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ETHEPHON INDUCED MALE STERILITY IN *CICER ARIETINUM* L., *LENS CULINARIS* L., *LYCOPERSICON ESCULENTUM* MILL. AND *NICOTIANA TABACUM* L.

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Efficacy of ethephon or ethrel (2-chloroethyl phosponic acid) as a chemical hybridizing agent was evaluated on two leguminous (*Cicer arietinum* L., *Lens culinaris* L.) and two solanaceous (*Lycopersicon esculentum* Mill. and *Nicotiana tabacum* L.) crops. Foliar sprays with aqueous solutions of 0.2 and 0.3% (v/v) ethrel could induce 100% pollen sterility, lasting for the whole flowering period in *C. arietinum, L. culinaris* and *L. esculentum*. However, this was associated with the reduction in various yield parameters. This was largely due to the reduction in the number of flowers and fruits/plant. Maximum reduction in the number of flowers and fruits was recorded in plants of all the crops sprayed thrice with 0.3% ethrel. The number of days taken for the appearance of first floral bud were also enhanced in more or less all the treated plants, while one and two treatments with 0.1% ethrel induced early flowering in *C. arietinum*. It was interesting to note that three sprays with 0.1% ethrel in *N. tabacum* induced 100% pollen sterility lasting for 15-25 days but the reduction in yield in such plants was not significantly different from those of control plants.

Key words: Ethephon, Male sterility, *Cicer arietinum, Lens culinaris, Lycopersicon esculentum, Nicotiana tabacum*

Ethephon or ethrel (2-chloroethyl phosphonic acid) is an ethylene generating synthetic compound that acts as a plant growth regulator. It has the unique property of releasing ethylene in plant tissue. Ethephon is hygroscopic crystalline substance, highly soluble in water and other polar solvents. It is relatively non-toxic and stable in aqueous solution below pH 3.5 but disintegrates with the rise in pH above 4. This compound when applied as foliar spray invokes all the ethylene induced responses in plants and has proved to be invaluable in understanding the hormonal role of ethylene. Ethrel is known to induce male sterility in some crops e.g. wheat (Rowell and Miller, 1971; Fairey and Stoskopf, 1975), barley (Colhoun and Steer, 1983) and broad beans (Chauhan and Chauhan, 2003). According to Cross and Schulz (1997), ethrel acts as an inhibitor of microspore development. However, use of ethrel as a potential gametocide in chickpea, lentil, tomato and tobacco has not been tested so far. Therefore, present investigation was undertaken to find out the efficacy of ethrel as a gametocide for these crops.

MATERIALS AND METHODS

The seeds of chickpea (*Cicer arietinum* L.var.Rachna), lentil (*Lens culinaris*. L. var. K.45), tomato (*Lycopersicon esculentum* Mill. var. Choice-21) and tobacco (*Nicotiana tabacum* L. var. NP.70) collected from different sources, were sown at Botanical garden, School of Life Sciences, Dr. B.R. Ambedkar University, Agra.

The experiment was laid out in a randomized block design with three replications for each treatment. In chickpea and lentil, the distance between row to row was 40 cm and 30 cm between plant to plant, while in tomato and tobacco, the plants were transplanted from the nursery 25 days after germination keeping a distance of 75 cm between row to row and 45 cm between plant to plant.

The plants of all the four species were sprayed with aqueous solutions of ethrel at different concentrations (0.1, 0.2 and 0.3% v/v) at three stages of development. A group of 120 plants were sprayed a week before floral bud initiation (T_1) with each concentration. Leaving forty plants after first

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treatment (T_1), the other eighty plants were sprayed again at the time of floral bud initiation (T_2). Leaving forty plants after T_1 and T_2 treatments, the other forty plants were sprayed again at the time of anthesis (T_3). Simultaneously a group of ninety plants were treated with distilled water to serve as control (T_0). A drop of liquid soap (Ezee) was added in each solution as a surfactant. 15 ml of each concentration was sprayed on one plant to run off.

Pollen fertility of treated (T_1,T_2&T_3) and control(T_0) plants was tested at regular intervals throughout flowering period with 1% tetrazolium chloride solution in 0.15 ml Tris-HCl buffer at 7.8 pH.

