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Pathology

Control of Foliar Diseases of Groundnut Using Inorganic and Metal Salts

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Late leaf spot (LLS) caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* are the two major foliar diseases of groundnut (*Arachis hypogaea*) which usually occur together and significantly reduce the crop yield (Subrahmanyam et al. 1995). Desirable levels of host plant resistance against these two diseases are not available in cultivars commonly grown by farmers. Fungicidal control of LLS and rust is expensive and requires alternative strategies for management of these destructive diseases. Several inorganic and metal salts possess antifungal activity and control pre-harvest and postharvest diseases caused by pathogenic fungi (Reuveni et al. 1995, Olivier et al. 1998). These chemicals were also proved to elicit the plant defense mechanisms against invasion of pathogenic fungi (Gamil 1995). We studied the effects of 33 inorganic and metal salts on the germination of conidia of *P.personata* and urediniosporcs of *P. arachidis* under in vitro conditions and the efficacy of selected salts to reduce the incidence of LLS and rust in detached leaf bioassay.

In vitro antimicrobial assay

Inorganic and metal salts at a final concentration of 10^{-2} M and 10^{-3} M were evaluated for their inhibitory effects on germination of *P.personata* conidia and *P.arachidis* urediniospores. Conidia and urediniosporcs were taken separately onto cavity slides and mixed with respective salt solutions. The final concentration of conidia and urediniosporcs was 30,000 ml^{-1}. Conidia and urediniospores suspended in sterile double distilled water were treated as controls. Three replications were maintained for each treatment and the experiment was repeated once. The slides were incubated in a humid chamber at 23±1°C in dark. Conidia and urediniospores were observed for germination at 24 h and 8 h after incubation, respectively. In each replication, one hundred spores were observed randomly for germination and the percentage inhibition with respect to control was calculated separately for each treatment. The differences between the percentage inhibition values in two sets of experiments were not significant and hence were pooled and subjected to analysis of variance.

Of the 33 salts tested, chromium trioxide, cupric sulfate, ferric chloride, nickel chloride, and zinc chloride at 10^{-3} M concentration had significant inhibitory activity (P=0.01) against both *P.personata* and *P.arachidis.* At the same concentration sodium carbonate and sodium molybdate were effective against *P.personata* alone, and ammonium dihydrogen orthophosphate and cobalt chloride were effective against *P.arachidis* alone. Ammonium fluoride, ammonium sulfate, ammonium tartrate, borax, calcium chloride, calcium sulfate, magnesium chloride, magnesium nitrate, sodium carbonate, sodium citrate, sodium fluoride, and sodium phosphate were inhibitory to both the test fungi, only at 10^{-2} M concentration (Table 1).

Detached leaf bioassay

Chromium trioxide, cupric sulfate, ferric chloride, nickel chloride, and zinc chloride at 10^{-3} M concentration were tested to control the development of LLS and rust on detached groundnut leaves of the susceptible genotype TMV 2 (Subrahmanyam et al. 1983). Cultures of *P.personata* and *P.arachidis* were maintained on detached leaves of genotype TMV 2.

Conidia and urediniospores suspended in sterile double distilled water at a concentration of 20,000 ml^{-1}

Table 1. Percentage inhibition of in vitro germination of conidia of *Phaeoisariopsis personata* and urediniospores of *Puccinia arachidis* by various inorganic and metal salts at 10^{-2} and 10^{-3} M concentrations[1].

