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Phytotoxic effect of organophosphate insecticides; phosphomidon and monocrotophos on wheat, maize and mustard

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ABSTRACT

Wheat, maize and mustard were selected to observe the phytotoxic effect of two important organophosphate insecticides; phosphomidon and monocrotophos. The experiment was divided into two parts. In first part, seed germination experiment was carried out in which parameters related to seed germination were recorded. In second part pot culture experiment was done where plants were grown in polythene bags containing same soil and parameters related to growth and development were recorded on 30th day after sowing the seeds. The effect of both insecticides on seed germination percentage on wheat, maize and mustard showed a gradual decrease at increasing concentration. However, the lower concentration of monocrotophos slightly induces the germination. The delay in seed germination was also pronounced as evident by sprouting time. As concentration increased there was delay in germination time. Mean rootlet length and shootlet length were badly affected by the increasing concentration of both insecticides. The Seedling Vigour Index (SVI) of rootlets and shootlets indicates the decrease in vigourness as increasing concentration of both insecticides. Vigourness slightly increased with lower concentration of monocrotophos. In pot culture experiment, shoot length growth was decreased as the concentration of both insecticides increased. In mustard lower concentration of monocrotophos promotes the growth over control. There were reduction in leaf area of wheat, maize and mustard, but lower concentration of monocrotophos promotes the leaf area of mustard. Number of leaf was also decreased as concentration increased in all three plants and for both insecticides. The chlorophyll contents were decreased at increasing concentration of both insecticides. The phenomenon of chlorosis and necrosis were also observed, which starts from margins of the leaves and later leaves become whitish and dry.

Key words: Phytotoxicity, phosphomidon, monocrotophos, wheat, maize, mustard.

INTRODUCTION

Organophosphate insecticides are one the most important group of insecticides in common use these days. These are preferred over organo-chlorine derivatives because of their non persistent nature. They are effective over a wide range of pestilent insects and quickly degraded into harmless metabolites within the living system as well as within the environment. Within a period of three months after application they almost completely eliminated from the system (Helling *et al.,* 1971). Organophosphate insecticides implicate the nervous system of target insect. They are capable of inhibiting the activity of enzyme acetyl-choline from the synaptic cleft after an impulse has passed through the junction (Murphy, 1969). The negative effect of insecticide application became visible when it was found to affect the non target fauna of soil (Thompson and Edward, 1974). As the nervous system does not occur in plants it is generally thought to be harmless to them.

However, the present study clearly indicates that the use of organophosphate insecticides badly affect the growth and

development of plants in a concentration which generally applied to the crops. For present study two important organophosphate insecticides viz., Phosphomidon (Trade name- Dimecron) and Monocrotophos (Trade name- Nuvacron) were used to study their effect on common crop plants; wheat, maize and mustard.

Phytotoxic response varies with types and varieties of plants, its concentration, physico-chemical characteristics of soil etc. The phytotoxic response often appears as delayed germination, stunted growth, depressed photosynthesis and defoliation (Edward *et al.,*1978).

MATERIAL AND METHODS

Wheat (var.UP-262), maize (var. Jaunpuri desi) and mustard (var. Varuna type-4) were selected to assess the phytotoxic effect of organophosphate insecticides; phosphomidon and monocrotophos. These varieties are grown to a large extent in eastern Uttar Pradesh. Experiment was divided into two parts. The first part was seed germination experiment in which parameters related to seed germination were recorded. The second part was pot culture experiment in which plants were grown in polythene bags and parameters related to growth and development were recorded.

In seed germination experiment 100 healthy seeds of wheat and mustard each and 20 seeds of maize were placed in a pot having flat bottom with sand as a suitable absorbent medium to provide equal status of solution and other conditions to all seeds. The seeds were soaked with different concentrations of phosphomidon and monocrotophos along with a control at room temperature (25±5 °C). Three replicates were also maintained for each plant and each concentration. The time of appearance of first sign of germination was recorded for ten seeds of each sample and mean was calculated. The germination percentage, rootlet length and shootlet length of seedlings (10 plants were taken for each sample) were recorded on 15th day after soaking the seeds. Seedling Vigour Index (SVI) was calculated by method of Abdul Baki and Anderson (1973).

In pot culture experiment 10 seeds of each are grown in polythene bags of equal size containing equal quantity of soil. Plants were irrigated with different concentration of phosphomidon and monocrotophos along with a set of control for each crop. Vegetative characters like shoot length, number of leaf, area of largest leaf and chlorophyll content were measured on 30th day after sowing. The leaf area was measured with the help of graph paper. Chlorophyll a and chlorophyll b were measured by the method of Jayaraman (1981), and their summations were considered as total chlorophyll.

