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Cytological Effects of Certain Insecticides: II. Effect of Gesal Insecticides on *Vicia faba*

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Abstract. The cytological effects of Gesal insecticides in the form of sticks and spray were studied using *Vicia faba* plants. Gesal insecticide sticks affected the mitotic index and caused marked chromosomal aberrations. The sprays induced the appearance of chromosomal aberrations in a distinctly high percentage. The percentage of total abnormalities were decreased on increasing the time of recovery. The chromosomal aberrations induced by Gesal insecticides were stickiness, disturbance, despiralization, non-orientation, contraction, fragmentation and rough surface.

Introduction

A large number of different plant species contain natural insecticidal materials [1]. The most important examples of botanical insecticides are nicotine, rotenone and pyrethrum. Synthetic insecticides are chemicals designed to combat the attacks of various insects on agricultural and horticultural crops. The earlier insecticides were non-systemic (contact). In contrast, many of the more recent insecticides are systemic in character. These can effectively penetrate the plant cuticle and move through the plant vascular system. In case of non-systemic insecticides, the phytotoxicity does not present such a great problem as it does in the case of systemic ones.

Most insecticides are applied as sprays, while some insecticides may be applied as sticks. Gesal insecticides are used in the form of sprays or sticks.

Gesal insecticide spray may be applied to indoor plants such as Bamboo Palm, Arabia and Hibiscus. Gesal insecticide spray protects plants against aphids, thrips, white flies and red spiders. It contains the active ingredient permethrine in the ratio of 0.08% and has the chemical name 3-phenoxybenzyl (1RS)-cis, Trans-3-(2,2-

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dichlorovinyl)- 2,3- dimethyl- cyclo- propane- carboxylate. It contains also 0.05% Bromopropylate and 99.8% inert ingredients.

Gesal insecticide sticks protect plants against pests such as aphids, mealy bugs and spider mites. They can be used by inserting the sticks in the pot; the number of sticks inserted depends on the diameter of the pot. Gesal sticks have a systemic effect. They have the active ingredient butoxicarboxim in the ratio of 9.8% and has the chemical name 3-(methyl sulphonyl) butanone 0- Methyl carbamoyloxim. Gesal sticks contain also 1.7% inert ingredients and 88.5% carton.

The present study was carried out to investigate the cytological effects of Gesal insecticides on *Vicia faba*. The cytological studies included mitotic and meiotic effects.

Materials and Methods

Gesal insecticide sticks, Reckitt & Colman AG, Switzerland. Gesal insecticide spray, Reckitt & Colman AG, Switzerland. *Vicia faba* plants.

Mitotic Studies

Seeds of *Vicia faba* were soaked in tap water for 24 hours, then sown in sawdust in pots of diameter 10 cm until the appearance of secondary roots. One stick of Gesal insecticide was inserted in the pot. After 24 hours the roots were thoroughly washed, cut and fixed in freshly prepared acetic acid:alcohol (1:3 v/v) for 24 hours. The roots were then stored in 70% ethyl alcohol. About 4000 cells from five different root tips were counted and examined.

Meiotic Studies

Seeds of *Vicia faba* were soaked in water for 24 hours and then cultivated in soil. The plants of 13 days old were sprayed with Gesal insecticide and were sprayed again at the flowering stage. The flower buds were collected 4 days, 6 days and 8 days after the second spraying. They were fixed in acetic acid:alcohol (1:3 v/v) for 24 hours and then stored in 70% ethyl alcohol for the meiotic studies. The treated flower buds were collected at random from 20 plants for each treatment.

Leuco basic Fuchsin stain was used for mitotic studies while iron aceto-carmine solution was used for the meiotic studies.

Results

Mitotic Studies

Cells of *Vicia faba* roots showed a decrease in the mitotic index after treatment with Gesal insecticide sticks compared with the control (Table 1). In the same time, Gesal sticks caused the appearance of a high percentage of abnormal cells. The highest percentage of these abnormal cells was noted in the ana-telophases. Accumulation of ana-telophases and metaphases at the expense of prophases (Table 1) was also observed in the treated roots.

Table 1. Mitotic index*, percentage of total abnormalities and percentage of each mitotic stage in *Vicia faba* roots treated with Gesal insecticide sticks

Treatment	Mitotic index	Total abn. (%)	Prophase (%)	Metaphase (%)	Anateloph. (%)
Control	24.76	4.26	90.87	4.44	4.62
Roots treated with the insecticide for 24 hours	15.28**	24.68**	69.94	11.32	18.74

* The mitotic index is the percentage of dividing cells to the total number of cells examined.
** Significant from control at 0.01 level of probability (t-test).

