

Detergent induced pollen sterility in some vegetable crops

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Summary: Efficacy of a popular synthetic detergent, Surf excel in some important vegetable crops viz. Okra or lady finger (*Abelmoschus esculentus* L.), chilli or red pepper (*Capsicum annuum* L.) and tomato (*Lycopersicon esculentum* Mill) was evaluated for inducing male sterility and hybrid seed production. Foliar sprays with aqueous solutions of Surf excel (1.0 and 1.5% w/v) in these crops induced complete pollen sterility. The treated plants showed a delay in flowering, a reduction in the number of flowers and fruits/plant, number of seeds/fruit resulting in a reduction in yield/plant. However, the male sterility thus induced was successfully exploited for hybrid seed production.

Key words: Male sterility, surf excel, *Capsicum annuum*, *Lycopersicon esculentum* and *Abelmoschus esculentus*

Introduction

Because of the potential application of male sterility in hybrid seed production, a large number of chemicals have been tested for their ability to induce pollen sterility. Such chemicals have been designated as male gametocides (Mohan Ram & Rustagi, 1966) or chemical hybridizing agents (Cross & Schulz, 1997). They have a unique potential to facilitate cross-pollination for the development of hybrids directly out of elite germplasm without the time and effort required to regressively back-cross male sterility genes and fertility restoration system. The new generation of chemical hybridizing agents has been tried for the induction of male sterility in several crops in recent years (Cross & Schulz, 1997; Singh & Chauhan, 2001). Some synthetic detergents have been tested for the induction of male sterility in different crops (Singh, 1999). Recently, Surf excel, a popular synthetic detergent has also been successfully used to induce complete pollen sterility in some crops e.g. *Brassica juncea* (Singh & Chauhan, 2002, 2003), *Vicia faba* (Chauhan & Chauhan, 2003); *cicer arietinum* (Chauhan & Gupta, 2005). The induced male sterility in these crops has also been exploited for hybrid seed production.

Surf excel, a popular detergent commonly used for removing all kinds of dirt, consists of surface-active agents, builders (phosphates) and fillers. In addition, it has additives e.g. anti deposition agents, optical brighteners, bluing agent, bleaching agent, foam regulator, organic sequestering agent and enzyme etc. Sodium borate and sodium carbonate are commonly added to neutralize acid constituents of dirt. Since some other detergents are known to induce male sterility (Singh, 1999), the present investigation has been undertaken to find out the efficacy of Surf excel for inducing male sterility in some important vegetable crops viz. *Abelmoschus*

esculentus L., *Lycopersicon esculentum* Mill. and *Capsicum annuum* L. for its exploitation in hybrid seed production

Material and method

The present experiment was conducted on *Abelmoschus esculentus* L. var. Anamica, *Lycopersicon esculentum* var. Choice 21 and *Capsicum annuum* var. Pusa jwala. The seeds of these varieties obtained from National Seed Corporation, Agra were sown at the Botanic garden of the School of Life Sciences, Dr. B.R. Ambedkar University, Agra. The experiments were laid out in a randomized row design with five replicates of ten plants each. The distance between rows was 75 cm and between plants within a row was 45 cm.

The plants of *Abelmoschus esculentus*, *Lycopersicon esculentum* and *Capsicum annuum* were sprayed with aqueous solutions of 0.5, 1.0 and 1.5 % (w/v) Surf excel. 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 of floral bud initiation (T_2) and again after leaving out 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 variety were sprayed with distilled water to serve as control. 15 ml of each concentration was sprayed on one plant to run off. Pollen fertility of variously treated and control plants were checked at regular intervals with the help of Alexander's (1980) staining technique. The extent of pollen viability was also determined by recording the percentage of seed-set in the selfed flowers of treated plants and in the flowers of untreated plants pollinated with the pollen of treated plants. Female fertility was checked by percentage of seed-set in treated and untreated plants.

In order to ensure the availability of insect pollinators in sufficient number for cross-pollination for hybrid seed production, small beehives were maintained in the experimental plots.

Data on days taken to first flowering, number of flowers/plants, fruits/plant, number of seeds/fruit and total yield/plant were collected from the treated and control plants. This was statistically analyzed by analysis of variance (ANOVA).

