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Effect of Benomyl, Copper oxychloride and Mancozeb on Rhizosphere Microflora of Potato

A K SHUKLA, B K TIWARI and R R MISHRA
Department of Botany, School of Life Sciences, North-Eastern Hill University, Shillong 793 014

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The effect of fungicides, Benomyl, Copper oxychloride and Mancozeb on the rhizosphere microflora of potato has been studied. The fungal and bacterial populations of rhizosphere and non-rhizosphere soils dropped significantly following application of the fungicides and throughout the study treated plots harboured lower populations than the control plots. The effect of fungicides was more pronounced in the rhizosphere region than the non-rhizosphere. The species composition was also altered and dominant species were more severely affected.

Key Words: Potato, Rhizosphere, Fungicides, Fungi, Bacteria

Introduction

Microbial population of soils are altered by the fungicides application (Wainwright 1977, 1978, Wainwright & Pugh 1973, 1974, 1975 a, Kuthubutheen 1979, Torstensson 1979, Chandra et al. 1982, Torstensson & Wessen 1984). Foliar application of fungicides affects rhizospheric microflora by changing the chemical nature and/or quantity of root exudates (Vrany et al. 1962, Balasubramanian et al. 1970, Srivastava et al. 1970). Most of the studies concern with crops like rice, wheat and legumes (Sunar & Chohan 1971, Gupta 1974, Srivastava & Dayal 1981, Bagyaraj & Rangaswami 1982). Although during recent times use of fungicides in potato crops has increased many folds, the effect of fungicides on rhizosphere microflora of potato has not received ample attention. Present study was conducted to investigate the effect of foliar spray of three most commonly used fungicides on the rhizosphere microflora of potato.

Materials and Methods

The study was conducted in the farms of Central Potato Research Station (CPRS), Shillong. (altitude 1706 M. latitude 25°34″N, longitude 91°56″E). Atmospheric temperature, relative humidity and total monthly rainfall of the study area was recorded.

Disease free tubers were procured from the CPRS, Shillong. The crop was sown in the last week of March 1986. Five $30M^2$ plots were taken for each treatment and the control. The plots were randomized. Three fungicides recommended for potato and commonly used by the growers of this region were used. The chemical names, commercial names, recommended doses and manufactures of the fungicides were as follows: Benomyl, Methyl 1-(Butyl Carbomyl)-2-benzimidazole Carbamate, Benlate, (0.37 kg/ha), Du Pont, USA; Copper oxychloride, Blitox 50, (7.4 kg/ha), Rallis India; Mancozeb, Zinc ethylene bisdithio Carbamate, Dithane M-45, (2.0 kg/ha), Indofil India.

Initial sampling for microbiological analysis was done 20 days after emergence of the plants and on the same day recommended doses of the fungicides were sprayed. The samples were collected at 15, 30, 45 and 60 days after application of fungicides. The method of sampling and the assessment of rhizosphere and non-rhizosphere microflora was done following standard methods described elsewhere (Srivastava & Mishra 1971). For enumeration of fungal propagules 0.5 ml of appropriate dilution was inoculated on sterilized petriplates containing 20 ml of rose bengal agar medium (Martin 1950). For bacterial population

