Effect of pesticides on pollen germination of some monocot and dicot crops

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ABSTRACT. – An attempt has been made to study the effect of pesticides (Lasso and karathane) on pollen grains of some monocot and dicot crops. Lasso increased the diameter, percentage of polle germination and the tube length. Whereas karathane inhibited the diameter,percentage of pollen germination and tube elongation. The physiological implication of these results are discussed.

INTRODUCTION

Pollen abortion, abnormal tapetal behaviour and poor vascular supply of pollen were recorded in *Ranunculus muricatus* with the effect of various chemical pesticides (Chauhan and Kumar, 1980a). Again Chauhan and Kumar (1980b) observed abnormal tapetum, and endothecium of anther in *Capsicum* with the influence of MH,FW 450 and Dalapan applied to the leaves. The present investigation has been undertaken to study the effect of pesticides on pollen grains of some crop plants.

MATERIALS AND METHODS

Pollen from mature anthers, as collected from the flowers of monocotyledonous crops, such as *Oryza sativa, Eleusine coracana, Pennisetum typhoides* and dicotyledonous crops *Gossypium herbacium, Cajanus cajan* and *Lycopersicon lycopersicum.*

Pollen germination, tube length and diameter were studied according to the method of Padmanabhan (1977). Medium containing 1% of sucrose solution, 250 ppm of boric acid and 150 ppm of calcium chloride solution was chosen as a standard solution for the study. Lasso (2-chloro 2'6' diethyl acetanilide) and karathane (Isomeric mixture of 4 octayl phenyl crotanate) and Karathane (Isomeric mixture of 4 octayl phenyl crotanate) solutions of required concentrations were prepared in the above medium. The pollen grains were incubated in standard or in pesticidal solution for 30 minutes and centrifuged at low speed for five minutes. Pellet was redispersed in to small amount of respective suspension medium.

From the above suspension small quantities were removed and spread on a slide and the diameter of the pollen grain and the pollen tube length were measured with precalibrated ocular

micrometer. The diameter and the tube length were measured at two hourly interval up to the 6th hour, and 60 pollen grains were measured and average of ten such observations were recorded. Similarly separate sets of pollen grains were incubated, were spread over slide, and observed at two hourly intervals for the per cent of germination, and the germination percentage was calculated.

Results

Due to the effect of Lasso in *E. coracana* and *P. typhoides* an initial swelling of the pollen grain, followed by shrinkage was observed. No change was observed in *O. sativa*. In *C. cajan* swelling of the grain was noticed as the chemical effect (Table 1). Whereas the effect of Karathane is consistent in *E. coracana*; in *O. sativa, G. herbacium* and *C. cajan* showed initial swelling and later shrinkage. No change was observed in *P. typhoides* and swelling of the pollen grain with increasing concentration was observed in *L. lycopersicum* (Table 2). Increase in percentage of germination was found as effect of Lasso in *O. savita* and *E. coracana* (Table 3). In *P. typhoides*, except in 100 ppm, the per cent of germination was increased by the chemical. In dicotyledonous crops like *G. herbacium, C. cajan* and *L. lycopersicum* germination was increased at 5 and 10 ppm of Lasso (Table 3). On the contrary Karathane induced severe inhibition in the germiantion of all the species examined (Table 4).

Table 1

Effect of Lasso on Diameter of Pollen Grain

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons			Dicotyledons		
		E. coracana	*P. typhoides*	*O. sativa*	*C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	45.2	33.9	33.9	22.6	101.7	11.3
	5	33.9	33.9	33.9	45.2	101.7	22.6
	10	45.2	45.2	33.9	45.2	101.7	11.3
	50	45.2	45.2	33.9	33.9	90.4	11.3
	100	45.2	33.9	33.9	33.9	101.7	11.3
4	Control	45.2	33.9	33.9	33.9	90.4	22.6
	5	33.9	45.2	33.9	45.2	90.4	11.3
	10	45.2	45.2	33.9	45.2	90.4	16.9
	50	45.2	33.9	33.9	45.2	90.4	22.6
	100	33.9	22.6	33.9	45.2	79.1	16.9
6	Control	33.9	33.9	33.9	33.9	101.7	22.6
	5	22.6	45.2	33.9	45.2	79.1	11.3
	10	22.6	45.2	33.9	45.2	56.5	16.9
	50	33.9	33.9	33.9	45.2	101.7	22.6
	100	22.6	22.6	33.9	45.2	79.1	16.9

Average of 10 individual experiments with 60 observations each.

