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Short Communication

Efficacy of Benzotriazole as a chemical hybridizing agent in chilli (*Capsicum annuum* L.), cotton (*Gossypium arboreum* L.) and radish (*Raphanus sativus* L.)

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Although production of hybrids is achievable through cytoplasmic male sterility, interest began to develop in the use of chemicals that could induced selective male sterility. Chemical induction of sterility in plants has been of interest since 1950, and so far a large number of chemicals have been tested for induction of male sterility in sixty five species, fifty four genera of twenty two families of angiosperms [1] and recent work done has been reviewed by Cross and Schulz [2]. It was recognized that there may be some disadvantages with chemicals; however, there could also be advantages especially in terms of the time required to discover economically viable hybrids. The chemical method for inducing sterility can obviate the often lengthy time period required to obtain male-sterile and restorer lines, which usually must precede evaluation of hybrid performance. Consequently, chemicals became of interest both for use as breeding tools and as well as a means of producing hybrid seed on a commercial scale. In recent years, however, companies in the private sector have tested and developed proprietary chemical hybridizing agents and have made them available on a very restricted basis to public and seed company breeders. Benzotriazole, a copper chelator acts as an inhibitor of microspore development and has been used as a chemical hybridizing agent for some crops [2]. However, perusal of available literature shows that it has not been tested as chemical hybridizing agent in chilli, cotton and radish.

The present experiment was conducted on *Capsicum annuum* var. Pusa Jwala, *Gossypium arboreum* var. RG.8 and *Raphanus sativus* var. Hill Queen. The seeds of these varieties obtained from National Seed Corporation, Agra were sown at Botanic Garden, School of Life Sciences, Dr. B. R. Ambedkar University, Agra. The experiments were laid out in a randomized row design with five replicates with fifty plants each. The distance between row to row was 75cm and between plant to plant it was 45 cm. The plants of chilli (*Capsicum annuum*), cotton (*Gossypium arboreum*) and radish (*Raphanus sativus*) were sprayed with aqueous solutions of 0.5, 1.0 and 1.5% (w/v) benzotriazole. In each variety, 200 plants were sprayed a week before the initiation of first floral buds (T_1), while leaving a group of 50 plants after first treatment, the remaining 150 plants were sprayed again at the time floral bud initiation (T_2) and again after leaving a group of 50 plants, the other 100 plants were sprayed again at the time of anthesis, thus receiving three sprays (T_3). A group of 50 plants of each varieties were sprayed with distilled water to serve as control (T_0). 30 ml of each concentration was sprayed on one plant to run off. Pollen fertility of variously treated and control plants was checked at regular intervals with the help of Alexender's staining technique [3].

Data on days taken to first flowering, number of fruits/plant, fruit size and total yield in treated and control plants were collected and statistically analyzed by analysis of variance (ANOVA).

Days taken to first flowering: All the treatments with various concentrations of benzotriazole enhanced the number of days taken to first flowering in all the crops. Increase in the days taken to first flowering increased with increase in number of treatments and concentrations. Plants treated thrice (T_3) with 1.5% benzotriazole exhibited maximum delay and chilli, cotton and radish plants took 167, 73.2 and 83.3 days for flowering after sowing as compared to their control counterparts taking only 144, 40 and 72.8 days respectively (Table 1).

Pollen sterility: Foliar applications of different concentrations of benzotriazole effectively induced pollen sterility in all the three crops ranging between 78.8-100% (Table 1). Plants sprayed twice (T_2) and thrice (T_3) with 1.0 and 1.5% benzotriazole induced 100% pollen sterility in all the three crops lasting for 20-25 days.

Number of fruits/plant: There was a significant reduction in the number of fruits/treated plants of chilli, cotton and radish. The number of fruits/plant gradually decreased with the increase in concentrations and number of treatments. There were only 10.1 fruits/chilli, 33.7 fruits/cotton and 363.8 fruits/radish plants treated thrice (T_3) with 1.5% benzotrizole as compared to 26.3 fruits/chilli, 60.8 fruits/cotton and 462.2 fruits/radish untreated plants (Table 1).