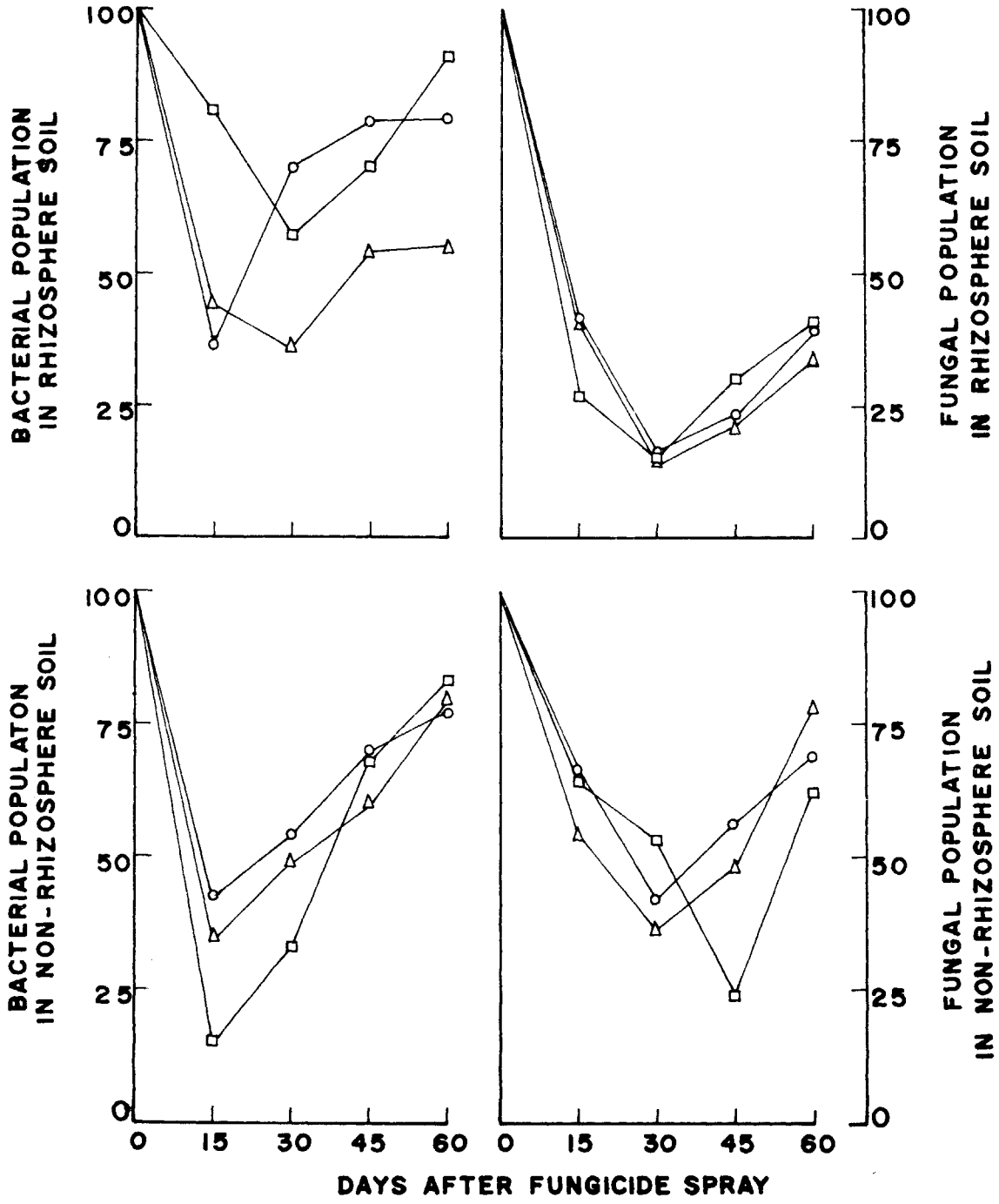

Figure 1 Bacterial and fungal population in non-rhizospheric and rhizospheric soil sprayed with fungicides