TABLE 2

EFFECT OF KARATHANE ON DIAMETER OF POLLEN GRAIN

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons *E. coracana*	*P. typhoides*	*O. sativa*	Dicotyledons *C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	33.9	33.9	33.9	45.2	90.4	11.3
	5	33.9	28.3	45.2	45.2	90.4	11.3
	10	22.6	33.9	45.2	33.9	101.7	11.3
	50	33.9	33.9	33.9	45.9	45.2	22.6
	100	33.9	33.9	45.2	33.9	33.9	22.6
4	Control	28.25	33.9	33.9	33.9	101.2	22.6
	5	33.9	33.9	33.9	45.2	67.8	16.5
	10	22.6	33.9	45.2	33.9	67.8	16.5
	50	11.3	33.9	45.2	45.2	67.8	22.6
	100	33.9	33.9	33.9	33.9	67.8	22.6
6	Control	22.6	33.9	45.2	90.4	101.7	22.5
	5	33.9	33.9	28.9	45.2	56.5	16.5
	10	22.6	33.9	22.6	33.9	56.5	16.5
	50	11.3	33.9	33.9	33.9	67.8	22.6
	100	22.6	33.9	22.6	33.9	45.2	22.6

Average of 10 individual experiments with 60 observations each.

TABLE 3

EFFECT OF LASSO ON PERCENTAGE OF POLLEN GERMINATION

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons *E. coracana*	*P. typhoides*	*O. sativa*	Dicotyledons *C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	20.0	20.0	6.6	50.0	70.0	10.6
	5	26.6	55.0	30.0	60.0	125.0	40.0
	10	33.3	50.0	20.0	90.0	75.0	24.0
	50	46.6	45.0	40.0	53.3	45.0	13.3
	100	56.0	22.5	53.3	40.0	71.0	13.3
4	Control	45.3	35.0	20.0	66.6	90.0	10.6
	5	36.6	55.0	40.0	83.0	135.0	40.0
	10	40.0	60.0	26.6	96.6	80.0	24.0
	50	46.6	65.0	46.6	60.0	45.0	13.3
	100	65.3	22.5	60.0	70.0	35.0	13.3
6	Control	56.0	35.0	50.0	100.0	105.0	53.3
	5	36.6	65.0	60.0	105.0	140.0	90.0
	10	43.3	67.5	56.60	100.0	80.0	23.0
	50	66.6	70.0	80.0	70.0	45.0	46.6
	100	80.0	37.5	100.0	80.0	35.0	22.6

Average of 10 individual experiments with 60 observations each.

TABLE 4

EFFECT OF KARATHANE ON PERCENTAGE OF POLLEN GERMINATION

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons *E. coracana*	*P. typhoides*	*O. sativa*	Dicotyledons *C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	2.0	6.5	4.0	6.5	29.0	1.0
	5	1.8	1.0	3.2	1.8	10.2	1.0
	10	1.0	3.0	2.5	0.5	5.0	2.1
	50	..	0.8	0.8	0.25	3.0	0.5
	100	..	0.5	0.45	0.10	2.0	0.2
4	Control	6.0	7.8	7.5	8.2	38.0	5.0
	5	1.8	2.1	3.3	6.0	10.5	2.0
	10	1.2	3.5	2.5	3.9	7.5	8.3
	50	..	0.8	0.8	1.8	3.2	0.5
	100	..	0.5	0.45	0.5	2.5	0.22
6	Control	9.0	9.5	9.0	9.8	57.0	8.2
	5	1.8	2.5	3.3	6.5	30.0	12.0
	10	1.5	3.8	2.5	4.4	7.55	18.0
	50	..	0.85	0.8	2.0	3.5	0.5
	100	..	0.5	0.45	1.5	2.8	0.22

Average of 10 individual experiments with 60 observations each.

In monocotyledonous crops, like *O. sativa*, pollen tube length was enhanced in all concentrations of Lasso. Enhancement of tube length was observed in all concentrations of Lasso in *L. lycopersicum* and at 5 and 10 ppm in *C. cajan* and *G. herbacium* (Table 5).

TABLE 5

EFFECT OF LASSO ON POLLEN TUBE

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons *E. coracana*	*P. typhoides*	*O. sativa*	Dicotyledons *C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	20.0	10.0	6.0	48.0	68.0	1.8
	5	25.5	55.0	29.0	60.0	130.0	7.8
	10	33.0	49.0	19.0	88.0	78.0	8.4
	50	46.5	44.0	39.0	52.0	43.0	10.5
	100	53.0	22.0	52.0	39.0	37.5	3.0
4	Control	42.0	33.0	18.0	62.0	90.0	3.0
	5	28.0	55.0	38.0	80.0	135.0	12.1
	10	38.0	59.0	22.5	92.0	78.0	10.5
	50	45.0	63.0	43.0	58.0	42.0	11.8
	100	61.0	22.0	58.0	65.5	37.0	9.0
6	Control	50.0	35.0	48.0	98.0	98.0	6.0
	5	38.6	62.0	57.0	105.0	138.0	20.0
	10	39.0	66.0	52.5	98.0	78.0	14.0
	50	62.0	68.4	77.0	63.0	42.07	15.0
	100	78.0	38.0	98.0	78.0	38.0	12.1

Average of 10 individual experiments with 60 observations each.

In contrast, the pollen length of monocotyledonous and dicotyledonous plants tested showed severe inhibition with Karathane (Table 6).