Results and discussion

1. Days taken to first flowering: All the treatments with various concentrations of Surf excel enhanced the number of days taken to first flowering in all the crops. Increase in the days taken to first flowering increased with the increase in the number of treatments and concentrations and three treatments with 1.5% Surf excel causing the maximum delay. The plants of okra, tomato and chilli plants treated thrice with 1.5% Surf excel took 39.9, 90.7 and 160.6 days for flowering after sowing as compared to their control plants taking only 34, 57.2 and 144 days, respectively (Table 1). Delayed flowering by sprays with Surf excel has also been recorded in *Brassica*

juncea, *Vicia faba* and *Cicer arietinum* by Singh & Chauhan (2002, 2003), Chauhan & Chauhan (2003), and Chauhan & Gupta (2005), respectively.

- 2. Number of flowers/ plant:** There was a reduction in the number of flowers/plant in all the crops treated with various concentrations of Surf excel and reduction was directly proportional to the number of treatments as well as concentrations. There were 20.3, 241, 23.3 flowers/plant in okra, tomato and chilli treated only once with 0.5% Surf excel, as compared to 24, 394.5, 30 flowers/control plant, respectively. A significant reduction in the number of flowers/plant treated with Surf excel has also been reported in some other crops e.g. *Gossypium arboreum*, *Brassica juncea* and *Vicia faba* (Chauhan et al., 2003).
- 3. Pollen fertility:** Foliar applications of different concentrations of Surf excel effectively induced pollen sterility in all the crops ranging between 70.5–100% (Table 3). In plants sprayed twice (T₂) or thrice (T₃) with 1.0 and 1.5% concentrations, Surf excel induced a lasting 100% pollen sterility in all the three crops. Complete pollen sterility has also been induced by treatments with Nirma, a synthetic detergent in rice by Singh (1999). Recently, Surf excel has also been found to

Table 1. Effect of Surf excel on days taken to first flowering in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Days taken to first flowering								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	59.2	65.5	66.0	145.6	146.6	158.0	35.0	35.6	37.3
	1.0	69.2	71.0	74.5	153.6	154.0	162.3	37.6	40.0	42.0
	1.5	78.5	79.7	90.7	153.8	156.6	160.6	37.8	38.7	39.9
CD value at 5% level			4.72			8.8			3.1	
Control			57.2			144.0			34.0	

T₁: Single spray, a week before floral bud initiation

T₂: Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃: Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

Table 2. Effect of Surf excel on the number of flowers / plant in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Number of flowers / plant								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	241.0	221.2	208.5	23.3	20.0	18.0	20.3	18.0	17.6
	1.0	141.5	129.2	148.0	17.0	12.6	10.0	16.3	15.6	12.0
	1.5	105.5	93.2	73.2	12.3	10.0	5.3	10.6	9.7	8.6
CD value at 5% level			12.7			4.9			2.8	
Control			300.5			30.1			24.0	

T₁: Single spray, a week before floral bud initiation

T₂: Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃: Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

Table 3. Effect of Surf excel on pollen sterility in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Pollen sterility								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	70.5	80.5	100	87.1	92.8	100	90.1	95.0	99.9
	1.0	85.0	92.8	100	91.1	93.6	100	96.7	100.0	100.0
	1.5	92.0	99.0	100	98.3	100.0	100	98.7	100.0	100.0
C D value at 5% level			3.1			2.8			3.7	
Control			3.7			14.1			4.6	

T₁ : Single spray, a week before floral bud initiation

T₂ : Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃ : Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

Table 4. Effect of Surf excel on the number of fruits / plant in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Number of fruits / plant								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	65.5	62.2	49.2	18.0	14.3	12.6	15.3	13.0	12.6
	1.0	56.0	42.5	34.3	11.3	8.3	8.0	11.3	10.6	7.3
	1.5	26.6	24.7	12.5	7.3	5.7	4.9	7.0	6.7	6.0
C D value at 5% level			12.9			6.6			3.07	
Control			100.2			27.1			19.0	

T₁ : Single spray, a week before floral bud initiation

T₂ : Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃ : Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

be effective in inducing complete pollen sterility in *Brassica juncea* (Singh & Chauhan, 2003), *Vicia faba* (Chauhan & Chauhan, 2003) lasting for days without causing deleterious phytotoxic effect.