RESULT AND DISCUSSION

The result of seed germination experiment is summarized in table 1 and pot culture experiment in Table 2.

Seed Germination Experiment

In the seed germination experiment all the parameters except time for sprouting was observed on 15th day. Effect of phosphomidon and monocrotophos both on all three plants viz., wheat, maize and mustard were very pronounced. As the concentration increased the germination percentage was decreased. Germination of wheat seeds were 91% in control, it decreased to 88% in 250 ppm, 83% in 500 ppm and 79% in 1000 ppm concentration of phosphomidon. The germination percentage for wheat at same concentrations of other insecticide, monocrotophos was 93%, 85% and 81% respectively. At lower concentration of 250 ppm monocrotophos slightly induces the germination over control. The similar results were also observed by Ramulu and Rao (1990) on cluster bean. Sithanathan (1973) reported similar concentration dependent reduction in germination on cotton seeds treated with organophosphate insecticides. In maize similar pattern was observed that of wheat. However, in mustard concentration as lower as 250 ppm of monocrotophos reduces the germination percentage from control, and the effect of monocrotophos was greater than phosphomidon.

The delay in seed germination was also pronounced as evident by sprouting time. As the

Table 1: Seed germination experiment

Plant	Parameters	Control	Concentration of Phosphomidon in ppm			Concentration of Monocrotophos in ppm		
			250	500	1000	250	500	1000
Wheat	Seed Germination (%)	91	88	83	79	93	85	81
	Time of Sprouting (in hrs)	51	54	65	69	51	58	66
	Mean Rootlet length(cm) ± SD	6.9±2.7	5.9±2.4	3.5±1.7	3.4±1.2	6.1±2.7	4.7±1.6	3.0±0.7
	Mean Shootlet length(cm) ± SD	7.1±2.9	6.0±2.1	4.1±1.5	3.8±0.9	6.8±2.3	5.2±1.1	3.5±0.5
	SVI for Rootlet	627	519	290	268	569	399	243
	SVI for Shootlet	1274	1047	630	568	1199	841	526
Maize	Seed Germination (%)	93	89	86	80	94	88	85
	Time of Sprouting (in hrs)	53	58	64	71	51	63	70
	Mean Rootlet length(cm) ± SD	4.8±1.4	3.9±2.1	3.9±2.0	1.6±0.3	6.0±2.1	5.4±1.8	2.9±0.7
	Mean Shootlet length(cm) ± SD	6.2±2.1	4.3±1.9	4.3±2.5	3.1±1.7	7.3±2.5	5.9±2.1	3.2±0.5
	SVI for Rootlet	446	347	335	24	564	475	246
	SVI for Shootlet	1023	729	705	272	1150	994	518
Mustard	Seed Germination (%)	99	95	89	85	89	85	81
	Time of Sprouting (in hrs)	37	49	55	71	48	53	57
	Mean Rootlet length(cm) ± SD	-	-	-	-	-	-	-
	Mean Shootlet length(cm) ± SD	-	-	-	-	-	-	-
	SVI for Rootlet	-	-	-	-	-	-	-
	SVI for Shootlet	-	-	-	-	-	-	-

Table 2: Pot cultivation experiment

Plant	Parameters	Control	Concentration of Phosphomidon in ppm			Concentration of Monocrotophos in ppm		
			250	500	1000	250	500	1000
Wheat	Mean Shootlet length(cm) ± SD	14.5±2.5	14.3±2.3	11.8±3.2	8.2±2.5	14.4±2.1	12.8±3.7	9.1±1.7
	Leaf Area of largest leaf(cm^2)	38.8	38.5	29.1	21.3	23.8	29.1	25.1
	No of leaves	12	10	10	6	12	10	8
	Chlorophyll a (mg/l)	5.17	4.08	3.23	0.1	3.13	3.68	3.68
	Chlorophyll b (mg/l)	4.84	3.98	2.54	1.91	3.95	3.67	3.48
	Total Chlorophyll (mg/l)	11.01	8.06	5.77	1.92	7.08	7.35	7.16
Maize	Mean Shootlet length(cm) ± SD	13.8±3.3	14.1±2.4	13.9±2.3	11.8±2.7	12.1±3.1	11.2±1.8	8.9±1.7
	Leaf Area of largest leaf(cm^2)	45.9	51	45.8	41	45.3	41.2	37
	No of leaves	6	8	6	4	8	8	4
	Chlorophyll a (mg/l)	6.22	2.41	0.92	2.16	1.19	2.38	2.4
	Chlorophyll b (mg/l)	3.18	1.08	1.29	1.71	0.29	1.27	1.19
	Total Chlorophyll (mg/l)	9.4	3.49	2.21	4.87	1.38	3.65	3.59
Mustard	Mean Shootlet length(cm) ± SD	15.8±4.1	13.8±5.8	12.3±6.1	9.0±5.0	16.2±2.8	15.9±4.7	15.2±3.7
	Leaf Area of largest leaf(mm^2)	940	406	229	168	1045	1012	938
	No of leaves	10	9	9	5	15	12	9
	Chlorophyll a (mg/l)	2.31	2.14	1.19	1.17	2.11	1.9	2.37
	Chlorophyll b (mg/l)	1.17	1.96	1.76	0.77	2.12	1.76	2.22
	Total Chlorophyll (mg/l)	3.48	4.1	2.95	1.94	4.23	3.66	4.59

