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EFFICACY OF INORGANIC SALTS AGAINST POTATO LATE BLIGHT

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ABSTRACT: Eighteen inorganic salts were evaluated for control of late blight. In detach leaf test, cupric sulphate (0.25%) and zinc sulphate (0.5%) were completely inhibitory to the pathogen. Aluminium chloride (0.5%) was also effective. All the three salts were also effective in controlling late blight at whole plant level.

Some of the inorganic salts like manganese, zinc and copper have shown protective properties against late blight pathogen *Phytophthora infestans*. Hill *et al.* (1998) while working with wide range of chemical compounds such as calcium chelates, phosphates and pectin opined that we might be able to use environmentally safe chemicals to control late blight. Anju Rani *et al.* (2006) have also identified several salts, which showed suppressive effect against *P. infestans in vitro*. In the present study, 18 selected salts which were effective *in vitro* (Anju Rani *et al.*, 2006) were further evaluated *in vivo.*

Salts evaluated were ammonium chloride, potassium bicarbonate, ammonium sulphate, ammonium nitrate, ammonium dihydrogen phosphate, sodium hydrogen carbonate, magnesium nitrate, ammonium acetate and di-sodium hydrogen phosphate (at 1, 2, and 5%) and ferrous sulphate, ammonium ferrous sulphate, aluminium chloride, zinc sulphate, cupric sulphate, potassium meta bisulfite, sodium meta silicate, tetra sodium pyrophosphate and ammonium molybdate (at 0.1, 0.2 and 0.5%). Latter category salts were tested at lower concentrations due to phytotoxicity at > 0.5%. Plants of cv. Kufri Bahar were used. At 40 days after planting, fourth leaf from the top was sprayed till run off with the salt solution prepared in distilled water at pre-determined concentration. Free moisture from treated leaves was removed by drying in shade and placed upside down in the screening trays. Twenty µl of zoospore suspension (6 x 10^4 zoospores/ml) was placed at the center of each leaflet and the inoculated leaflets were incubated at 18°C for five days. Five replications were maintained for each treatment. Untreated control was sprayed with distilled water. Length and breadth of the lesions were measured and the lesion area was calculated following the method of Singh and Bhattacharya (1995). Number of sporangia/cm^2 of leaflet were also recorded. Salts, which gave promising results, were further tested by employing whole plant method. Forty days old plants were raised in earthen pots, later shifted to screening chamber and sprayed with salts solutions at the pre-determined concentration till run off and allowed to dry. Filter paper discs (0.5 mm) dipped in 6 x 10^4 zoospores/ml were used for inoculating the plants. In all, 15 filter paper disks were placed on each plant. Each treatment consisted of three replications of five pots each. The inoculated plants were incubated at 18° C and RH > 90% under dark for 48 h. Thereafter, chamber was illuminated by fluorescent light (120-140 µmoles m^{-2} S^{-1}). Infection frequency (IF), lesion area (LA) and sporulation capacity (SC) were estimated as described by Tooley *et al.* (1986). Based on these observations, composite fitness index (CFI) was calculated.

In detach leaf method, out of 9 salts tested at 1, 2 and 5% concentration, except disodium hydrogen phosphate, none was found much effective in suppressing the tissue colonization by *P. infestans* (**Table 1**). However, sporangial production was inhibited by all the salts at 2 and 5% concentrations with the least sporangial production at 5%.

Table 1. Effect of salts tested against *P. infestans* in detached leaf test

Salt	Concentration at					
	1%		2%		5%	
	Lesion size (cm^2)	Sporangia/ cm^2 x10^4	Lesion size (cm^2)	Sporangia/ cm^2 x10^4	Lesion size (cm^2)	Sporangia/ cm^2 x10^4
1	2	3	4	5	6	7
Ammonium chloride	8.9^{bc*}	3.920^{b}	8.2^{def}	2.800^{b}	8.5^{cd}	3.3^{d}
Potassium bicarbonate	7.8^{b}	4.320^{b}	5.8^{b}	3.640^{c}	5.7^{b}	2.7^{c}
Ammonium sulphate	8.1^{b}	4.240^{b}	7.4^{cd}	3.080^{b}	Phytotoxic	-
Ammonium nitrate	8.4^{bc}	3.800^{b}	8.6^{ef}	3.640^{c}	7.5^{c}	3.5^{d}
Ammonium dihydrogen phosphate	8.3^{bc}	3.040^{a}	7.5^{cde}	3.560^{c}	7.9^{c}	1.9^{b}
Sodium hydrogen carbonate	8.1^{b}	3.840^{b}	Phytotoxic	-	-	-
Magnesium nitrate	8.3^{b}	4.440^{b}	7.2^{cd}	4.640^{de}	7.5^{c}	3.6^{d}

