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EFFECT OF SOME GAMETOCIDES ON POLLEN STERILITY AND ANTHER DEVELOPMENT IN COTTON *GOSSYPIMUM ARBOREUM*

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Introduction

In recent years chemical induction of male sterility in flowering plants has received considerable attention (see CHAUHAN and KINOSHITA).¹⁾ The effects of various phytogametocidal compounds on anther development in a wide variety of taxa have been studied.^{6,7,8,13)} However, our understanding of the effects of gametocidal compounds on anther development in cotton is meagre. The present paper deals with the effects of FW-450 or Mendok, maleic hydrazide and coumarin on pollen sterility and anther development in cotton (*G. arboreum*).

Materials and Methods

Plants of *Gossypium arboreum* var. 35/1 were sprayed with aqueous solutions of the gametocides at different stages of development (Table 1). Some plants

TABLE 1. Gametocides, their concentration and number of treatments made on *G. arboreum*

| Gametocide | Concentration (% aqueous solution) | Treatments |
|-----------------------|---------------------------------------|---|
| FW-450 or Mendok | 0.5, 1.0 & 1.5 | T 1: Treatment made a week before the bud initiation. |
| | | T 2: Treatment made at the time of bud initiation. |
| Maleic hydrazide (MH) | 0.1, 0.5 & 1.0 | T 3: Treatment made at the time of anthesis. |
| | | T 4: Treatments made twice, one before bud initiation and second at the time of bud initiation. |
| Coumarin | 1, 2 & 3 | T 5: Treatments made twice, one before bud initiation and second at the time of anthesis. |

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were sprayed with distilled water to serve as control.

Pollen viability in treated and untreated plants was tested at regular intervals with ALEXANDER'S staining procedure.¹¹ Flower buds of treated and untreated plants were fixed in formalin-acetic-alcohol. These were passed through customary schedules and sections were cut at 6-15 μ m in thickness. HEIDENHEIN'S iron-alum haemotoxylin was used for staining.

Results and Discussion

POLLEN STERILITY: The extent of pollen sterility induced by various treatments with different gametocides is shown in Table 2.

It is evident from the data presented in Table 2. that the extent of pollen sterility increased gradually with the increase in the concentration and number of treatments made with various gametocides. The plants sprayed twice, first spray before floral bud initiation and second at the time of bud initiation (T 4) with the highest concentration of all the chemicals exhibited the highest pollen sterility and FW-450 was the most effective in inducing the highest degree of pollen sterility (97.8%). On the other hand, two sprays (T 4) of 1% MH and 3% coumarin caused 80.2% and 78% pollen sterility respectively.

The findings by several authors^{16, 19, 29, 20, 22, 23)} have indicated that FW-450 is not suitable for inducing male sterility in cotton on a large scale. On the other hand, BHARDWAJ and SANTHAM,²⁾ TER-AVANESJAN and SEMENOVA,²⁴⁾ BOUHAR-MOUNT and POCKET,³⁾ GURUSWAMIN RAJA¹⁷⁾ and DUBEY and SINGH¹⁵⁾ have induced 100% pollen sterility in *G. hirsutum* by FW-450 treatments. According to DUBEY and SINGH,¹⁵⁾ three sprays of 1.5% FW-450 induced perfect male sterility. They have also induced 100% pollen sterility in cotton by treatment

TABLE 2. Extent of sterility caused by various treatments of different gametocides

| Chemical | Concentration (%) | Pollen sterility (%) | | | | |
|----------|-------------------|----------------------|----------|----------|----------|----------|
| | | T 1 | T 2 | T 3 | T 4 | T 5 |
| FW-450 | 0.5 | 75.1±2.5 | 63.7±1.9 | 60.1±2.1 | 82.4±2.7 | 78.3±4.1 |
| | 1.0 | 80.6±1.7 | 76.7±3.1 | 73.4±4.3 | 89.7±3.1 | 83.7±3.1 |
| | 1.5 | 92.2±4.2 | 83.6±1.8 | 76.3±3.3 | 97.8±4.3 | 95.7±4.3 |
| MH | 0.1 | 60.7±6.1 | 60.0±2.1 | 57.9±6.2 | 68.1±3.3 | 65.3±4.1 |
| | 0.5 | 70.6±5.8 | 69.8±3.4 | 67.4±3.2 | 77.6±2.6 | 73.4±3.1 |
| | 1.0 | 76.8±4.7 | 71.6±3.4 | 70.1±4.7 | 80.2±3.1 | 78.4±2.7 |
| Coumarin | 1.0 | 49.0±3.4 | 47.6±3.9 | 46.0±3.8 | 53.3±2.4 | 50.7±4.3 |
| | 2.0 | 46.5±4.1 | 46.1±4.2 | 45.7±5.2 | 49.3±3.6 | 47.6±3.4 |
| | 3.0 | 74.3±3.2 | 70.2±5.2 | 67.6±3.4 | 78.0±5.8 | 75.7±2.5 |
| Control | — | 1.4±0.7 | | | | |

± Standard deviation

with 2-3% coumarin.