TABLE 6

EFFECT OF KARATHANE ON LENGTH OF POLLEN TUBE

Time (Hrs.)	Concentration of the Chemical PPM	Monocotyledons			Dicotyledons		
		E. coracana	*P. typhoides*	*O. sativa*	*C. cajan*	*G. herbacium*	*L. lycopersicum*
2	Control	20.0	25.0	10.0	53.0	60.0	20.0
	5	6.6	45.0	6.6	24.0	36.6	24.0
	10	10.0	12.5	6.6	10.0	16.0	23.3
	50	..	5.0	3.3	66.6	10.0	16.0
	100	..	7.5	3.3	56.0	6.0	16.0
4	Control	45.0	35.0	20.0	64.0	73.3	36.0
	5	12.0	60.0	10.0	43.3	40.0	40.0
	10	10.0	25.0	8.3	22.6	30.0	23.3
	50	..	5.0	3.3	66.6	10.0	16.6
	100	..	7.5	3.3	56.0	6.0	13.3
6	Control	50.0	40.0	43.3	100.0	53.3	50.0
	5	12.0	72.0	13.3	105.0	90.0	53.3
	10	10.0	25.5	10.0	100.0	23.0	23.3
	50	..	5.0	3.3	70.0	46.6	16.6
	100	..	7.5	3.3	80.0	22.6	13.3

Average of 10 individual experiments with 60 observations each.

DISCUSSION

In modern agriculture, the farmer is bound to use several agrochemicals on the crop plants to protect the yield from the increasing pest. These foliarly applied chemicals are bound to touch the generative organs of the flower like gynoecium and androecium. The pollen has more chance than the gynoecium of coming into contact with the chemicals applied. In the present work an attempt has been made to test the effect of various chemicals used by the farmer on the pollen grains, and the results are discussed on the basis of literature available.

Some pesticides, Alachlor (Santakumari et al., 1977) and Dalapan (Santakumari and Rajagopal Reddy, 1980) are already known to behave like auxin-type chemicals or as growth regulators. Herbicides, such as sencor and Tribunil were found to decrease the pollen fertility in weeds (Somashekar and Digamber Rao, 1984). Thus, seed production will be reduced and help to minimise the weeds propagation.

On the other hand, where there is enhancement of pollen tube growth, the chemical can be utilised for promoting fertilization in the hybrid crops which exhibit sexual incompatibility due to slow growth of pollen tube.

In the present paper, it is showen that lasso brought enhancement in the pollen tube length in important crops like *O. sativa* and *C. cajan*. Furthermore, percentage of germination is also enhanced in *O. sativa, E. coracana, L. lycopersicum* and *G. herbacium*.

The diameter of the pollen grain seems to be influenced by the chemicals. Shrinkage and swelling may be interpreted to exosmosis and endosmosis respectively, alternatively, or the cell wall might have got damaged due to the chemical. It will ultimately result in the failure of the germination or bursting of the pollen tube. The pollen tube of *Tradescantia occidentales* showed bulging, coiling, branching due to the effect of Colchicine treatment (Smith 1942). Colchicine and indole-3-acetic acid also induce abnormalities in pollen tube of *Alium scorodoprasum, Thea sinensis*, barley, wheat and in rice (Loo and Hwang, 1944).

The present work on pollen grain is an attempt to understand the effect of various chemicals applied by the farmer on crop plants. The advantages and disadvantaces of the chemicals on the pollen grain viability, mortality has been analysed and discussed in the light of limited literature available. Still a lot of research is required in this direction to understand the biochemical reasons and to ascertain the behaviour of pollen and the yield analysis in order to know the effects on total production.

Future research in this direction will be great help to the farmer.

REFERENCES

CHAUHAN S.V.S. and KUMAR R., 1980a – *Effect of Maleic hydrazide and Dalapan on pollen viability and anther development in* Ranunculus muricatus. Acta Bot. Indica, **8:** 61-66.

CHAUHAN S.V.S. and KUMAR R., 1980b – *Effect of maleic hydrazide, F.W. 450 and Dalapan on anther development of* Capsicum annuum. J. Ind. Bot. Soc. **59:** 133-136.

LOO T.L. and HWANG T.C., 1944 – *Growth stimulation by manganese sulphate. Indole-5-acetic acid and colchicine in pollen germination and pollen tube growth.* Amer. J. Bot. **31:** 356-367.

PADMANABHAN D., 1977 – *The male gametophyte germination of pollen grain: A manual of plant development.* 10-11 School of Biological Sciences, Madurai Kamaraj Universityu, Madurai-625 021, India.

SANTAKUMARI M., REDDY C.S. and DAS V.S.R., 1977 - *Alachlor: a new potent antitranspirant on maize plants.* Proc. Indian Acad. Sci., **86:** 143-150.

SANTAKUMARI M. and RAJAGOPAL REDDY C., 1980 – *The use of Dalapan to improve the nutritive value of sorghum* (Sorghum bicolor L.). Seed research **8:** 33-37.

SMITH P.F., 1942 – *Studies on the growth of pollen respect to temperature auxins.* Amer. J. Bot., **29:** 55-56.

SOMASHEKHAR and DIGAMBER RAO, 1984 – *Herbicide induced variabilities on radish* (Raphanus sativus). Comp. Physiol. Ecol., **9:** 312.