Data on days taken for the appearance of first floral bud, number of flowers/plant, pollen fertility, number of fruits/plant and total yield in treated and control plants were collected and statistically analyzed by standard deviation and analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Days taken for the appearance of first floral bud:

All the treatments with various concentrations of ethrel enhanced the number of days taken for the appearance of first floral bud in all the four crops. However, single treatment with 0.1% ethrel in chickpea plants induced early flowering. Increase in the days taken to first floral bud appearance increased with increase in the number of treatments and concentrations. The maximum delay in the number of days taken for the appearance of first floral bud was recorded in all the crop plants treated thrice with 0.3% ethrel (Table 1). Ethrel is known to promote early flowering in several crops (Munsi *et al.*,1980;

Table 1. Effect of ethrel on various reproductive parameters in Cicer arietinum, Lens culinaris, Lycopersicon esculentum and Nicotiana tabacum

Crops		Days taken to first flower			No. of flowers/plant			Pollen sterility (%)			No. of fruits/ plant			Total yield (g)		
Concentrations		0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
No. of Treatments																
Cicer arietinum	T_1	[illegible] ± 4.2	107.6 ± 3.3	112.0 ± 1.5	101.6 ± 7.9	84.6 ± 10.4	57.0 ± 4.9	92.0 ± 1.6	100.0 ± 0.0	100.0 ± 0.0	58.3 ± 6.2	47.0 ± 5.7	35.6 ± 2.8	7.8 ± 0.4	5.9 ± 0.6	4.2 ± 0.1
	T_2	104.3 ± [illegible]	112.6 ± 4.2	112.6 ± 4.2	79.0 ± 3.7	89.6 ± 5.5	49.3 ± 5.5	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	43.3 ± 8.4	37.6 ± 2.9	31.6 ± 2.6	5.1 ± 0.7	4.8 ± 0.4	3.1 ± 0.6
	T_3	112.3 ± [illegible]	113.0 ± 1.6	113.0 ± 4.7	57.0 ± 2.9	60.6 ± 3.4	43.3 ± 3.4	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	28.0 ± 2.4	23.0 ± 3.2	16.3 ± 2.8	3.2 ± 0.4	2.8 ± 0.3	1.7 ± 0.1
	T_0		106.0 ± 2.8			178.0 ± 5.8			3.6 ± 3.2			127.0 ± 7.5			23.7 ± 1.0	
CD Value at 5% level			5.0			6.2			1.7			6.9			0.6	
Lens culinaris	T_1	[illegible]	86.3 ± 0.1	89.6 ± 0.1	109.6 ± 2.0	80.3 ± 4.6	56.6 ± 0.4	98.3 ± 2.3	100.0 ± 0.0	100.0 ± 0.0	109.3 ± 2.6	76.0 ± 0.9	56.6 ± 1.2	3.7 ± 0.5	2.7 ± 0.2	2.0 ± 0.4
	T_2	[illegible]	88.0 ± 0.4	89.3 ± 0.5	99.1 ± 1.2	73.4 ± 4.6	39.0 ± 0.7	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	98.0 ± 2.6	72.0 ± 2.3	30.3 ± 2.5	1.9 ± 0.7	1.8 ± 0.4	1.7 ± 0.1
	T_3	[illegible]	90.3 ± 0.0	92.6 ± 0.7	75.4 ± 2.7	71.0 ± 1.2	12.6 ± 0.2	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	74.0 ± 4.1	67.0 ± 3.3	12.0 ± 0.8	0.7 ± 0.5	0.4 ± 0.1	0.2 ± 0.1
	T_0		71.0 ± 1.2			207.6 ± 2.0			1.3 ± 0.4			207.3 ± 2.0			4.3 ± 0.8	
CD Value at 5% level			3.0			3.6			1.7			5.9			0.8	
Lycopersicon esculantum	T_1	[illegible]	[illegible] ± 4.6	64.2 ± 2.7	209.7 ± 46.1	187.0 ± 37.4	147.5 ± 20.1	82.0 ± 1.6	92.6 ± 1.3	100.0 ± 0.0	47.0 ± 13.1	45.7 ± 6.5	38.5 ± 3.9	15.2 ± 1.6	14.9 ± 1.9	14.0 ± 1.5
	T_2	[illegible]	[illegible] ± 2.1	71.0 ± 4.7	161.7 ± 20.2	141.2 ± 36.2	132.2 ± 20.5	97.0 ± 1.5	100.0 ± 0.0	100.0 ± 0.0	46.0 ± 5.2	35.0 ± 10.1	22.7 ± 3.9	14.4 ± 2.4	13.5 ± 1.6	10.3 ± 1.7
	T_3	[illegible]	[illegible]	82.7 ± 6.1	161.5 ± 32.6	132.3 ± 12.6	92.2 ± 6.5	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	34.2 ± 9.2	27.2 ± 4.2	18.7 ± 4.1	13.3 ± 1.7	10.5 ± 2.6	6.7 ± 1.8
	T_0		[illegible]			294.5 ± 12.9			3.7 ± 2.6			100.2 ± 11.7			26.5 ± 3.0	
CD Value at 5% level			5.2			47.1			2.2			14.8			0.4	
Nicotiana tabacum	T_1	[illegible]	[illegible]	75.0 ± 1.3	153.0 ± 12.5	158.8 ± 14.3	140.0 ± 12.1	95.2 ± 1.8	96.8 ± 1.4	100.0 ± 0.0	136.0 ± 12.5	143.8 ± 14.6	130.0 ± 13.3	15.5 ± 2.5	16.0 ± 3.0	14.0 ± 4.2
	T_2	[illegible]	[illegible]	78.0 ± 1.8	160.0 ± 13.2	160.2 ± 13.6	148.0 ± 17.7	98.0 ± 1.2	100.0 ± 0.0	100.0 ± 0.0	138.2 ± 14.2	150.0 ± 14.2	136.8 ± 19.8	15.9 ± 1.6	16.5 ± 3.2	14.9 ± 4.7
	T_3	[illegible]	[illegible]	80.0 ± 2.0	162.2 ± 17.7	169.8 ± 19.2	149.2 ± 14.2	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	149.8 ± 17.7	159.2 ± 21.9	137.2 ± 13.3	16.3 ± 1.9	17.6 ± 1.8	15.5 ± 2.0
	T_0		[illegible] ± 2.9			172.6 ± 13.4			1.9 ± 3.4			162.8 ± 14.7			29.0 ± 4.2	
CD Value at 5% level			[illegible]			11.9			1.9			12.1			2.9	