ANTHER DEVELOPMENT: The anthers of plants treated twice (T 4) with 1.5% FW-450 exhibiting 97.8% pollen sterility showed tapetal abnormalities in both pre and post-meiotic stages of development. In a limited number of anthers of such plants, the sporogenous tissue and tapetal cells degenerated much earlier than the onset of meiosis (Fig. 1). Further development of such anthers ceased at this stage. The tapetal cells in yet another limited number of anthers of 1.5% FW-450 treated plants degenerated along with the vacuolate microspores (Fig. 3).

By contrast in most anthers of plants sprayed with 1.5% FW-450, the tapetal cells failed to show signs of degeneration at microspore tetrad stage, instead elongating radially (Fig. 2). The tapetal cells remained intact up to anthesis in the form of a narrow band with degenerated protoplast (Fig. 4). The development of endothecium was also fully inhibited in such anthers.

Anther development in plants showing 50% pollen sterility treated with various concentrations of coumarin was more or less similar to that of control plants (Fig. 5). However, the cells in the tapetal layer showed a slight variation. The degeneration of tapetal cells in the anther of such plants was delayed and complete degeneration was recorded only at a late vacuolate pollen stage. Fibrous bands on the radial walls of endothelial cells appeared only after complete tapetal breakdown (Fig. 8). Tapetal degeneration was further delayed in the anthers of plants exhibiting a high degree of pollen sterility (50-95%) induced by sprays of FW-450 and maleic hydrazide. The cells in this layer degenerated only at the time of anthesis. Development of endothelial cells was also inhibited and formation of fibrous thickenings was either fully inhibited (Fig. 7) or partially inhibited (Fig. 6). It was interesting to note that tapetal protoplast was completely absorbed from the anthers showing the formation of characteristic fibrous thickenings (Fig. 6), while in the anthers showing the absence of fibrous bands, the tapetal protoplast was not fully degenerated (Fig. 7).

Pollen abortion associated with tapetal abnormalities of various types at different stages of development is well known in a wide variety of taxa where male sterility is either cytoplasmic or genic or induced by gametocides or by gamma rays.^{7,8,9,10,18)} Present findings also lend support to the earlier findings of several authors on the concept of tapetal control on endothelial development.^{4,5,13,14)}

Summary

The effects of FW-450, maleic hydrazide and coumarin on pollen sterility and anther development in cotton (*Gossypium arboreum*) were studied. Two treatments of 1.5% FW-450 caused maximum pollen sterility (97.8%), while 1% MH and 3% coumarin induced 80.2% and 78% pollen sterility respectively. Anther development of treated plants exhibiting a higher degree of pollen sterility

showed tapetal abnormalities associated with inhibition of endothelial development.

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Legend for Plate

- Figs. 1-8. Transverse sectional part of anthers of treated and untreated plants. 280 \times .
- Fig. 1. Treated with 1.5% (T4) FW-450 showing degeneration of both sporogenous tissue (ST) and tapetum (T).
- Fig. 2. Treated with 1.5% (T 4) FW-450 showing radial enlargement of tapetal cells (T) at misrospore tetrad (MT) stage.
- Fig. 3. Treated with 1.5% (T 4) FW-450 showing degeneration of tapetal cells (T) and vacuolate microspores (M).
- Fig. 4. Treated with 1.5% (T 4) FW-450 showing intact tapetal cells (T) and mature non-viable pollen grains with degenerated cytoplasm.
- Fig. 5. Untreated. Note the presence of well developed fibrous thickenings in the endothecium (EN) and viable pollen grains.
- Fig. 6. Treated with 1% (T 4) maleic hydrazide showing non-viable pollen grains and feebly developed endothelial (EN) thickenings.
- Fig. 7. Treated with 0.5% (T 4) maleic hydrazide showing degenerating tapetal protoplast (T), undeveloped endothecium (EN) and non-viable pollen grains.
- Fig. 8. Treated with 1% (T 4) coumarin showing viable pollen grains and fairly well developed endothecinm (EN).

