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INTERACTIVE EFFECT OF PESTICIDE AND SO_2 ON MAIZE PLANTS

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SUMMARY

Effects of three different pesticides on free proline content, total soluble proteins and nitrate reductase activity in SO_2 fumigated and non-fumigated maize plants (CM-124xCM-128) were studied under pot conditions. Total free proline content reduced in response to all the three pesticides used, while total soluble proteins and nitrate reductase activity increased. Protein content and NRA decreased in SO_2 fumigated plants over unfumigated control, while free proline content increased. Pesticide treated plants revealed lesser effect of SO_2 fumigation than the untreated plants. Thus pesticides reduced the effect of SO_2 fumigation in maize plants.

Key words **: Maize, nitrate reductase, pesticide, proline, proteins, SO_2.**

INTRODUCTION

Pesticides are used in agriculture mainly for the purpose of increasing plant productivity. The main categories of pesticides used for agricultural practices are herbicides, fungicides, insecticides and nematicides. Pesticides appear in the air as pollutant by drift of aerial or ground applications of spray or dust formulations. As air pollutant they may affect adversely the quality of plants so that they can not be used safely (Levitt 1972). A lot of work has been done on the role of pesticides in providing protection to plants against weeds in terms of crop yield (Davies and Duray 1992, Azam *et al.* 1997, Bhagat and De 2001). Only a little work has been established on the role of pesticides in affecting bio-chemical characteristics of the plants (Jerlin 2001), but interaction of pesticide and SO_2 pollution has not been studied earlier. It is quite possible that in the environment plants are exposed to more than two stresses at a time. The present study was carried out to evaluate the interactive effects of pesticides and SO_2 pollutant on different bio-chemical parameters of nitrogen metabolism in maize (*Zea mays*) plants.

MATERIALS AND METHODS

Two fungicides, dithane (DM-45), 75%WP and ridomil MZ-72 (metelaxayl 8% + mancozeb 64% WP) and one insecticide, endosulfan (oxydemeta-methyl) were used in the experiments. Dithane was supplied by Bayer Ltd, Ghaziabad Industries, India, Ridomil by Rallis India Ltd, India and endosulfan was supplied by Hoechst Pharmaceuticals Ltd. India. Surface sterilized (sodium hypochlorite solution 0.5%) seeds of maize. (*Zea mays* L.) cultivar CM-124xCM-128, were germinated in sterilized petri-plates at room temperature (30 ± 2^0C). After seven days of germination, seedlings were transferred to soil in plastic pots (8"dia). A number of 6 sets (having 4 pots in each set) were maintained for pesticidal application. One set was sprayed uniformly with endosulfan (0.25 ml/l), second set with dithane (0.25%) and third set with ridomil (0.2%). Remaining

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three sets were maintained as control (without pesticide treatment). After 20 days of pesticidal spray, 2 pots from each set were fumigated and remaining two pots were kept as unfumigated. Fumigation was done for 2 hrs with 1.0 ppm SO_2 in an airtight fumigation chamber placed in the growth room (temp.27± 2^{0}C, RH 60± 2%, light intensity 400 ± 2 Lux). Control plants were also fumigated in chamber that was identical in all respects, except no SO_2 was added to the air. After 2 hrs both fumigated and unfumigated plants were analysed for total free proline content (Bates *et al.* 1973), total soluble proteins (Lowry *et al.* 1951) and nitrate reductase activity (Hageman and Hucklesby 1971).

RESULTS AND DISSCUSSION

In both fumigated and unfumigated plants, application of different pesticides resulted in reduction of free proline content (Table 1). This might be associated with the promotory effects of pesticides. Bhagat and De (2001) reported the promotory effects of insecticide endosulfan in tomato plants. They observed significantly higher yield of tomato plants in response to foliar application of endosulfan. Total carotene content and fresh weight were also increased in iprodione (fungicide treated lettuce plants (Rouchaud *et al*. 1985). Koleva *et al*. (1990) found a reduction in essential amino acids and amides in sunflower plants treated with carbendazim. The decrease of total free proline content may be associated with the inhibitory effects on various enzymes of proline synthesis pathway due to different pesticides. It is also possible that the various pesticides might be causing proline oxidation to glutamic acid. According to Singh and Kang (1984), different amino acids might have been diverted towards protein synthesis.