The treatment of *Vicia faba* roots with Gesal insecticide sticks resulted in the appearance of different types of chromosome abnormalities. These are despiralization, spindle disturbance, stickiness, lagging, breaks and bridges. Despiralization and spindle disturbance were the most common abnormalities. Table 2 shows that, despiralization was more obvious in the prophase stage while, stickiness was common in the metaphase stage. Spindle disturbance was the dominant aberration in the ana-telophase stage where the chromatids were scattered as the result of pole disturbances.

Table 2. Percentages of the different types of abnormalities in each mitotic stage in *Vicia faba* roots treated with Gesal insecticide sticks

Mitotic stage	Types of abnormalities					
	Despiralization	Spindle disturb.	Stickiness	Lagging	Breaks	Bridges
Prophase	88.89	8.33	2.79	0.00	0.00	0.00
Metaphase	21.05	18.42	57.89	0.00	2.62	0.00
Anatelophase	13.08	62.71	10.17	5.08	1.69	1.69

Meiotic Studies

Table 3 indicates that the total percentage of abnormalities was obviously decreased on increasing the recovery time from 4 days to 8 days. This is evident also for the percentage of abnormalities in the first and second meiotic divisions.

Table 3. Percentages of abnormalities in the meiosis of *Vicia faba* plants sprayed with Gesal insecticide and after recovery for 4, 6 and 8 days

Time of recovery (days)	No. of cells counted	Total % of abn. P.M.C.s	First division			Second division		
			Abn. metaph. (%)	Abn. ana-telo- (%)	Total abn. (%)	Abn. metaph. (%)	Abn. ana-telo- (%)	Total abn. (%)
–(Control)	1046	12.52	15.64	19.24	17.63	3.85	3.02	2.93
4	806	84.99	99.24	91.26	95.96	93.16	33.33	73.22
6	753	85.66	68.93	99.00	88.85	96.21	72.15	83.48
8	1402	13.69	7.59	19.61	8.93	74.07	12.41	22.73

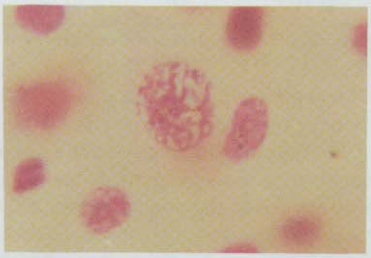

Fig. 1. Shows despiraalization in prophase stage after treatment with 20 μg/ml harmine

Fig. 2. Shows abnormal prophase after treatment with 20 μg/ml harmol

Fig. 3. Shows prophase metaphase after treatment with 20 μg/ml harmine.

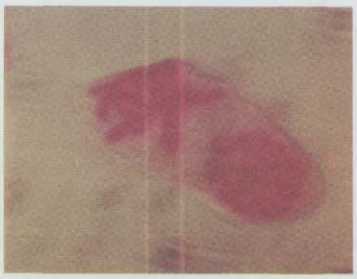

Fig. 1. Shows disturbed metaphase after treatment with 40 μg/ml harmine

Gesal insecticide spray caused several types of chromosomal aberrations in the pollen mother cells of *Vicia faba* plants (Figs 1-4). Stickiness was the most dominant abnormality especially in the plants recovered for 6 and 8 days (Table 4 and Fig. 1). Contraction was another type of abnormality which was noted obviously in the plants recovered for 4 days. In this aberration, the chromosomes became thicker and shorter than normal at metaphase I of the control. Non-oriented chromosomes or bivalents as well as spindle disturbance were common abnormalities although present as small percentages. Non-orientation was seen at the metaphase I and II. Spindle disturbance included the following types of irregularities:

1) Many disturbed 1st metaphases and ana-telophases (Fig. 2).
2) Disturbed 2nd metaphases and ana-telophases (Fig. 3).
3) Multipolarity (Fig. 4).

Fragmented chromosomes were observed in the pollen mother cells of the treated plants recovered for 4 days. The fragmented chromosomes are formed of seg-

ments or parts weakly attached together at the points of gaps. Rough surfaced chromosomes (chromosomes with rough appearance), bridges and breaks were other forms of chromosomal abnormalities present in more or less small percentages.

