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# EFFECT OF pH OF COPPER FUNGICIDES ON GERMINATION OF SPORES OF *EXOBASIDIUM VEXANS*

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The Blister Blight disease of tea is controlled effectively by the use of copper fungicides. Since of late there have been some claims that the efficacy of the copper fungicides is influenced by the pH of the spray medium.

In order to ascertain the influence of pH, several *in vitro* studies were carried out using the spore fall technique by varying the pH of copper fungicides at specific rates of 420g/170 l, 280g/170 l as well as at 200 ppm. The pH of the medium (plain agar) was also checked and maintained as a control. The pH of the medium was altered and the germination of basidiospores were examined.

The results revealed that the pH of the tested copper fungicides did not have any effect on germination of basidiospores.

## INTRODUCTION

Blister Blight, a major leaf disease of tea (*Camellia sinensis* L.) is caused by the fungus *Exobasidium vexans* (Massee) and is spread by wind borne spores. This fungus is an obligate parasite, incapable of getting nourishment from dead matter. Germination of spores can be observed under a moist environment within 6-10 hours of the spores coming into contact with young leaves or stems. The spore germination is found to be best in the thinnest film of water such as those formed by condensation (Gadd and Loos, 1950).

Since the advent of this disease in 1946 in this country, copper fungicides including Bordeaux mixture (copper sulphate and hydrated lime), copper oxide, copper hydroxide, copper oxychloride and copper carbonate are being used to control it. Copper fungicides are protective in action and are recommended to be sprayed at 4 to 10 day intervals depending on the severity of the monsoon and the stage of growth (plucking fields or in tea recovering from pruning) of the plant (Arulpragasam, 1986). Even though copper fungicides have been used effectively for the control of the disease there has been some concern in the recent past that the pH of the fungicidal medium may have some effect on the activity of the fungicides and germination of *Exobasidum* spores. In this study several *in vitro* experiments were carried out with different copper formulations in order to ascertain the influence of pH on germination of the spores of the fungus.

## MATERIALS AND METHODS

The spore fall technique was used to collect basidiospores onto the surface of the medium (Parbery, Brown and Bofinger, 1981).

Plain agar was used as the medium for this study and the pH of the media was changed after adding fungicides to the medium. The pH of the medium was altered by adding an acid (HCl) or a base (KOH) to the medium. Affected shoots with sporulating blisters were collected from St. Coombs Estate and the shoots were kept humid to prevent drying. Petri dishes were kept open overnight to collect the basidiospores from the sporulating blisters and were incubated for 6-12 hours for germination. As high relative humidity is required for spore release, the shoots together with the opened Petri dishes were enclosed within bell jars under moist conditions.

The pH of the medium (plain agar) was also checked and maintained as a control. A similar test was carried out with plain agar without adding fungicides but by changing the pH over a range of 3 to 10. The germination of basidiospores was examined under a microscope and germination counts were taken.

The pH values of recommended copper fungicides such as copper oxide, copper hydroxide and copper oxychloride were tested each at 280g in 170 l water, 420g in 170 l water and at 200 ppm in order to determine their normal pH values.

## RESULTS AND DISCUSSION

The pH values of different copper fungicides at recommended rates were found to be between 6 and 10 (Table 1).

TABLE 1 – *pH values of different copper fungicides at recommended rates of application*

| *Fungicide* | *Rate of application (per ha)* | *Type of sprayer* | *pH* |
|---|---|---|---|
| *Copper oxide (perenox)* | 280 g/170 l | Knapsack | 6.50 |
| | 420 g/170 l | Knapsack | 6.63 |
| | 560 g/170 l | Knapsack | 6.64 |
| | 280 g/37.5 l | Mist-blower | 6.92 |
| | 420 g/37.5 l | Mist-blower | 7.09 |
| | 560 g/37.5 l | Mist-blower | 7.64 |
| *Copper oxychloride* | 280 g/170 l | Knapsack | 6.75 |
| | 460 g/170 l | Knapsack | 6.91 |
| | 560 g/170 l | Knapsack | 7.16 |
| | 280 g/37.5 l | Mist-blower | 7.75 |
| | 460 g/37.5 l | Mist-blower | 8.21 |
| | 560 g/37.5 l | Mist-blower | 8.29 |

| | | | |
|---|---|---|---|
| *Copper hydroxide (Kocide)* | 280 g/170 l | Knapsack | 9.00 |
| | 420 g/170 l | Knapsack | 9.28 |
| | 560 g/170 l | Knapsack | 9.34 |
| | 280 g/37.5 l | Mist-blower | 9.54 |
| | 420 g/37.5 l | Mist-blower | 9.74 |
| | 560 g/37.5 l | Mist-blower | 9.85 |

The basidiospores were disposited evenly on the plates by employing the spore fall technique. The results showed that germination of basidiospores were totally inhibited when treated with different copper fungicides irrespective of their pH (Tables 2, 3, 4). The germination of basidiospores under untreated control conditions was uniform being within the range of about 85-95 per cent.