Protein content was slightly increased in response to various pesticides (Table 2). These results confirm the earlier findings of other workers (Beaumont *et al.* 1979, Moly 1986). Dominick and Mohanasundharam (1992) reported that insecticide decamethrim spray on cotton increased the level of total soluble proteins in leaves. Foliar application of carboxin and oxycarboxin to wheat in boot stage increased protein content of harvested grains (Reyes *et al.* 1969). Protein and total N-contents increased at low doses of herbicide metribuzin in castor bean and maize plants (El-Saht *et al.* 1994). The increase in protein content may be associated with the incorporation of amino acids into soluble protein. Atrazine tended to accumulate more protein at the expense of soluble nitrogen and free amino acids in *Fusarium fabae* (Mahmoud *et al.* 1981). Pulver and Ries (1973) found that simazine increased the ^{14}C-leucine incorporation into soluble proteins. The second factor responsible for increase of soluble proteins might be associated with the lesser hydrolysis of proteins due to pesticide application.

Table 1. Effect of different pesticides on total free proline content in unfumigated and fumigated maize plants

Treatment	Proline content (µg g^{-1}fw) Unfumigated plants	Fumigated plants	% increase over unfumigated control
Without endosulfan	52.18	70.50	35.11
With endosulfan	46.13* (11.59)	56.83* (19.43)	23.13
Without dithane	53.25	81.63	53.28
With dithane	49.85 (6.3)	73.10** (10.44)	46.63
Without ridomil	54.0	87.25	61.57
With ridomil	51.75^{ns} (4.16)	81.62* (6.45)	57.72

*Significant at 0.5%, **significant at 1%, ns-non-significant
Figures in bracket represent the percentage decrease over the control value (without pesticidal spray).

Table 2. Effect of different pesticides on total soluble proteins in unfumigated and fumigated maize plants

Treatment	Protein content (µg g^{-1}fw) Unfumigated plants	Fumigated plants	% increase over unfumigated control
Without endosulfan	9026.67	7390.53	18.13
With endosulfan	9452.17* (4.71)	8624.33* (11.83)	12.56
Without dithane	9024.67	7274.33	19.39
With dithane	9392.0* (4.07)	7995.0* (9.9)	14.87
Without ridomil	9021.83	7345.0	18.58
With ridomil	9350.3* (3.64)	7892.33*	15.59 (7.45)

*Significant at 0.5%
Figures in brackets represent the percentage increase over the control value (without pesticidal spray)

Table 3. Effect of different pesticides on nitrate reductase activity in unfumigated and fumigated maize plants

Treatment	Nitrate reductase activity (µmol NO_2 g^{-1} fw h^{-1}) Unfumigated plants	Fumigated plants	% decrease over unfumigated control
Without endosulfan	5.75	4.25	26.08
With endosulfan	6.30* (9.56)	5.32* (25.17)	15.55
Without dithane	5.72	4.21	26.39
With dithane	6.18* (8.04)	5.05* (19.95)	18.28
Without ridomil	5.70	4.18	26.67
With ridomil	6.12* (7.37)	4.92* (7.70)	19.61

*Significant at 0.5%
Figures in brackets represent the percentage decrease over the control value (without pesticidal spray)

Tripathi *et al*. (1982) reported that fungicide inhibits degradation of chlorophyll, RNA and protein and checks the activity of protease, ribo-nuclease and esterase.

Nitrate reductase activity also increased in response to different pesticide treatments in maize (Table 3). This is in agreement with the work of Pulver and Ries (1973), where an increase of ten fold in nitrate reductase activity at 9.6 x 10^{-6} M simazine was observed. It may due to the fact that low concentrations of pesticide may cause promotory effects on plant metabolism and enzymes. Shetty and Magu (2001) observed the stimulation in nitrogenase activity in mung bean treated with metalaxyl. Peroxidase activity and 1,3, ß glucanase activity was also enhanced by 2,4-D application (Lethbridge *et al*. 1981).

However, fumigation with SO_2 caused decline in NRA in both pesticide treated and untreated plants. When pesticide treated maize plants were exposed to SO_2 fumigation, total free proline content increased and protein content and NRA decreased in both pesticide treated and pesticide non-treated fumigated plants. Data showed that combined effect of pesticides and fumigation is nearly the same as of the effect of individual pesticide and SO_2 fumigation.

In the field, it is quite possible that plants are exposed to pesticidal treatment followed by SO_2 fumigations. In such cases, the pesticide treated plants would be showing lesser effect due to SO_2 fumigation than the non-pesticidal treated plants.

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