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'Vision' and 'War'

Lord Rayleigh's presidential address to the British Association for the Advancement of Science, which was reproduced in *Current Science* for last month, consists of two parts. The first part is devoted to the consideration of the historical development of the auxiliary physical instruments invented by scientists for assisting their natural organs of visual perception for exploration of those phenomena in the material universe which happily lie beyond the faculty of their physiological mechanism of vision. The second part forms a brief but effective defence of scientists who are generally but unreasonably accused of being responsible for all the atrocities of modern wars.

Nobody quarrels with scientific discoveries. Nobody suspects the intentions of scientists. Nobody doubts the urge of scientists to explore the unknown. The world is prepared to accept Lord Rayleigh's plea that scientists are not responsible for all the atrocities of war, but it is entitled to ask 'then, who is responsible?' He is perfectly right when he says, 'I venture to say that it never occurred to him (Sir William Roberts Austen) or to any of his hearers (Lord Rayleigh included) that thermite had any application in war'. But surely some one must have had the necessary vision to discover its application to the destruction of civil populations, and is that 'some one' a scientist or a politician or a journalist? But the 'world is ready to accept the gifts of science, and to use them for its own purposes. It is difficult to see any sign that it is ready to accept the advice of scientific men as to what these uses should be'. The world that Lord Rayleigh has in mind is innocent of dichlorodiethyl sulphide and is not likely to mix aluminium powder with red oxide of iron, but they form the material on which a few gifted men work and demonstrate their application to the practical uses in peaceful industry. These scientific men are said to have no notion that the 'oil, very poisonous and violently inflames the skin', and the 'great amount of energy which is liberated when aluminium combines with oxygen' can have any use for military purposes. We believe that there is a wide difference regarding the degree of responsibility attached to scientists investigating theoretical problems and those dealing with explosives and poison gases, and it is untenable to maintain that the entire school of chemists are innocent of the consequences of the products of their researches to the civil populations, or of the possibilities of their employment for military purposes. Will Lord Rayleigh defend the conduct of a well-meaning educationist who in the exuberance of his enthusiasm produces a tiger from the jungle for the purpose of giving the Sunday School children a lesson in natural history and, losing control over the beast, lets it loose on the unoffending boys and girls? Would the school master be justified, were he to protect that 'it never occurred to him that the cattle lifter was also a man-eater'.

SCIENTIFIC CORRESPONDENCE

Detergent-induced male sterility and bud pollination in *Brassica juncea* (L.) Czern & Coss

A large number of chemicals capable of selectively inhibiting pollen development have been identified as chemical-hybridizing agents for large-scale commercial production of hybrid seeds in various crops[1]. These chemicals are known to cause a range of effects, for example, feminization of male florets, abnormal development of reproductive organs, inhibition of early anther development, abnormal tapetal behaviour and suppression of microspore development[2]. The present paper reports the changes in floral biology, pollen fertility, seed-set and total yield in *Brassica juncea* plants sprayed with various concentrations of surf-excel – a commonly used detergent.

The seeds of *B. juncea* (L.) Czern & Coss var. Pusa bold were sown in a randomized row design at the Botanic Garden, School of Life Sciences, Dr B. R. Ambedkar University, Agra. A group of twenty-five plants in each row were sprayed only once (a week before the floral bud initiation, i.e. 21 days after sowing) with 2, 4 and 6% (w/v) surf-excel (synthetic detergent powder, Hindustan Lever Ltd, Mumbai); another group of 25 plants were sprayed with distilled water to serve as control. There were three replicates for each treatment. Two rows of 25 plants each were left untreated between a row of treated plants. A small beehive was placed in the experimental plot. Pollen fertility of treated and untreated plants was tested regularly throughout the flowering period at an interval of 24 h with FCR test, 1% TTC (tetrazolium chloride) in 0.15 M Tris-HCl buffer at pH 7.8, and by *in vitro* pollen germination test after Brewbaker and Kwack[3]; *in vivo* pollen germination in the pistil was verified by the procedure after Shivanna and Rangaswami[4]. The inflorescence of treated and untreated plants was bagged before making these tests. Data on the initiation of flowering, size of anther and style, time of stigma receptivity, number of pollen grains and ovules/ flower, pollen–ovule ratio, seed-set percentage (in selfed as well as in open-pollinated flowers) and mode of pollination from the 6–7 flowers at the base of an inflorescence at the time of anthesis were collected from 75 plants of each treatment and 75 untreated plants nearly 20 days after spray.