Table 4. Percentages of the different types of abnormalities in the pollen mother cells of *Vicia faba* plants treated with Gesal insecticide spray and recovered for 4, 6 and 8 days

Time of recovery (days)	Types of abnormalities									
	Stick-iness	Contr-action	Non-orienta-tion	Spin-dle dist.	Despi-ralis-ation	Fragm-ented	Brid-ges	Rough surf ace	Breaks	Lagg-ing
4	35.33	33.11	2.77	1.90	0.14	26.28	0.59	0.14	0.58	0.00
6	71.47	00.31	1.55	11.63	0.62	00.00	2.64	9.30	0.93	1.09
8	75.52	00.00	9.38	3.65	0.00	00.00	6.25	0.00	4.69	0.52

Discussion

It was observed from the results presented that Gesal insecticide spray or sticks had a pronounced effect on the mitotic and meiotic divisions of *Vicia faba*. However, this effect was different in both divisions.

With respect to the mitotic index, there was a significant ($P < 0.01$) decrease compared with the control. A depression of the mitotic index has been recorded by many investigators as a result of treatment with insecticides *e.g.* Fensulfothion [2] and Rogor [3].

Abdou and Ali [4] reported that the mitotic activity in *Vicia faba* roots decreased after treatment with the insecticide chlorpyrifos. They came to the conclusion that when the pesticide entered the cells, it permitted them to proceed to interphase where they lost their ability to undergo further division. This interpretation might be the most likely explanation for the inhibit on of the mitotic index in *Vicia faba* roots caused by Gesal sticks.

Gesal insecticide sticks caused the occurrence of chromosomal aberrations in the meristematic cells of *Vicia faba*. Soliman and Al-Najjar [5] found that treatment of wheat and two related species with Vitavax-200 and Diathane 5-60 increased the number of abnormal cells.

With respect to the effect of Gesal insecticides on the flower buds of *Vicia faba*, it can be concluded that such effects are temporary since the total percentage of

abnormalities as well as the abnormalities in both meiotic divisions are decreased by increasing the recovery time. It is worth mentioning that the effect of other chemicals on the flower buds found to be temporary *e.g.* Vinblastine and Yohimbine [6].

Different types of chromosomal aberrations were observed in both the mitosis and meiosis of *Vicia faba* plants after treatment with Gesal insecticides as spray or sticks.

Stickiness was more obvious in the meiotic divisions than in the mitosis and was the most dominant aberration in *Vicia faba* pollen mother cells. Amer and Farah [7] found also that stickiness was the dominant type of abnormality when *Vicia faba* plants were treated with Dursban insecticide.

On the other hand, disturbed poles and multipolar anaphases were the most common anomalies in the mitotic divisions. The occurrence of spindle disturbance was probably caused by some damage in the spindle function. Shehab [6] found that most abnormalities in *Allium cepa* roots treated with cyanine dyes were observed in the anaphase stage, and reported that cyanins affected the spindle function.

Despiralization of chromosomes was also noted obviously in *Vicia faba* meristematic cells treated with Gesal insecticide. This phenomenon was also observed by Kemp [8] in his study of the direct effect of inhibitors of RNA and protein synthesis on the cytological development during meiosis. So, Gesal might interfere with the process of synthesis between RNA and protein.

Non-oriented chromosomes or bivalents were clearly seen in *Vicia faba* pollen mother cells. Amer and Ali [9], in their study of the effects of 2,4,5- trichorophenol, 2,4,5- trichlorophenoxy acetic acid (2,4,5- T), 2,4- dichlorophenoxy acteic acid (2,4,D) and 2,4- dichlorophenol on *Vicia faba,* found single lagging bivalents in the first metaphase stage and attributed this phenomenon to the hinderance of the movement of the bivalent to the equatorial plane.

Contraction of chromosomes especially in metaphase I was observed in the meiosis of *vicia faba* plants sprayed with Gesal and left to recover for 4 days. This phenomenon might be a result of the toxic action of the insecticide. Kubiak [10] reported that solutions of diazo-dye-stuffs induced supercontraction of the chromosomes at late prophase and at metaphase in *Allium cepa* root cells.

Fragmented chromosomes were observed in some pollen mother cells of the plants treated with Gesal insecticides and recovered for 4 days. Fragmented chromo-

somes were observed also by Shehab [6] in *Vicia faba* pollen mother cells treated with Vincaleucoblastin (VLB) alkaloid. Sudharson Raj and Rao [11] reported extreme fragmentation in *Vicia faba* cells treated with Lathyrogens. They attributed such phenomenon to the interference of Lathyrogens with the ribonucleo-protein metabolism in the secondary constriction region.