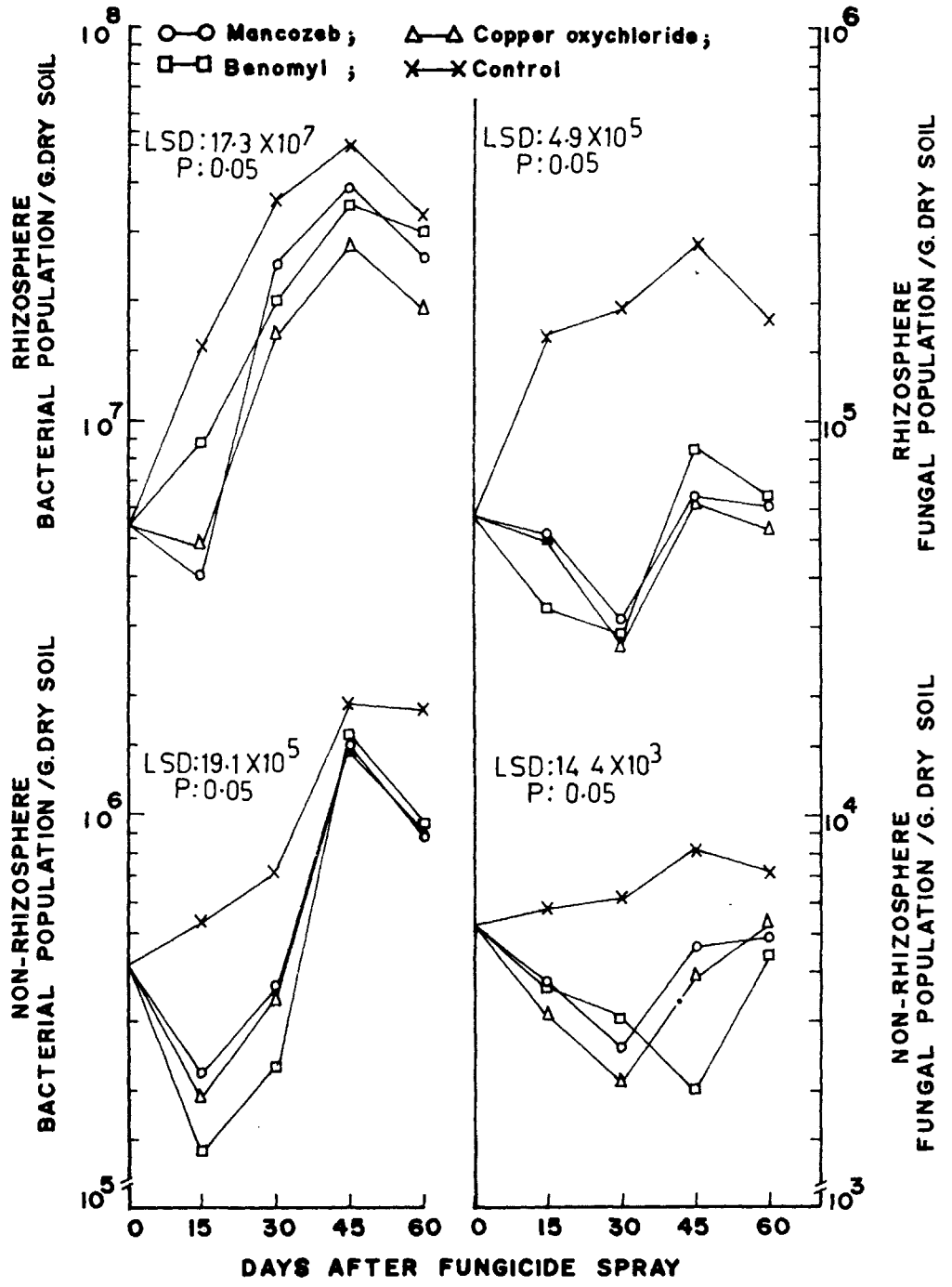

Figure 2 Bacterial and fungal population in non-rhizospheric and rhizospheric soil sprayed with fungicides expressed as percentage of the control. Symbols as in fig 1

nutrient agar medium (Johnson & Curl 1972) was used. Petriplates for fungi were incubated at 25°C for seven days and for bacteria at 30°C for 24 hrs. The microbial population was calculated on the basis of per gram dry weight of soil in rhizosphere and non-rhizosphere region. Three replicates were maintained for each analysis.