concentration of both the insecticides increased, there was delay in germination. The sprouting time in wheat was 51 hrs for control followed by 54 hrs for 250 ppm, 65 hrs for 500 ppm and 69 hrs for 1000 ppm solution of phosphomidon. The values for the same were 51 hrs, 58 hrs and 66 hrs respectively for monocrotophos. The same pattern was observed for both the insecticides on maize also. In the case of mustard sprouting was much delayed for phosphomidon than monocrotophos.

Mean rootlet length and shootlet length were badly affected by the increasing concentration of both the insecticides on wheat and maize. In wheat rootlet length was 6.9±2.7 cm in control, followed by 5.9±2.4 cm, 3.5±1.7 cm and 3.4±1.2 cm in 250 ppm, 500 ppm and 1000 ppm solutions respectively of phosphomidon. Values for the same when treated with monocrotophos were 6.1±2.7 cm, 4.7±1.6 cm and 3.0±0.7 cm respectively. The shootlet length also showed the same pattern. The effect of monocrotophos was very much similar to that of phosphomidon. Maize also behaved similarly to that of wheat for both the insecticides. However, in the mustard, being its seed very small and seedlings very fragile, it could not be separated out from the sands and was not measured.

The Seedling Vigour Index (SVI) of rootlet and shootlet for seed treated with phosphomidon in wheat and maize both, showed similar pattern as the concentration increased the vigouress was decreased. However, seeds treated with monocrotophos the vigourness slightly increased at lower concentration i.e. 250 ppm in wheat and maize both. SVI for mustard could not be calculated due to unavailability of data of rootlet length and shootlet length.

Pot culture experiment

In pot culture experiment the plant growth and development were observed on 30th day and data were recorded. In wheat the shoot length was 14.5±2.5 cm in control followed by 14.3±2.3 cm, 11.8±3.2cm and 8.2±2.5 cm when irrigated with the phosphomidon solution of 250 ppm, 500 ppm and 1000 ppm of respectively. It clearly indicates that as concentration increased the shoot length was decreased. Similar pattern was also observed for monocrotophos on wheat. The similar result was observed in maize for both insecticides. However, in the case of mustard the reduction of growth for both the insecticide was much smaller than wheat and maize. Even the lower concentration of monocrotophos promotes the growth over control by 2.5% in 250 ppm and 0.63% in 500 ppm solution. Whereas the same concentration of phosphomidon showed reduction in growth by 6% and 11% for wheat and 12% and 18.8% for maize respectively.

The area of largest leaf was recorded on 30th day. There was reduction in leaf area from control in wheat and maize, whereas in mustard leaf area was increased when it was irrigated with lower concentration of monocrotophos. However, the leaf area was decreased even in mustard when irrigated with phosphomidon. It was very effective in causing reduction in leaf size of mustard. It showed the gradual death of leaves started from margins and later interveinal injury. The reduction in leaf area of wheat from control i.e. 38.8 cm^2 was 0.7%, 35% and 45% for 250 ppm, 500 ppm and 1000 ppm concentration of phosphomidon respectively. The values for the same for monocrotophos were 1%, 25% and 35% respectively. The same pattern is observed for both the insecticides on maize except at 250 ppm of phosphomidon which enhances the leaf size over control by 11%. The reduction in leaf size of mustard was very pronounced for phosphomidon than monocrotophos, instead it enhances the leaf area up to concentration of 500 ppm. At 1000 ppm leaf area was decreased only by 0.2%.

Number of leaf per plant was recorded on 30th day. In all the three plants and for both insecticides the number of leaf was decreased as concentration increased.

The chlorophyll a, chlorophyll b and total chlorophyll were decreased in all three plants for both insecticides on increasing concentration. The phenomenon of chlorosis and necrosis were also observed which starts from the margins of the leaf. As the concentration of chlorophyll decreased it is but natural to expect the lower photosynthetic efficiency and thereby lower productivity.

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