EFFECT OF CHEMICAL ELEMENTS ON THE GROWTH OF CROP PATHOGENS

II. Effect of Hg-, Ni-, Sn-, Pb-, Fe-, and Al-Salts on Rice Blast and Sheath Spot Fungi

by

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INTRODUCTION

The effects of salts of Cd, Cu, Co, Zn and Mn on the growth of rice blast and sheath spot fungi were investigated in previous report. The present study was conducted to investigate the effects of Hg—, Ni—, Sn—, Pb—, Fe—, and Al—salts on the growth of the same pathogens.

MATERIAL AND METHOD

The salts used in the experiments were shown in Table 1. The isolates of the pathogens were the same as those in the previous experiment. They were renewed on 2% glucose potato agar medium before using for the experiment. Twenty-day culture of the rice blast fungus and 4-day culture of the sheath spot fungus were used throughout the experiment. The composition of media and the concentration of the salts were same as those used in previous experiment.[1] Plate dilution method was employed. Sheath spot fungus grew rapidly and the margins on the colonies were often vague, but the density of the mycelia was influenced distinctly by various treatments. For this reason, in addition to measuring the diameters (size) of colonies, the density of growing mycelia was also observed to evaluate the effects of various treatments when sheath spot fungus was tested. On the contrary, the margins of colonies of rice blast fungus were so clear that their sizes could be measured. So the size of colony was taken as the measure of the effects of various treatments.

Table 1. The Salts used in the experiment

Compounds / Elements	Sulfates	Nitrates	Chlorides	Remarks
Aluminum	$Al_2(SO_4)_3 \cdot 18H_2O$	$Al(NO_3)_3 \cdot 9H_2O$	$AlCl_3 \cdot H_2O$	C. P.
Nickel	$NiSO_4 \cdot 7H_2O$	$Ni(NO_3)_2 \cdot 6H_2O$	$NiCl_2$	C. P.
Tin	$SnSO_4$	—	$SnCl_2 \cdot 2H_2O$	C. P.
Lead	$PbSO_4$	$Pb(NO_3)_2$	$PbCl_2$	C. P.
Iron	$FeSO_4 \cdot 7H_2O$	$Fe(NO_3)_2 \cdot 9H_2O$	$FeCl_2$	C. P.
Mercury	—	—	$HgCl_2$	C. P.

RESULT AND DISCUSSION

1. Effect of various salts on the growth of rice blast fungus.

Table 2 shows the sizes of colonies of rice blast fungus which has been cultured for 12 days on the media containing various salts of different concentrations. As shown in the table, among the salts investigated, $HgCl_2$ has the strongest suppressing effect on the growth of rice blast fungus. This salt still has some suppressing effect at 10^{-4} mol concentration, but does not have remarkable effect at 10^{-5} concentration. Nickel salt ranks second to $HgCl_2$ in regard to suppressing the growth of rice blast fungus. The extension of growing mycelia at 10^{-3} mol concentration was only 1/5 or 1/3 of that of control. But at 10^{-5} mol, Ni-salt did not effect the growth of mycelia. Nickel Chloride was stronger as a poison of the mycelia than its nitrate and sulfate; the sulfate was weakest. The salts of Fe and Pb have a slight suppressing effect on the growth of the fungus. Their chlorides have stronger effects than nitrate and sulfate. Lead nitrate and sulfate do not seem to affect the growth of mycelia.

Neither Al-salt nor Sn-salt showed any influence on the growth of rice blast fungus at the concentrations tested.

From the results shown in Table 2, the orders of suppressing effects of various salts may be as follows:

$$Hg > Ni > Fe > Pb > Al = Zn$$

$$\text{Chloride} > \text{nitrate} > \text{sulfate}$$

Table 2. The effects of some salts on the growth of the rice blast fungus

Concentration / Salts	10^{-3} Mol (cm×cm)	10^{-4} Mol (cm×cm)	10^{-5} Mol (cm×cm)	Remarks
$Al(SO_4)_3 \cdot 18H_2O$	8.0×8.6(1)	8.0×8.0	8.0×8.0	No any effects
$Ni(SO_4) \cdot 7H_2O$	2.3×2.5	7.0×7.0	7.8×7.8	Suppressing effect
$SnSO_4$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$PbSO_4$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$FeSO_4 \cdot 7H_2O$	7.5×7.5	7.8×7.8	7.9×7.9	Slight suppressing effect
$Al(NO_3)_3 \cdot 9H_2O$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$Ni(NO_3)_2 \cdot 6H_2O$	1.7×1.8	6.9×7.0	7.8×8.0	Suppressing effects
$Pb(NO_3)_2$	7.8×8.0	8.0×8.0	8.0×8.0	No any effect
$Fe(NO_3) \cdot 9H_2O$	7.4×7.6	7.8×7.9	8.0×8.0	Slightly suppressing effect
$AlCl_3 \cdot H_2O$	7.8×7.9	8.0×8.0	8.0×8.0	No any effects
$NiCl_2$	1.5×1.5	6.5×6.7	7.5×7.8	Highly suppressing effect
$SnCl_2 \cdot 2H_2O$	8.0×8.0	8.0×8.0	8.0×8.0	No any effects
$FbCl_2$	7.5×7.6	7.6×7.6	8.0×8.0	Slightly suppressing
$FeCl_3$	7.3×7.3	7.5×7.5	7.9×8.0	Slightly suppressing effect
$HgCl_2$	—	6.0×6.0	7.0×7.0	No growth at 10^{-4} Mol
Control	8.0×8.0	Density of all colonies.....		

(1) Average of four replications each in two trials.

2. The effects of various salts in the growth of sheath spot fungus.

The influence of various salts on the area and the density of mycelia of sheath spot fungus were presented in Table 3. Since this pathogen grew rapidly, the size of mycelia were observed on the 3rd day after inoculation, but the size was not affected by adding salts. However, the densities of mycelia varied from treatment to treatment, so the density was used as the measures of suppressing effects of the salts.

Table 3. The effects of the various salts on the growth of the sheath spot fungus

Concentration / Salts	10^{-3} Mol		10^{-4} Mol		10^{-5} Mol		Remarks
	Mycelia (area)	Densi.	Mycelia (area)	Densi.	Mycelia (area)	Densi.	
$Al_2(SO_4)_3 \cdot 18H_2O$	full	+	full	++	full	+++	Suppressing effect at 10^{-3} mol
$NiSO_4 \cdot 7H_2O$	5.5×6.3	-+	full	-+	full	-+	Suppressing effect
$SnSO_4$	full	+++	full	+++	full	+++	No effect
$PbSO_4$	full	-+	full	++	full	+++	Slightly suppressing effect at 10^{-3} mol
$FeSO_4 \cdot 7H_2O$	full	++	full	+++	full	+++	No effect
$Al(NO_3)_3 \cdot 9H_2O$	full	++	full	++	full	+++	No effect
$Ni(NO_3)_2 \cdot 6H_2O$	5.2×5.2	-+	full	-+	full	-+	Suppressing effect
$Pb(NO_3)_2$	full	++	full	+++	full	+++	No effect
$Fe(NO_3)_2 \cdot 9H_2O$	full	++	full	+++	full	+++	No effect
$AlCl_3 \cdot H_2O$	full	-+	full	++	full	+++	Slightly suppressing effect at 10^{-3} mol
$NiCl_2$	4.8×5.0	-+	full	-+	full	+++	Suppressing effect at 10^{-3}–10^{-4}
$PbCl_2$	full	-+	full	++	full	+++	Suppressing effect at 10^{-3} mol
$FeCl_2$	full	++	full	+++	full	+++	Slightly suppressing effect at 10^{-3} mol
$HgCl_2$	—	—	full	-+	full	-+	Highly suppressing effect.
Control	full	+++					

(1) Average of four replications each in two trials.

As shown in Table 3, the suppressing effects of various salts on the growth of sheath spot fungus were similar to those on rice blast fungus. Mercuric chloride has the strongest suppressing effect on sheath spot fungus, it inhibits the growth of mycelium completely at 10^{-3} mol concentration; at lower concentrations some growth of mycelium can be observed, but the mycelium is rather scant and lacking in vigor. Nickel salts show inhibiting effects on the area 5 of mycelium as well as on its density regardless of kind of anion.

Aluminum and lead salts have similar effects on the growth of sheath spot fungus. Although the area of mycelium is not influenced by the concentration of the salts, the density is apparently scant at 10^{-3} mol concentration. These salts do not inhibit the growth of sheath spot fungus at 10^{-5} mol concentration. Nitrates

of Al and Pb have weaker effects than sulfates and chlorides. Even at 10^{-3} mol concentration of the nitrates, the growth of mycelium is quite extensive.

Ferrous salts seem to be less poisonous to sheath spot fungus than Al-salts. Only slight suppressing effect on the density of mycelium is found at 10^{-3} mol concentration. Higher concentrations of Fe salts must be required to suppress the growth of this fungus. Stannous salts do not be have as poisons for sheath spot fungus, but they seem to be have as stimutants at low concentration such as 10^{-5} mol.

With a few exception, the effects of various salts on the growth of sheath spot fungus are similar to those for rice blast fungus.

