J. King Saud Univ., Vol. 4, *Science* (1), pp. 29-36 (1412 A.H./1992)

Cytological Effects of Certain Herbicides: I. Meiotic Effects of "Hoelon"

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(Received 16 May 1990; Accepted for Publication 16 July 1991)

Abstract. "Hoelon" is a herbicide used to control annual grasses, wild oats, foxtail and other weeds. It can be applied to wheat and barley in any plant stage. The present study was done to investigate the effects of "Hoelon" on the meiotic division of the pollen mother cells of *Vicia faba*. "Hoelon" was found to affect the meiotic behaviour of chromosomes. The dominant types of abnormalities observed were stickiness, disturbance, bridges, non-oriented and lagging chromosome.

Introduction

The herbicide methyl 2-[4- (2,4 dichlorophenoxy) phenoxy] propionate is known as diclofop-methyl and has the trade names "Hoelon" and "Hoe-Grass." It is used in Saudi Arabia as a postemergence grass weed herbicide. "Hoelon" can be used for crops like alfalfa, barley, wheat, soybean, broad beans, cabbage, carrots, cauliflowers, lettuce, onion, peas, potatoes and several other dicot crops.

Some pesticides have been reported to affect mitosis and meiosis in higher plants [1-5].

This study was done to investigate the effect of "Hoelon" on both meiotic division and chromosome behaviour in the flower buds of *Vicia faba*.

Materials and Methods

Vicia faba plants were sprayed with "Hoelon" (active ingredient 38.7% EC) solution in two concentrations, namely, 8 and 16% w/w. The plants were sprayed at the

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beginning of the appearance of the flower buds when they were 23 days old. The flower buds were collected when the plants were 45 days old. The specimens (treated flower buds) were collected at random from 20 plants for each treatment, fixed in acetic – alcohol solution (1:3) for 24 hours and then stored in 70% alcohol for the cytological studies. Aceto carmine solution stain was used.

Results and Discussion

Spraying the plants with "Hoelon" solution causes harmful cytogenetic effects in *Vicia faba* pollen mother cells. The total percentage of abnormalities and percentages of abnormalities in the first and the second meiotic divisions were increased by increasing the herbicide concentration from 8 to 16% w/w. Table 1 shows that, the percentage of abnormalities in the second meiotic division was higher than that in the first division after treatment with both "Hoelon" concentrations. These effects resulted in "Hoelon" affecting the pollen grain viability. It is observed also from Table 1 that, the percentage of abnormal pollen mother cells in metaphase II stage was higher than that in metaphase I. This phenomenon was also observed in the meiosis of *Allium cepa* after treatment with the drug promethazine HCl [6].

Table 1. Total percentage of abnormalities and percentage of abnormalities in each meiotic stage in *Vicia faba* pollen mother cells after treatment with "Hoelon"

			1st			2nd division		
Herbicide conc. (% w/w)	No. of counted cells	Total % of abnor.	% abnormalities meta.	ana.	% total abnor.	% abnormalities meta.	ana.	% total abnor.
–(control)	1275	10.90	13.17	18.70	15.26	10.00	3.50	3.78
8	1194	44.90	35.32	47.84	39.06	85.18	34.72	51.39
16	1698	63.11	52.20	73.39	59.31	76.64	80.36	78.93

Hakeem and Shehab [1, 2] reported that, the treatment of the flower buds of *Vicia faba* plants with the herbicides "2,4-D amine" and "Eptam" caused high percentages of abnormalities in both meiotic divisions.

It may be mentioned in this respect that, a significant increase in the percentage of abnormal pollen mother cells in *Vicia faba* plants was observed after spraying with the insecticides "Phosvel", "Dursban" and "Methamidophos" [7-9].

Substantial increases in the percentage of abnormalities in the meiotic stages were observed on increasing the "Hoelon" concentration from 8 to 16% w/w (Table 1).

Table 2. Percentage* of each type of abnormalities in the meiotic division of *Vicia faba* after treatment with "Hoelon"

Herbicide conc. (% w/w)	Abnormalities (%)					
	Stickiness	Bridges	Non-oriented chromosome	Spindle disturbance	Lagging	Breaks
8	81.90	6.33	3.54	7.45	0.56	0.19
16	76.32	7.89	8.26	6.59	0.64	0.27

*The percentage of the types of abnormalities was calculated relative to the number of abnormal pollen mother cells.

Table 2 shows that, both concentrations of "Hoelon" produced different kinds of chromosomal abnormalities; these were stickiness, non-oriented chromosomes, bridges, spindle disturbance, lagging and breaks.