Results and Discussion

The effect of foliar application of Benomyl, Copper oxychloride and Mancozeb on bacterial and fungal population of rhizosphere and non-rhizosphere soils are depicted in figures 1 and 2. Except rhizosphere bacterial population in the case of Benomyl treated plants, fungicide spray resulted into a drop in the microbial population. Throughout the study, rhizosphere and non-rhizosphere soils of fungicides treated plants harboured less population than the control. Similar results have been reported by several other workers (Srivastava et al. 1970, Kuthubutheen 1979, Abdelfattah et al. 1982, Doneche et al. 1983). Figure 2 shows that in most cases after the initial drop in population a recovery was observed. The recovery was speedy and maximum in the case of non-rhizospheric bacteria (75%–85%), while slow and minimum in the case of rhizospheric fungi (35%–40%). Fast and rapid recovery of bacteria may be attributed to their tolerance to the action of fungicides (Peeples 1974, Chaube 1985) and capacity of quick growth rate (Wainwright & Pugh 1975b). It could be inferred that the adverse effect of fungicides was severe and prolonged in the case of rhizospheric fungi (figure 2). It is established that foliar spray of chemicals affect the chemical composition and quantity of root exudates (Vrany et al. 1962, Balasubramanian & Rangaswami 1967). These chemicals are translocated through the plant body and are excreted through the root (Linder & Mitchell 1963, Lukose & Singh 1985). The results of present study demonstrate the possiblity of exudation of fungicidal substances in the rhizosphere region as is evident from the significant drop in the fungal population in the rhizosphere region of the fungicide treated plants (figures 1, 2). In the case of fungi, however, fungicidal effects being more pronounced, the general pattern of variation did not follow similar pattern. Continued increase in the microbial population of untreated soils could be attributed to the more favourable temperature and moisture conditions during later part of the study (table 1). This is in general conformity with the earlier studies of Mishra and Srivastava (1969), Srivastava and Mishra (1971). The higher microbial population in the rhizosphere could be attributed to rhizosphere effect. R/S ratio for fungi varied between 9 and 43 while in the case of bacteria it ranged between 11 and 88 (table 2). Similar range of R/S values have been reported by Zukovskaya (1941) and Rangaswami and Vasantharajan (1961). Generally R/S value of fungi were lower in fungicide-treated plants indicating that fungi of rhizosphere region were more severely influenced as compared to the soil fungi which further strengthens our inference on possibility of exudation of fungicides through the roots. R/S values for bacteria did not follow any general trend.

Table 3 lists fungal species isolated from rhizoshere and non-rhizosphere soils of treated and control plants. *Fusarium oxysporum* and *Mucor hiemalis* were common to all the treated as well as control soils. *Acremonium rutilum, Aspergillus flavus* and *Necteria ventricosa* were isolated only from the fungicide-treated plants. Irrespective of treatment, *Acremonium rutilum* and *Necteria ventricosa* were isolated only from the rhizospheric soils while *Arthrobotrys conoides, Oligospora, Oidiodendron echinulatum* and *Rhizo-*

Table 1 *Temperature and relative humidity of the atmosphere and rainfall of the study area*

Months	Mean Temp. (°C)		Mean Relative humidity (%)		Rain-fall (mm)
	Max.	Min.	08.30 hrs.	17.30 hrs.	
March (1986)	20.1	7.7	44	56	13.4
April (1986)	20.0	11.1	74	78	143.4
May (1986)	21.3	11.7	72	78	246.5
June (1986)	22.9	15.8	84	88	274.8

Table 2 *Influence of fungicides on Rhizosphere effect (R/S)* of Fungal and bacterial population. Upper values are R/S of fungi and lower values are R/S of bacteria*

Sampling Period	Control	Benomyl	Copper oxychloride	Mancozeb
15	21.40	9.00	15.90	13.50
	20.20	11.60	25.70	18.30
30	29.80	8.80	12.20	11.90
	50.00	87.70	36.40	69.40
45	34.30	43.20	15.70	14.00
	27.90	28.40	25.60	35.90
60	22.00	14.20	10.40	12.50
	19.20	30.90	19.90	29.30