(*Contd.*)

Table 1. (*Contd.*)

1	2	3	4	5	6	7
Di sodium hydrogen phosphate	6.7[a]	4.160[b]	4[a]	1.760[a]	4.5[a]	1.2[a]
Ammonium acetate	8.1[b]	4.200[b]	6.6[bc]	4.400[d]	5.8[b]	3.4[d]
Control	9.5[c]	5.120[c]	9[f]	5.040[e]	9.1[d]	5.0[e]
Ferrous sulphate	7.2[c*]	3.48[cd]	6.8[d]	3.72[e]	Phytotoxic	-
Ammonium ferrous sulphate	7.3[c]	4.08[de]	5.2[c]	2.84[cd]	Phytotoxic	-
Aluminium chloride	4.1[b]	2.76[ab]	3.7[b]	2[b]	1.2[b]	1.12[b]
zinc sulphate	3.0[b]	2.32[ab]	3.2[b]	1.64[b]	0[a]	0[a]
cupric sulphate	0.9[a]	0.8[a]	0[a]	0[a]	Phytotoxic	-
ammonium molybdate	6.8[c]	4.08[de]	7.5[d]	3.6[e]	5.1[c]	2.6[d]
potassium meta bisulfite	6.3[c]	4.68[ef]	8.6[e]	3.2[de]	6.1[d]	3.36[e]
sodium meta silicate	7.3[c]	4[de]	7.3[d]	2.92[cd]	6.4[d]	3.24[e]
tetra sodium pyrophosphate	6.6[c]	3[bc]	7.4[d]	2.52[c]	6[cd]	1.92[c]
control	8.9[d]	5.12[f]	9.6[e]	4.8[f]	8.9[e]	4.96[f]

* Numbers in each column followed by the same letter are not significantly different according to Duncan's multiple range test at P≤0.05

Out of 9 salts evaluated at 0.1, 0.25 and 0.5% concentrations, ferrous sulphate, ammonium ferrous sulphate and cupric sulphate were phytotoxic. Cupric sulphate at 0.25% showed complete inhibition whereas zinc sulphate and aluminium chloride showed encouraging results at 0.1%. These salts also reduced the sporangial production compared with untreated control. At 0.5%, zinc sulphate was completely inhibitory while aluminium chloride was also effective.

Three salts *viz*., zinc sulphate, copper sulphate and aluminium chloride were tested at whole plant level. Zinc sulphate and copper sulphate were highly effective resulting in lesion size of only 0.121 and 0.089 cm^2 and were at par (**Table 2**). Aluminium chloride was next in effectiveness resulting in lesion size of 0.568 cm^2 as compared to 4.650 cm^2 in control. Similar trend was noticed with regard to sporangial production.

Table 2. Effect of selected salts against *P. infestans* at whole plant level

Treatment	Lesion size (cm^2)	Sporulation/cm^2 ($x10^4$)	Infection efficiency	CFI ($x\ 10^4$)
Zinc sulphate (0.5%)	0.121[a*]	0.29333[b]	0.500[c]	0.0959[a]
Cupric sulphate (0.25%)	0.089[a]	0.17333[ab]	0.367[b]	0.0427[a]
Aluminium chloride (0.5%)	0.568[b]	0.86[c]	0.833[d]	0.4661[b]
Mancozeb (0.25%)	0[a]	0[a]	0.000[a]	0[a]
Control	4.650[c]	1.8333[d]	0.867[d]	8.1634[c]

* Numbers in each column followed by the same letter are not significantly different according to Duncan's multiple range test at P≤0.05

Copper and zinc sulphate are known to have fungicidal effects (Kishore *et al*., 2001, Lakshikanta-Ganguly *et al*., 2003). The present study shows that aluminium chloride is also having a having fungicidal effect against *P. infestans*. These three salts were effective against *P. infestans* both *in vitro* and *in vivo.*

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