For scanning electron microscopic (SEM) studies, the floral buds were fixed in 2.5% glutaraldehyde in phosphate buffer (pH 7.4) at 4.0°C and dehydrated through aqueous acetone series. These were dried in HCP-2 Hitachi Critical Point dryer using liquid CO_2 at 1000 lb per inch. The floral buds were mounted on stubs using colloidal silver as adhesive and coated with gold (20 mm coating) in a SCD 020 sputter coating unit (Polaran Equipment Ltd, Walford, England). The stubs were stored in a desiccator and observed and photographed in LEO EM-SEM at the All India Institute of Medical Sciences, New Delhi.

The results of the present experiment are summarized in Table 1. The flowering in plants treated with 2, 4, and 6% surf-excel was delayed by 2, 3, and 5 days, respectively compared to control plants where floral bud initiation occurred 28 days after sowing (Table 1). The size of flowers in plants treated with 6% surf-excel was slightly reduced. The anthers in the flowers of treated plants were smaller and indehiscent in nature. The reduction in anther size was directly proportional to the concentration of surf-excel. There was a reduction in the number of pollen grains per flower and maximum reduction was recorded in plants sprayed with 6% surf-excel (15,121 pollen grains/ flower). All the treatments with surf-excel were found to be quite effective in inducing complete pollen sterility (Table 1). The results of pollen fertility tested at regular intervals indicate that plants sprayed with 6% surf-excel exhibited complete pollen sterility even 25 days after treatment. However, 2% surf-excel-treated plants after 15, 20 and 25 days exhibited a slight reduction in their pollen sterility (96.8, 87.7 and 85%, respectively). On the other hand, plants sprayed with 4% surf-excel exhibited 94.6 and 92% pollen sterility after 20 and 25 days, respectively (Table 1). The surf-excel-treated bagged flowers failed to produce any seeds. Surf-excel consists of surface-active agents, builders (phosphates) and fillers. In addition, it has additives, e.g. antideposition agents, optical brighteners, bluing agent, bleaching agent, foam regulators, organic sequestering agent and enzymes, etc. Alkalines, e.g. sodium carbonate (soda ash) and sodium borate are commonly added to neutralize the acid constituents of dirt. It seems that the presence of sodium carbonate in the detergent induces male sterility. This is supported by the fact that recently, another synthetic detergent – Nirma, containing similar ingredients, including soda ash has also been used to induce male sterility to a considerable extent in rice[5].

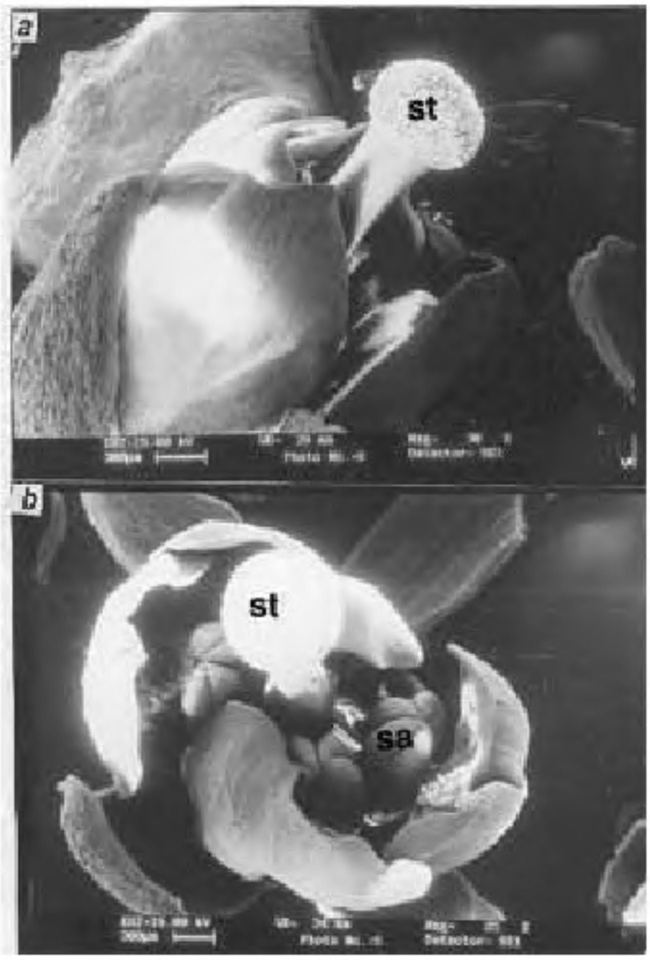

Figure 1. Scanning photomicrograph of floral buds treated with detergent (6% surf-excel). Floral bud with ***a***, elongated style and raised stigma (st); and ***b***, raised stigma (st) and indehiscent sterile anthers (sa).