TABLE 2 – *Percentage germination of Exobasidium vexans at different pH levels of copper fungicides*

| *Copper oxide (480 g/170 l)* | | *Copper hydroxide (480g/170 l)* | | *Copper oxychloride (480g/170 l)* | |
|---|---|---|---|---|---|
| *pH* | *Germn. %* | *pH* | *Germn. %* | *pH* | *Germn %* |
| 3.58 | 0.00 | 3.38 | 0.00 | 3.25 | 0.00 |
| 4.47 | 0.00 | 4.51 | 0.00 | 4.15 | 0.00 |
| 5.27 | 0.00 | 5.51 | 0.00 | 5.31 | 0.00 |
| 6.42 | 0.00 | 6.37 | 0.00 | 6.63 | 0.00 |
| 7.61 | 0.00 | 7.54 | 0.00 | 7.57 | 0.00 |
| 8.57 | 0.00 | 8.78 | 0.00 | 8.83 | 0.00 |
| 9.95 | 0.00 | 9.50 | 0.00 | 9.91 | 0.00 |
| Control (pH = 6.62) | 94.87 | Control (pH = 6.62) | 94.44 | Control (pH = 6.62) | 92.86 |

TABLE 3 – *Percentage germination of Exobasidium vexans at different pH levels of copper fungicides*

| *Copper oxide (280 g/170 l)* | | *Copper hydroxide (280g/170 l)* | | *Copper oxychloride (280g/170 l)* | |
|---|---|---|---|---|---|
| *pH* | *Germn. %* | *pH* | *Germn. %* | *pH* | *Germn %* |
| 3.28 | 0.00 | 3.07 | 0.00 | 3.35 | 0.00 |
| 4.40 | 0.00 | 4.05 | 0.00 | 4.40 | 0.00 |
| 5.45 | 0.00 | 5.00 | 0.00 | 5.45 | 0.00 |
| 6.67 | 0.00 | 6.15 | 0.00 | 6.30 | 0.00 |
| 7.45 | 0.00 | 7.16 | 0.00 | 7.62 | 0.00 |
| 8.52 | 0.00 | 8.20 | 0.00 | 8.66 | 0.00 |
| 9.98 | 0.00 | 9.86 | 0.00 | 9.89 | 0.00 |
| Control (pH = 6.62) | 91.89 | Control (pH = 6.62) | 95.65 | Control (pH = 6.62) | 91.43 |

TABLE 4 – *Percentage germination of Exobasidium vexans at different pH levels of copper fungicides*

| *Copper oxide (200 ppm)* | | *Copper hydroxide (200 ppm)* | | *Copper oxychloride (200 ppm)* | |
|---|---|---|---|---|---|
| *pH* | *Germn. %* | *pH* | *Germn. %* | *pH* | *Germn %* |
| 3.16 | 0.00 | 3.34 | 0.00 | 3.32 | 0.00 |
| 4.24 | 0.00 | 4.34 | 0.00 | 4.63 | 0.00 |
| 5.42 | 0.00 | 5.42 | 0.00 | 5.48 | 0.00 |
| 6.78 | 0.00 | 6.15 | 0.00 | 6.76 | 0.00 |
| 7.47 | 0.00 | 7.45 | 0.00 | 7.66 | 0.00 |
| 8.89 | 0.00 | 8.45 | 0.00 | 8.49 | 0.00 |
| 9.78 | 0.00 | 9.89 | 0.00 | 9.84 | 0.00 |
| Control (pH = 6.62) | 94.59 | Control (pH = 6.62) | 93.48 | Control (pH = 6.62) | 88.57 |

In the untreated control medium (plain agar), germination was inhibited when the pH was below 4.0 and the germination of spores was also found to be low when the pH was above 10. The results of three experiments with plain agar without adding fungicides show that the optimum range of pH for germination was between 6-9 (Table 5). Venkata Ram (1976) carried out a study on the effect of pH on the basidiospore germination of blister blight fungus. He made germination counts at the end of a 24 hour period and found that the percentage spore germination was highest at a pH of 9.0.

TABLE 5 – *Effect of pH on germination of Exobasidium vexans*

| *Experiment 1* | | *Experiment 2* | | *Experiment 3* | |
|---|---|---|---|---|---|
| *pH* | *Germn. %* | *pH* | *Germn. %* | *pH* | *Germn %* |
| 03.16 | 00.00 | 03.16 | 00.00 | 03.08 | 00.00 |
| 04.15 | 04.69 | 04.15 | 01.55 | 04.02 | 00.81 |
| 05.30 | 93.48 | 05.30 | 93.02 | 05.22 | 90.08 |
| 06.58 | 93.75 | 06.58 | 81.82 | 06.62 | 95.43 |
| 07.50 | 94.74 | 07.50 | 80.81 | 07.33 | 90.30 |
| 08.24 | 87.80 | 08.24 | 77.78 | 08.54 | 92.09 |
| 09.22 | 82.20 | 09.22 | 85.19 | 09.75 | 92.18 |
| 10.23 | 63.79 | 10.23 | 73.77 | – | – |

It will be seen that in the untreated medium optimum spore germination was observed at a pH of 6-9 while it has been clearly demonstrated that in the presence of copper-based fungicides, germination was inhibited all throughout, irrespective of the pH. This establishes the fact that inhibition of germination is caused by the metallic copper itself quite independent of the pH of the carrier medium.

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