Among the salts investigated, Hg-salt is most poisonous to sheath spot fungus and the suppressing effects on the growth of its mycelium decrease in the following order:

Hg>Ni>Al>Pb>Fe>Sn

As indicated in Tables 2 and 3, Hg- and Ni-salts have strong suppressing effects on the growth of rice blast and sheath spot fungi. Other salts do not seem to have remarkable on their growth. This result was probably due to their hydrolyses in aqueous solutions. In the solutions there were some sediments, which might be hydroxides. According to Ram[3] who compared the control effects of various salts on tea blister blight, hydroxides are least effective as a fungicide.

The fungicidic effect of Hg-compounds have been well recognized for many years. Chien[3] reported that $HgCl_2$ had some control effect on rice blast fungus when it was applied to soil. In addition to inorganic Hg-salts,[6] organic mercury has been widely used as a fungicide.

The fungicidic effects of Ni-salts have been also observed by Venkata[2] in India. He found that tea blister blight was most effectively controlled by spraying solutions of Ni-salts and that the chloride was most effective, being followed by the nitrate and the sulfats. Although Ni compounds have not been used extensively as fungicides up to present, they are promising for this purpose. Their fungicidic effect must be further investigated.

As shown above, kind of anion may influence the fungicidic effects of salts. This result has been also obtained by Sasaki[4] (Ram) and Mukoo[5]. The fungicidic effects of heavy metall salts seem to derive not only from their cations but also from the anions.

From the results obtained in previous and present experiments, the control effects of various salts on the growth of rice blast fungus decrease in the following order:

Cd>Hg>Co>Cu>Ni>Zn>Fe>Pb>Al>Sn>Mn

For sheath spot fungus, the order may be as follows.

Cd>Hg>Co>Ni>Cu>Zn>Al>Pb>Fe>Sn>Mn

SUMMARY

The effects of some inorganic saltes on the growth of rice blast and sheath spot

fungi were investigated. Among the salts tested, $HgCl_2$ shows the strongest fungicidic effect. Nickel salts also has inhibitory effects on both fungi, but the effect decreases rapidly as the concentration is decreased.

Ferrous- and lead-salts at 10^{-3} mol concentration inhibit slightly the growth of rice blast fungus, while Al- and Sn-salts show little effect. Aluminum- and lead-salts seem to affect the density of mycelium of sheath spot fungus, but Fe-and Sn-salts show no effect.

In both previous and present experiments, chlorides are most effective for inhibiting the growth of both fungi.

Fungicidal effects of the salts so far tested on rice blast fungus decreases in the following order:

Cd>Hg>Co>Cu>Ni>Zn>Fe>Pb>Al>Sn>Mn

The order for sheath spot fungus is as Follows:

Cd>Hg>Co>Ni>Cu>Zn>Al>Pb>Fe>Sn>Mn

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化學元素對作物病原菌之影響

第二報 Hg, Ni, Sn, Pb, Fe, Al 等元素對稻熱病及稻紋枯病菌發育之影響

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摘　　要

爲明瞭各種化學元素對作物病原菌發育之影響如何，而舉辦本試驗。所得結果，希望可供爲農藥資源開發及植病防治上之參考資料。

在本試驗之第一報，曾使用 Cd, Co, Cu, Zn ，及 Mn 等五種重金屬元素爲材料並已報告(1)，故本試驗仍依照第一報之設計及方法，繼續檢討 Hg, Ni, Sn, Pb, Fe，及 Al 等元素對稻熱病菌及稻紋枯病菌發育之影響。茲將所得之結果摘錄如下：

(1) 本試驗使用之六種元素中，氯化汞對稻熱病菌及稻紋枯病菌發育之抑制力最強。

(2) Ni 化合物在 10^{-3} Mol 濃度時，能抑制稻熱病菌及稻紋枯病菌之發育。

(3) Pb 及 Fe 兩元素在 10^{-3} Mol 濃度時稻熱病菌菌絲之發育稍有影響，但 Al 及 Sn 在 10^{-3} Mol 濃度時仍無任何影響。

(4) Al 及 Pb 在 10^{-3} Mol 濃度時對稻紋枯病菌菌絲發育密度有抑制現象。但 Fe 與 Sn 對菌絲密度之影響並不顯著。

(5) 本試驗採用之三種鹽類中，以氯化物之抑制力最大。此與第一報之結果相同。

(6) 本試驗使用之六種元素，對稻熱病菌之發育抑制力之順序是 Hg>Ni>Fe>Pb>Al>Sn，而對稻紋枯病菌之順序則是 Hg>Ni>Al>Pb>Fe>Sn，兩者因病原菌之不同略有差異。