Table 1. Effect of benzotriazole on reproductive parameters in *Capsicum annuum*, *Raphanus sativus* and *Gossipium arboreum*

Crops		*Capsicum annuum*			*Raphanus sativus*			*Gossypium arboreum*		
Concentrations (%)		0.5	1.0	1.5	0.5	1.0	1.5	0.5	1.0	1.5
Days taken to first flowering	T_0		144.0			72.8			40.0	
	T_1	150.3	157.3	159.0	73.1	74.9	77.7	52.0	58.8	60.1
	T_2	160.6	163.0	164.0	75.0	77.7	79.9	60.0	64.9	68.2
	T_3	165.0	166.6	167.0	78.0	79.9	83.3	62.1	66.0	73.2
CD at 5% level			3.37			2.12			4.92	
Pollen sterility (%)	T_0		4.9			1.1			3.1	
	T_1	89.1	93.9	100.0	97.2	100.0	100.0	98.0	100.0	100.0
	T_2	95.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	T_3	98.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CD at 5% level			2.30			0.50			0.89	
Number of fruits/plant	T_0		26.3			462.2			60.8	
	T_1	17.6	16.3	13.6	451.9	448.3	440.8	55.1	52.7	48.7
	T_2	16.1	14.9	12.7	445.2	437.8	430.6	50.4	44.8	40.0
	T_3	14.3	12.1	10.1	410.3	390.1	363.8	41.0	40.0	33.7
CD at 5% level			6.3			88.3			11.9	
Fruit size (cm)	T_0		10.1			0.72			2.5*	
	T_1	9.7	9.2	8.8	4.7	4.3	4.0	2.0	1.8	1.6
	T_2	9.3	9.0	8.7	4.4	4.0	3.7	1.8	1.7	1.5
	T_3	8.9	8.1	7.7	4.1	3.8	3.2	1.6	1.5	1.4
CD at 5% level			4.1			0.72			3.5	
Total yield/ plant (g)	T_0		80.3			28.8			128.3	
	T_1	77.2	72.9	69.7	26.7	24.1	22.ɔ	121.7	109.7	100.1
	T_2	75.4	71.3	68.7	22.7	19.7	17.1	115.2	100.8	88.2
	T_3	69.9	64.2	58.2	19.6	17.3	14.4	100.7	091.4	80.2
CD at 5% level			4.90			2.71			3.21	

T_0: Plant sprayed with distilled water T_1: Single spray before bud initiation T_2: Double spray, first before bud initiation and second after two three days bud initiations T_3: Three spray, first before bud initiation, second after bud initiation and third at the time of anthesis,* Fruit diameter

Fruit size: Treated plants showed reduction in fruit size that was inversely proportional to the increase in the concentrations as well as number of treatments. Maximum reduction in fruit size was recorded in plants treated thrice with 1.5% benzotriazole. The average fruit size in 1.5% benzotrizole treated chilli plants was 7.7 cm. 1.4 cm in cotton and 3.2 cm in radish as compared to 10.1 cm long fruits in control plants of chilli, 2.5 cm in cotton and in untreated plants of radish, the fruits were 5.0 cm long (Table 1).

Total yield: There was a significant reduction in the total yield in all the crops treated with various concentrations of benzotrizole and this reduction was directly proportional to the number of treatments as well as concentrations in all the three crops (Table 1). The maximum reduction in total yield was recorded in plants treated thrice with 1.5% benzotriazole and in chilli it was 58.2 g/plant as compared to 80.3 g/control plant, in cotton it was 80.2 g/plant as compared to 128.3 g/control plant and in radish it was 14.4 g/plant as compared to 28.8 g/control plant.

From the foregoing observations it is evident that all the treatments with benzotriazole at different concentrations are capable of inducing complete pollen sterility in all the three crops studied. Benzotriazole is a well known inhibitor of microspore development [2]. Selective induction of male sterility in wheat by sprays with benzotriazole has also been demonstrated [4]. Complete pollen sterility in *Helianthus annuus* has been successfully induced by treatments with benzotriazole [5]. Similarly benzotriazole has also been reported to be a potential hybridizing agent for *Brassica juncea* [6] and *Vicia faba* [7]. *Brassica juncea* plants treated with 0.5 and 1.0% benzotriazole not only induced 100% pollen sterility but also produced a large number of seeds on open pollination [6].

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