*R/S = $\frac{\text{Microbial population in rhizosphere region}}{\text{Microbial population in soil}}$

Table 3 *Effect of fungicides on the fungal population (per gram dry soil) of rhizospheric (R) × 10^4 and non-rhizospheric (N) × 10^3 soils of potato. Values are means of four determinations*

Isolates	Control		Benomyl		Copper oxychloride		Mancozeb	
	R	N	R	N	R	N	R	N
Acremonium rutilum	—	—	0.3	—	—	—	—	—
Aspergillus flavus	—	—	—	—	—	—	3.2	1.4
Arthrobotrys conoides	—	1.5	—	0.7	—	—	—	—
Arthrobotrys oligospora	—	1.5	—	0.7	—	—	—	—
Cladosporium cladosporioides	34.0	3.1	4.0	2.8	7.3	—	7.1	1.4
Fusarium oxysporum	3.9	6.6	6.8	2.2	5.6	2.9	12.0	4.4
Fusarium poae	7.1	—	—	2.3	—	1.5	—	—
Fusarium solani	3.0	2.3	—	2.3	—	1.5	—	1.5
Monilia sp.	2.0	2.9	—	5.2	—	3.8	—	3.0
Mortierella minutissima	—	1.5	—	1.5	1.8	2.3	—	—
Mucor circinelloides	—	1.5	—	—	0.7	—	—	—
Mucor hiemalis	43.6	2.3	16.5	1.5	11.2	3.6	1.3	3.8
Mucor plumbeus	22.6	6.8	—	2.2	2.4	2.8	2.6	1.4
Mucor racemosus	15.3	0.7	16.3	—	0.7	0.6	3.2	—
Necteria ventricosa	—	—	—	—	3.7	—	—	—
Oidiodendron echinulatum	—	—	—	—	—	—	—	3.1
Penicillium brevicompactum	24.8	4.5	—	2.3	3.7	2.3	0.8	—
Panicillium chrysogenum	19.4	6.1	3.2	4.1	—	7.2	7.6	9.6
Rhizopus oryzae	—	—	—	2.2	—	—	—	—
Trichoderma harzianum	—	1.5	1.3	2.2	—	3.7	—	2.2
Trichoderma viride	2.5	2.9	0.3	0.7	1.8	—	1.0	—
Sterile white	4.0	2.0	—	—	1.2	—	—	—
Sterile orange	—	12.8	1.9	4.3	13.5	5.2	7.9	8.1

oryzae were isolated from non-rhizospheric soils only. *Cladosporium cladosporioides, Fusarium poae, F. solani, Monilia* sp., *Mortierella minutissima, Mucor plumbeus, M. racemosus, Oediodendron echinulatum, Penicillium brevicompactum, P. chrysogenum, Trichoderma harzianum, T. viride* showed sporadic appearance and did not show any treatment or habitat (rhizosphere, non-rhizosphere) preference. Species composition of fungi isolated from rhizosphere and non-rhizosphere soils during the present study was similar to that of Sudha (1979) and Chandra et al. (1982). Srivastava and Dayal (1981) also reported change in the structure of fungal community following fungicidal application. Table 3 also depicts that population of dominant rhizosphere fungi like *C. cladosporioides, F. poae, M. hiemalis, M. plumbeus, M. racemosus, P. brevicompactum* and *P. chrysogenum* was drastically reduced in the fungicide treated sets. On the other hand, fungi with lower population were least affected. This also suggests that the fungicides treatment adversely altered the rhizosphere environment for the fungi community.

Results of the present study clearly demonstrate the possibility of exudation of fungicidal substances from the roots of fungicide treated potato plants. The fungal and bacterial populations of rhizosphere of fungicide treated plants is drastically reduced and significantly altered in species composition. It appears, the fungicide spray changes fungal community structure and thus adversely affects various fungi mediated processes of soil and rhizosphere. This may harmfully affect the process of nutrient release and aggravate soil pathogens due to indiscriminate killing of antagonistic saprotrophs of the root region.

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