Rough surfaced chromosomes were observed in the pollen mother cells of *vicia faba* plants sprayed with Gesal insecticide. This may be a result of depletion of the proteins surrounding the chromosomes leading to their rough appearance [6, 12].

References

[1] Cremlyn, R. *Pesticides, Preparation and Mode of Action*. Chichester, New York, Brisbane, Toronto: John Wiley & Sons, 1980.

[2] Panda, B.B. and Sahu, U.K. "Induction of Abnormal Spindle Function and Cytokinesis, Inhibition in Mitotic Cells of *Allium cepa* by the Organophosphorus Insecticide Fensulfothion." *Cytobios*, 42 (1985), 147-155.

[3] Amer, S.M. and Farah, O.R. "Cytological Effects of Pesticides. VI. Effect of the Insecticide Roger on the Mitosis of *Vicia faba* and *gossypium barbadense*." *Cytologia*, 39 (1974), 507-514.

[4] Abdou, R.F. and Ali, A.M. "Cytological and Developmental Effects of Certain Insecticides in *Vicia faba*." International pest control, September/October (1985), 123-125.

[5] Soliman, A.S. and Al-Najjar, N.R. "Cytological Effects of Fungicides. II. Chromosomal Aberrations Induced by Vitavax- 200 and Diathane S- 60 in Mitotic Cells of Wheat and Two Related Species." *Cytologia*, 45 (1980), 169-175.

[6] Shehab, A.S. "Cytological Effects of Vinca Alkaloids. I. Effect of Vinblastine and Yohimbine on Meiosis of *Vicia faba*." *Cytologia*, 50 (1985), 427-431.

[7] Amer, S.M. and Farah, O.R. "Cytological Effects of Pesticides. XIII. Meiotic Effects of the Insecticide Dursban." *Cytologia*, 48 (1983), 557-563.

[8] Kemp, C.L. "The Effect of Inhibitors of RNA and Protein Synthesis on Cytological Development during Meiosis." *Chromosoma*, 15 (1964), 652 656.

[9] Amer, S.M. and Ali, E.M. "Cytological Effects of Pesticides. V. Effects of some Herbicides on *Vicia faba*." *Cytologia*, 39 (1974), 633-643.

[10] Kubiak, R. "Mitotic Disturbances Induced by Extracts of *Merulius lacrymans*." *Acta Biologica. Cracoviensia, Series: Botanica*, VIII (1965), 155-170.

[11] Sudharson Raj, A. and Rao, V.R. "Cytological Studies in *Vicia faba* L. Treated with Lathyrogens." *Cytologia*, 37 (1972), 245-256.

[12] El-Sadek, L.M. "The Effect of TCA and its Herbicidal Forms on *Faba vulgaris* Root Meristems." *Egypt. J. Genet. Cytologia*, 1 (1972), 280-287.

التأثير السيتولوجي لمبيدات معيّنة: ٢ ـ تأثير مبيد الجيزال على الفول

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ملخص البحث. مبيد الجيزال أحد المبيدات التي يمكن استعمالها على هيئة رشاش أو عيدان. وقد اختير هذا المبيد لدراسة تأثيره على نبات الفول.

وقد شملت هذه الدراسة التأثيرات على الانقسامين الميتوزي والميوزي. استعمل المبيد على هيئة عيدان لدراسة تأثيره على الانقسام الميتوزي، بينما استعمل الرشاش لدراسة تأثيره على الانقسام الميوزي.

عولجت جذور الفول الثانوية بعيدان الجيزال لمدة ٢٤ ساعة، أما النباتات فقد رشت مرتين حيث كانت الرشة الأولى بعد ١٣ يومًا، والأخرى عند مرحلة الإزهار.

تبين من الدراسة أن لمبيد الجيزال تأثيرًا ملحوظًا على الانقسامين الميتوزي والميوزي لنبات الفول، حيث أحدثت عيدان الجيزال انخفاضًا في معدّل الانقسام الميتوزي، وأوجدت المعاملة نسبة عالية من الشذوذ الكروموسومي. وسببت المعاملة بالمبيد ـ على هيئة رشاش ـ نسبة عالية من الشذوذ الكروموسومي، وكان تأثيرها على الخلايا الأمية لحبوب اللقاح مؤقتًا.

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