	Inhibition of germination (%)			
	P. personata		*P. arachidis*	
Inorganic or metal salt	10^{-2} M	10^{-3} M	10^{-2} M	10^{-3} M
Ammonium chloride	26.9	16.2	89.2	8.2
Ammonium dihydrogen orthophosphate	46.9	22.5	91.8	53.2
Ammonium fluoride	96.1	45.2	100.0	32.0
Ammonium nitrate	39.0	37.7	90.3	36.7
Ammonium sulfate	57.1	20.6	96.1	42.4
Ammonium tartrate	82.1	23.2	99.1	17.2
Barium chloride	46.8	17.5	17.4	13.6
Borax	100.0	44.9	100.0	-7.8
Calcium chloride	53.9	22.0	52.9	32.7
Calcium sulfate	47.8	20.4	58.3	24.1
Chromium trioxide	100.0	100.0	99.6	100.0
Cobalt chloride	100.0	38.6	100.0	100.0
Cupric sulfate	100.0	99.4	100.0	100.0
Ferric chloride	100.0	100.0	100.0	100.0
Magnesium chloride	69.8	40.2	75.9	-12.1
Magnesium nitrate	79.6	12.0	S3.8	9.4
Magnesium sulfate	62.6	12.1	0.8	-10.0
Manganese chloride	89.6	45.3	41.2	31.2
Nickel chloride	99.4	98.7	100.0	99.1
Potassium carbonate	68.5	20.5	21.1	-0.3
Potassium chloride	47.0	27.3	16.2	-1.8
Potassium hydrogen phosphate	45.6	19.6	39.8	20.5
Potassium hydroxide	36.7	9.8	21 7	-21.9
Potassium nitrate	21.6	18.8	27.8	-3.1
Potassium sulfate	38.5	-9.3	50.8	-21.6
Sodium acetate	46.9	20.3	43.4	30.0
Sodium carbonate	84.2	51.3	67.4	-18.5
Sodium chloride	42.9	24.5	33.9	23.8
Sodium citrate	98.7	45.5	96.2	18.7
Sodium fluoride	61.6	35.0	61.8	41.0
Sodium molybdale	88.3	72.7	21.7	13.0
Sodium phosphate	66.2	9.6	64.0	34.0
Zinc chloride	100.0	84.5	99.0	76.2
Control	0	0	0	0
LSD (P = 0.01)	45.7		50.1	
CV (%)	33.4		37.2	

1. Data are means of six replications in two sets of experiments.

were used as inoculum. The salt solutions were sprayed onto the leaves at 24 h before pathogen inoculation and leaves sprayed with sterile double distilled water were treated as controls. Each replication consisted of ten detached leaves; three replications were maintained for each treatment and the experiment was repeated once. The lesion frequency (number of lesions cm^{-2} leaf area) was measured at 15 days after pathogen inoculation, both for *P. personata* and *P. arachidis* inoculated leaves.

None of the salts used in detached leaf bioassay were toxic to groundnut leaves. All the five salts tested significantly reduced the lesion frequency of both LLS and rust, when compared to control. Cupric sulfate and nickel chloride were effective in controlling both LLS and rust when compared to other salts (Table 2). Copper containing fungicides have been widely used against various pathogens. Nickel nitrate was effective in control of bacterial blight of rice *(Oryza sativa)* (Chandrasekaran and Vidhyasekaran 1988). These metal salts when used in combination with other fungicides or plant extracts may further enhance their disease control ability. The addition of iron to copper compounds enhanced the toxicity of copper compounds to the walnut blight pathogen *Xanthomonas campestris* pv. *juglandis,* as iron altered the physiology of the bacterium and increased the amount of free copper ions by reducing the pH (Lee el al. 1993). The efficacy of these metal salts to control LLS and rust is being verified under greenhouse and field conditions.

Table 2. Effect of metal salts at 10^{-3} M concentration on the development of late leaf spot (LLS) and rust on detached groundnut leaves as measured by lesion frequency at 15 days after pathogen inoculation[1].

	Lesion frequency (number of lesions cm - leaf area)	
Metal salt	LLS	Rust
Chromium trioxide	2.1	4.4
Cupric sulfate	1.4	3.3
Ferric chloride	2.2	5.6
Nickel chloride	1.6	3.9
Zinc chloride	2.3	4.9
Control	3.7	9.6
LSD (*P* = 0.01)	0.42	1.02
CV (%)	15.8	12.1

1. Data are means of six replications in two sets of experiments.

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