It was interesting to note that stylar length in the buds of treated plants increased with the increase in concentration of surf-excel. In the buds of plants sprayed with 6% surf-excel, the elongation of style was maximum (3 mm). Due to the increase in the size of the style, the stigma protruded out of all the buds of an inflorescence (Figures 1 *a* and *b*). The plausible cause of elongation of the style to raise the stigma seems to be due to the presence of some enzymes in surf-excel. The stigma of such floral buds was receptive and showed the presence of 55–60 pollen grains per stigma with 33% germination and 90–120 µm long tubes (Figure 2) compared to the stigma of untreated plants, which showed the presence of 100–150 pollen grains per stigma with 90% germination and 100–125 µm long pollen tubes. Thus, the complete pollen sterility, elongated style with raised receptive stigma in the buds of plants sprayed

Table 1. Comparative floral morphology of treated and untreated plants**

		Plants treated with surf-excel (%)		
Character	Control plant	2.0	4.0	6.0
Floral bud initiation (days)	28	30	31	33
Anther length (mm)	2.1 ± 0.11	2.0 ± 0.14	1.9 ± 0.44	1.8* ± 0.12
No. of pollen grains/ bagged flower	31590 ± 101	29437* ± 98	16744* ± 87	15121 ± 99
Pollen fertility (%)				
1st day after flowering	92.79*** ± 0.87	0	0	0
10th day		0	0	0
15th day		3.2	0	0
20th day		12.3	5.4	0
25th day		15.0	8.0	0
Stylar length (mm) in bud	2.0 ± 0.12	2.2* ± 0.11	2.5* ± 0.13	3.0* ± 0.11
Time of stigma receptivity	8.00 am–10.00 am		7.30 am–10.00 am	
No. of ovules/flower	18 ± 0.50	17 ± 0.41	14* ± 0.25	12* ± 0.22
Pollen–ovule ratio	1755 : 1	1732.6 : 1	1196 : 1	1260.1 : 1
Seed-set (%)	90.0 ± 2.22	93.33* ± 1.41	92.01* ± 1.26	90.2* ± 1.88
Total yield/plant (g)	27.19 ± 0.95	24.47 ± 1.33	19.26* ± 0.82	6.75* ± 1.03
Mode of pollination	Self + cross		Cross	

±, Standard deviation, *Significantly different from control at 5% level.
**Data from ten flowers of each plant among the seventy-five untreated plants and seventy-five plants treated with each concentration.
***Mean value from control plants throughout flowering period.

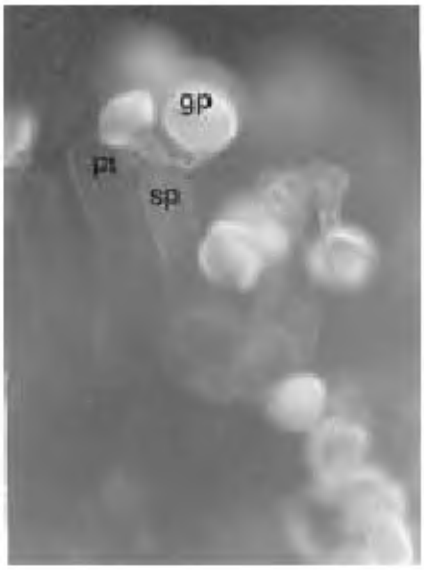

Figure 2. Fluorescence photomicrograph showing stigmatic papillae (sp), germinating pollen (gp) and pollen tube (pt) penetrating into the papillae (650 ×).

with surf-excel facilitated cross-pollination brought about by honey bees from the beehive in the experimental plot. The number of ovules/flower and pollen–ovule ratio were reduced in plants sprayed with surf-excel. However, there was a significant increase in the seed-set percentage in the plants sprayed with 2 and 4% surf-excel (93.33 and 92.01%, respectively) compared to control plants (90%). The increase in the seed-set percentage in treated plants may be attributed to the fertilization of all the ovules due to cross-pollination brought about by honey bees. On the other hand, treatments with different concentrations of surf-excel caused a slight reduction in total yield/plant (24.47 g/plant) sprayed with 2% surf-excel. This was not significantly different from that in control plants (27.19 g/plant). The reduction in total yield/plant treated with 6% surf-excel is largely because of the reduction in the seed size and their weight.

Brassicas are well-known to be partially self-sterile and the response of crop yield to insect pollination is known to be directly proportional to the extent of self-sterility[6]. The buds in the members of the family Cruciferae are quite capable of bud pollination, accepting self-pollen on their receptive stigma[7]. Thus, the raised receptive stigma in buds of surf-excel-treated plants of *B. juncea* are pollinated by honey bees and the seed-set percentage and yield were enhanced to a considerable extent. This is further supported by the fact that pollination brought about by bees is by far the most effective method for seed production in mustard[8].

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