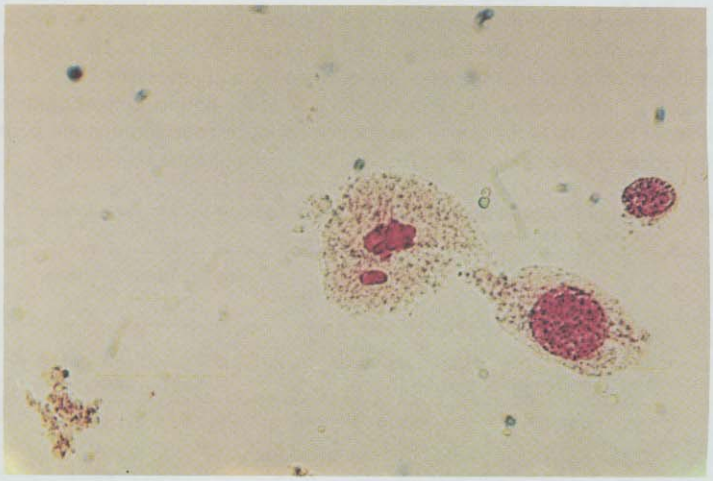

Fig. 1. Severe sticky metaphase I with non-oriented bivalent in *Vicia faba* treated with 16% w/w "Hoelon"

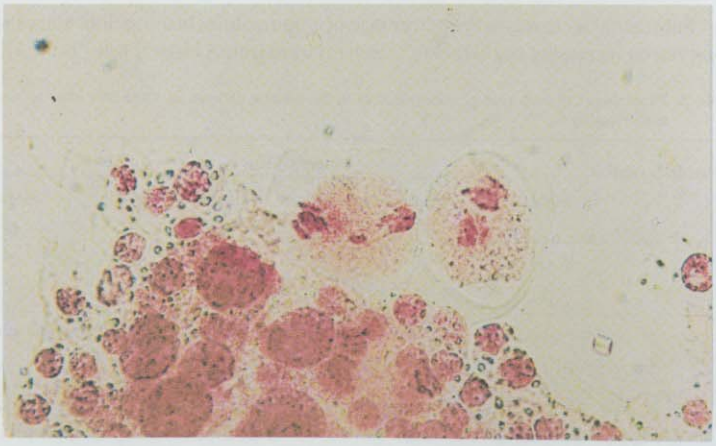

Fig. 2. Sticky anaphase I with lagging chromosome in *Vicia faba* treated with 16% w/w "Hoelon"

Stickiness was the most prominent abnormality observed in the pollen mother cells of *vicia faba* after treatment with "Hoelon" (*e.g.* Figs 1 and 2). The percentage of cells with chromosomes showing stickiness was higher in the second meiotic division than in the first meiotic division in the case of the herbicide concentration of 16% w/w (Table 3). In the case of the 8% w/w herbicide concentration, the percentage of stickiness was higher in the first division than in the second division.

Table 3. Percentage of different types of abnormalities in the first and second meiotic divisions in *Vicia faba* treated with "Hoelon"

Herbicide conc. (% w/w)	Abnormalities in 1st division (%)						Abnormalities in 2nd division (%)					
	Stick.	Brid.	Non-ori-	Spin. dist.	Lagg.	Breaks	Sticks.	Brid.	Non-ori.	Spin. dist.	Lagg.	Breaks
8	88.47	0.41	7.82	2.05	0.41	0.82	76.54	11.22	–	11.90	–	0.51
16	72.36	9.04	11.18	6.16	0.83	0.38	83.99	4.63	–	7.83	–	–

Amer and Farah [8] reported that spraying of the pollen mother cells of *Vicia faba* with "Dursban" insecticide induced some types of abnormalities of which the most dominant was stickiness.

Bridges were also found as another type of abnormality in *Vicia faba* pollen mother cells after spraying with "Hoelon" (Table 2). In the case of a herbicide concnetration of 8% w/w, the bridges were accompanied by sticky clumped metaphase chromosomes and they may have formed as a result of separation of sticky chromosomes. On the other hand, in the case of the herbicide concentration 16% w/w, the bridges were observed in distrubed anaphases.

Failure of orientation of univalent or bivalent chromosomes on the equator was another interesting abnormality which always accompanied sticky metaphase I or II. The univalent or bivalent chromosomes appeared diffuse in the cytoplasm and near the clumped chromosomes in the equator (Fig. 3). Sudhakaran observed this type of abnormality on treating *Vinca rosea* with gamma rays [10]. Kaul also found the same type of abnormality after treating *Ageratum conzoides* with a saturated solution of aesculin (6- glucoside- 7 hydroxy coumarin) [11].

