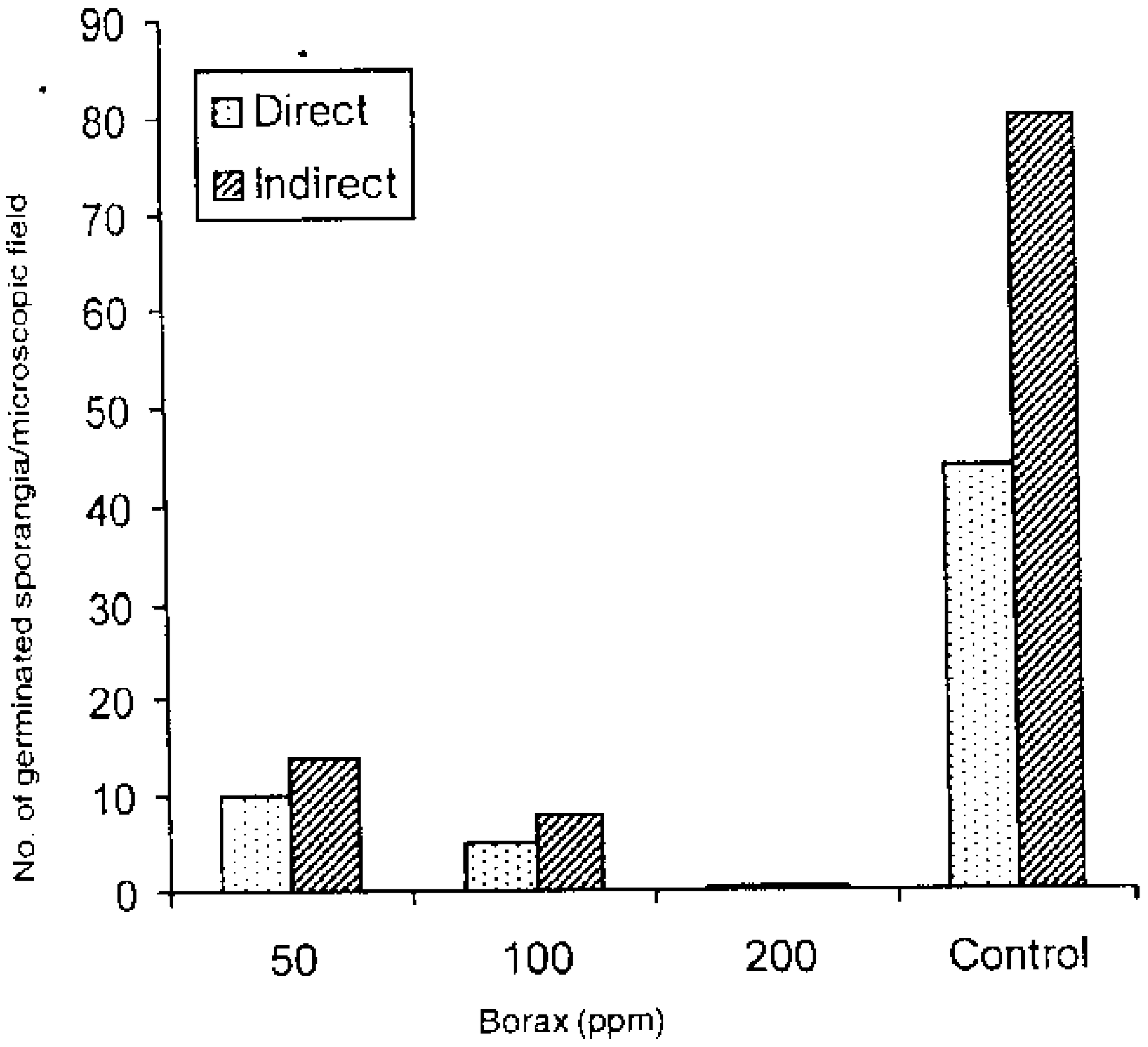

Fig1. Effect of borax on sporangial germination of *Phytophthora colocasiae*

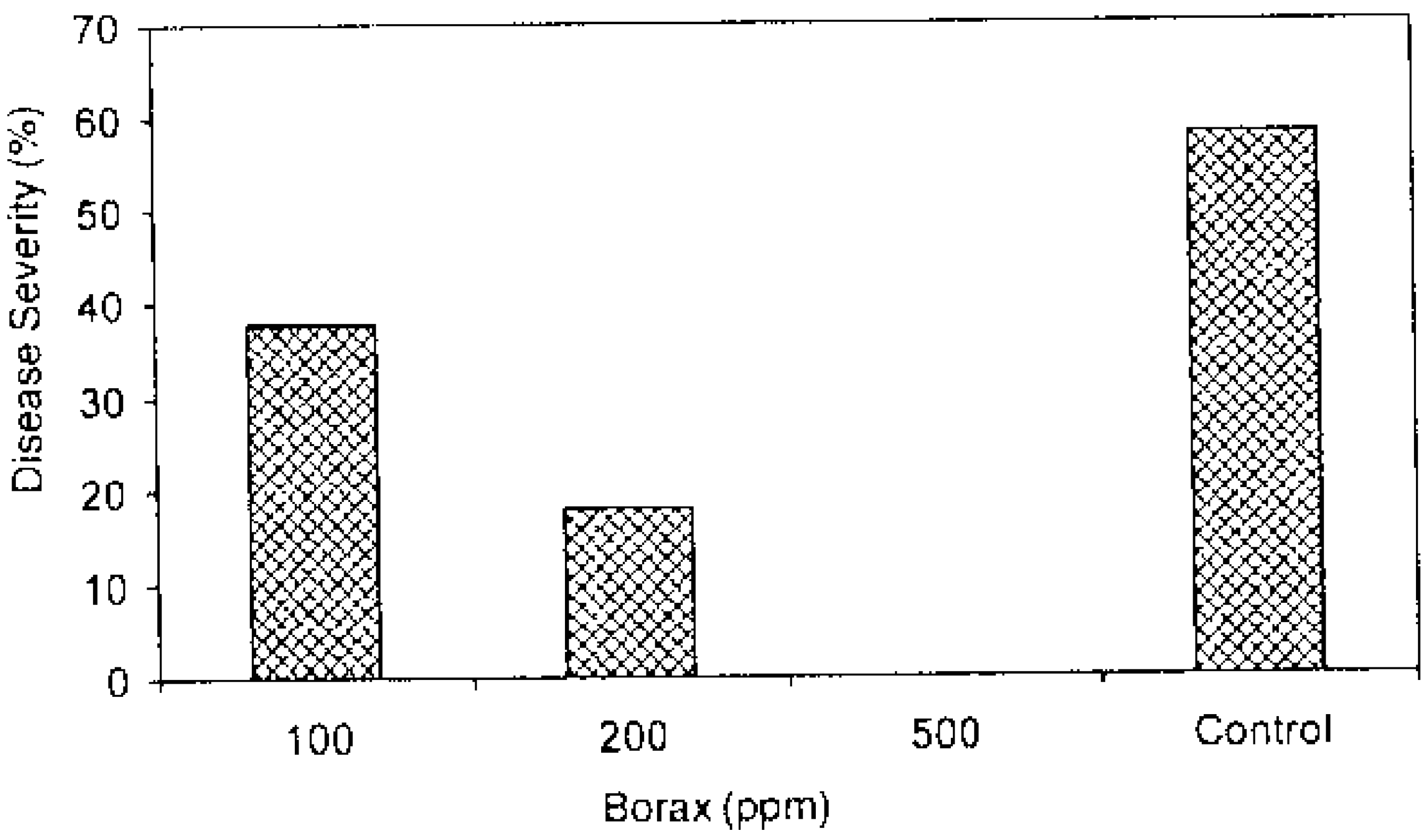

Fig 2. Effect of borax on taro leaf blight disease severity under growth chamber conditions

completely suppressed the disease (Fig. 2). The mechanism by which borax limits fungal growth has not been studied in pathosystem. However, it has been reported that high levels of boron inhibited the growth of *Saccharomyces cerevisae* and *Penicillium chrysogenum* by inhibiting the glycolysis pathway (Bowen and Gauch, 1966). Aldolase was suspected to be the target of toxic levels of boron, making the fungi unable to utilize carbohydrates at a sufficient rate to maintain metabolic processes involved in growth and reproduction (Parker et al., 1999). However, further studies are needed to determine whether dysfunction of glycolysis occurred with *P. colocasiae* when treated with borax or other mechanisms are involved in limiting fungal development. In the present study borax had the positive effect on the corm and cormel yield of taro. In all the taro genotypes, plants treated with borax (500 ppm) through foliar application produced greater corm and cormel yields

Table 1. Effect of borax on leaf area damage due to leaf blight disease and tuber yield of ten taro genotypes under field conditions

Genotype	Leaf area damage plant^{-1} (cm^2)		Tuber yield plant^{-1} (kg)	
	Treated	Control	Treated	Control
Kalasaru	2.74	77.99	0.968	0.725
Satasang	1.25	60.59	0.713	0.523
Telia	2.06	62.15	0.855	0.726
Topi	1.56	61.54	0.599	0.396
Sanasaru	2.76	22.56	0.618	0.557
KCS-3	1.68	55.38	0.866	0.714
Jhankiri	1.62	56.93	0.425	0.351
Kujeesaru	1.55	22.28	0.89	0.749
Muktakeshi	6.31	15.82	0.986	0.651
Bhubaneswar local	1.38	88.25	0.869	0.755
CD (p=0.05)	0.0046	NS	0.12	0.327

than that of untreated plants. Average corm/cormel yield per plant was highest in "Muktakeshi" followed by "Kalasaru' while lowest yield was obtained in the case of "Jhankiri" (Table 1). On the basis of these findings, it is concluded that foliar application of borax (500 ppm) can effectively control the leaf blight of taro caused by *Phytophthora colocasiae*.

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