4. **Number of fruits/plant:** Plants sprayed with different concentrations of Surf excel exhibited a significant reduction in the number of fruits/plant in all the three crops studied, The reduction gradually increased with the increase in concentrations as well as in the number of treatments. There were only 15.3 fruits/okra, 24.1 fruits/tomato and 23.3 fruits/chilli plants sprayed only once (T₁) with 1.0% Surf excel as compared to 394.5 fruits/tomato and 30 fruits/chilli control plants (Table 4).

5. **Number of seeds/fruit:** There was a reduction in the number of seeds/fruit in all the crops treated with various concentrations of Surf excel and the reduction was directly proportional to the number of the treatments as well as concentrations in all the three crops (Table 5). The plants sprayed only once with 0.5% Surf excel showed a minimum reduction in the number seeds/fruit and in okra there were 33.6 seeds/fruit, in tomato there

were 240 seeds/fruit and 77.1 seeds/chilli plant as compared to 39.6 seeds/okra, 243 seeds/tomato and 78.1 seeds/chilli control plants.

6. **Total yield/plant:** It was interesting to note that there was no seed-set in selfed flowers of treated plants clearly indicating 100% pollen sterility in them. There was a reduction in the total yield/plant in all the crops treated with various concentrations of Surf excel and the reduction was directly proportional to the number of treatments as well as concentrations in all the three crops (Table 6). The minimum reduction in total yield was recorded in plants treated once with 0.5% Surf excel and it was 22.4 g/okra plant, 21.1 g/tomato plant and 6.4 g/chilli plant. However, this reduction in yield was significantly different from that of control plants. The reduction in seed-set percentage in treated plants also indicated the extent of ovular sterility. Recently, Surf excel has also been used as a chemical hybridizing agent in various crops e.g. *Brassica juncea*, *Vicia faba*, *Cicer aritinum*, *Gossypium arboreum* and *Nicotiana tabacum* has also been reported by Singh & Chauhan (2003); Chauhan & Chauhan (2003); Chauhan & Gupta (2005); Chauhan et al. (2003) and Agnihotri & Chauhan (2004), respectively.

Table 5. Effect of Surf excel on number of seeds / fruit in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Number of seeds / fruit								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	240.0	236.2	231.1	72.1	70.0	63.0	33.6	32.0	28.6
	1.0	235.0	230.1	227.0	69.0	64.2	59.0	22.3	20.3	17.9
	1.5	230.0	227.8	224.3	59.1	53.0	50.2	15.0	13.1	10.1
C D value at 5% level			13.2			8.9			2.8	
Control			243.0			78.1			39.6	

T₁ : Single spray, a week before floral bud initiation

T₂ : Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃ : Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

Table 6. Effect of Surf excel on total yield in *Lycopersicon esculentum*, *Capsicum annuum* and *Abelmoschus esculentus*

Chemical Varieties Number of treatments	Concentrations (%)	Total yield / plant (g)								
		<i>Lycopersicon esculentum</i>			<i>Capsicum annuum</i>			<i>Abelmoschus esculentus</i>		
		Choice - 21			Pusa Jwala			Anamica		
		T ₁	T ₂	T ₃	T ₁	T ₂	T ₃	T ₁	T ₂	T ₃
Surf excel	0.5	21.1	19.7	18.7	2.5	2.1	1.8	22.4	20.8	18.1
	1.0	18.5	18.2	17.9	2.2	1.7	1.7	20.1	17.2	15.9
	1.5	14.2	12.1	10.8	2.1	1.9	1.6	15.1	13.1	11.1
C D value at 5% level			5.1			0.77			4.8	
Control			23.7			3.9			37.05	

T₁ : Single spray, a week before floral bud initiation

T₂ : Double spray, once a week before the floral bud initiation and second three days after floral bud initiation

T₃ : Triple spray, first a week before the floral bud initiation, second three days after floral bud initiation and third at the time of anthesis

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