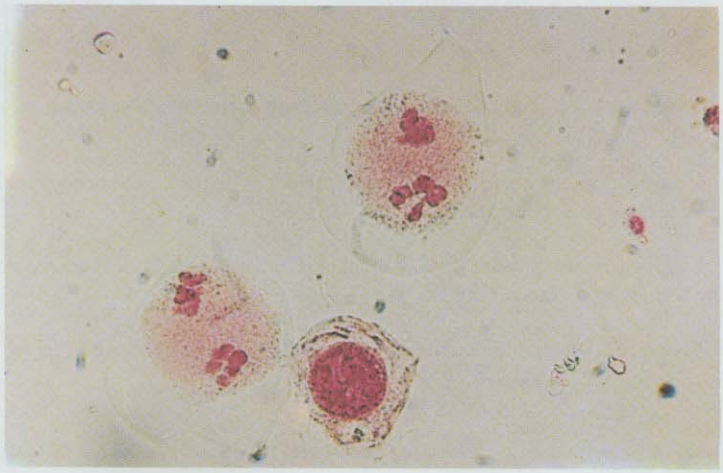

Fig. 3. Sticky metaphase II with non-oriented chromosomes in *Vicia faba* treated with 16% w/w "Hoelon"

Disturbed anaphases were observed also in the pollen mother cells of *Vicia faba* after spraying with "Hoelon" (Table 2). Disturbance was more obvious in anaphases than in metaphases (Fig. 4).

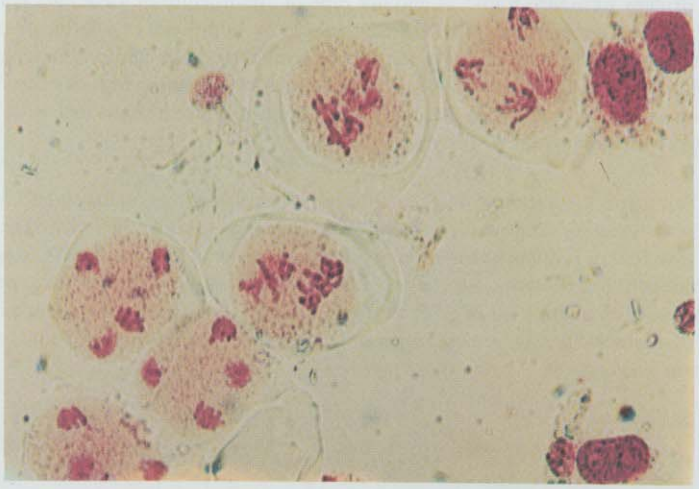

Fig. 4. Sticky anaphase II accompanied by bridges in *Vicia faba* flower buds after treatment with 8% w/w "Hoelon"

It is clear from the presented results that, "Hoelon" in the tested concentrations is toxic to the pollen mother cells.

Lagging was also noticed but in a small percentage (Table 2); it appeared only in the first division (Table 3 and Fig. 2).

Breaks, in a very small percentage, were also found in some pollen mother cells.

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التأثير السيتولوجي لمبيدات معيّنة: ١ ـ تأثير الهولون على الانقسام الاختزالي

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ملخص البحث. تهدف هذه الدراسة إلى معرفة تأثير مبيد الحشائش الهولون على سلوك الكروموسومات في الخلايا الأمية لحبوب اللقاح لنبات الفول، والهولون أحد المبيدات التي تستعمل في المملكة العربية السعودية لمكافحة الحشائش في كثير من المحاصيل وخصوصًا القمح والشعير. وقد رشت نباتات الفول قبل فترة الإزهار، وكان عمرها ٢٣ يومًا، ثم جمعت البراعم الزهرية عندما كانت النباتات عمرها ٤٥ يومًا، وفحصت الخلية الأمية لحبوب اللقاح للتعرف على الشذوذ الكروموسومي نتيجة المعاملة بالهولون.

وقد دلت هذه الدراسة على أن للهولون تأثيرًا كبيرًا على الانقسام الميوزي لنبات الفول حيث سببت المعاملة بالمبيد نسبة عالية من الشذوذ الكروموسومي في الخلايا الأمية لحبوب اللقاح، كما زادت النسبة المئوية للشذوذ الكروموسومي في كل من الانقسامين الميوزي الأول والثاني. وقد كانت لزوجة الكروموسومات الأكثر شيوعًا من بين أنواع الشذوذ الكروموسومي المشاهدة، والتي اشتملت على الجسور، الكروموسوم غير مصطف، الطور الاستوائي والانفصالي المبعثر ـ الكروموسوم المتأخر.

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