± Standard deviation

T_1 = Single spray, a week before floral bud initiation.

T_2 = Double spray, once a week before the floral bud initiation and second three days after floral bud initiation.

T_3 = Triple spray, first a week before the floral bud initiation, second 3 days after floral bud initiation and third at the time of anthesis.

Prasad and Roy,1987). However, delayed flowering by ethrel treatments has also been reported in several crops (Keyes and Sorrells, 1990; Chauhan and Chauhan, 2003). Chauhan and Chauhan (2003) have observed that the plants treated thrice with 0.1% ethrel showed maximum delay in flowering in *Vicia faba*.

Number of flowers/plant:

There was a reduction in the number of flowers/plant in all the crops treated with various concentrations of ethrel and the reduction was directly proportional to the number of treatments as well as concentrations in chickpea, lentil and tomato (Table 1). The lowest reduction in the number of flowers/plant observed in plants sprayed once with 0.1% ethrel in chickpea, lentil and tomato. It was 101.6, 109.6 and 209.7/plant respectively as compared to 178.0, 207.6 and 294.5 flowers/control plants respectively. On the other hand, reduction in the number of flowers/plant in tobacco was insignificant. The plants sprayed three times (T_3) with 0.2% ethrel produced 169.8 flowers/plant as compared to 172.6 flowers/control plant.

Nigam *et al.* (1979) observed that foliar sprays of 960-2880 ppm ethephon prior to flower bud initiation in groundnut decreased the number of flowers/plant. The reduction in number of flowers was also observed in *Vicia faba* by Chauhan and Chauhan (2003). According to them the foliar application of 0.3% ethrel caused maximum reduction in the number of flowers/plant as compared to control plants.

Pollen fertility:

Foliar applications of different concentrations of ethrel effectively induced pollen sterility ranging between 82-100% in all the crops studied (Table 1). All the treatments of 0.2 or 0.3% and two and three treatments with 0.1% ethrel induced 100% pollen sterility in chickpea. Similarly, two or three treatments with 0.1% and all the three treatments with 0.2 or 0.3% ethrel induced complete pollen sterility in lentil. Three treatments with 0.1% and two or three treatments with 0.2 and 0.3% ethrel induced 100% pollen sterility in both tomato and tobacco.

From the foregoing observations it is evident that all the treatments of ethrel are capable of inducing more or less complete pollen sterility in all the crops studied. The complete pollen sterility has been induced by treatments with ethrel in *Hordeum vulgare* (Colhoun and Steer, 1983), *Brassica juncea* (Banga and Labana, 1984; Banga *et al.*, 1986) *Triticum aestivum* (Keys and Sorrells, 1990) and *Vicia faba* (Chauhan and Chauhan, 2003).

Number of fruits/plant:

A significant reduction in the number of fruits/plant by various treatments was caused in chickpea, lentil and tomato. In these crops, the number of fruits/plant gradually decreased with the increase in concentration as well as number of treatments. The minimum reduction in number of fruits/plant were recorded in plants treated once with 0.1% ethrel. On the other hand, ethrel treated tobacco plants exhibited also caused reduction in the number of fruits/plant, but it was insignificant (Table 1).

Total Yield:

All the treatments with different concentrations of ethrel caused significant reduction in total yield/plant in chickpea, lentil and tomato (Table 1).

The total yield/plant gradually decreased with the increase in concentration as well as number of treatments in these crops. However, minimum reduction in total yield/plant in chickpea, lentil and tomato was recorded in plants treated only once (T_1) with 0.1% ethrel. However, maximum reduction in total yield in these crops was caused by two (T_2) or three (T_3) treatments with higher concentrations of ethrel. On the other hand, the reduction in total yield/plant in tobacco was insignificant (Table 1). The reduction in the number of fruits/plant and total yield in ethrel treated crops is largely associated with the reduction in the number of flowers/plant. Recently, Chauhan and Chauhan (2003) have also reported reduction in the number of fruits and total yield in *Vicia faba* plants treated with ethrel.

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