Through the intercross method a number of interchange heterozygotes showing ⊂6 + 4 II, 2⊂4 + 3 II, ⊙8 + 3 II, ⊂6 + ⊙4 + 2 II and ⊂10 + 2 II at diakinesis were obtained (Figs. 1–4). Plants involving 10 chromosomes in one or two separate rings were highly sterile.

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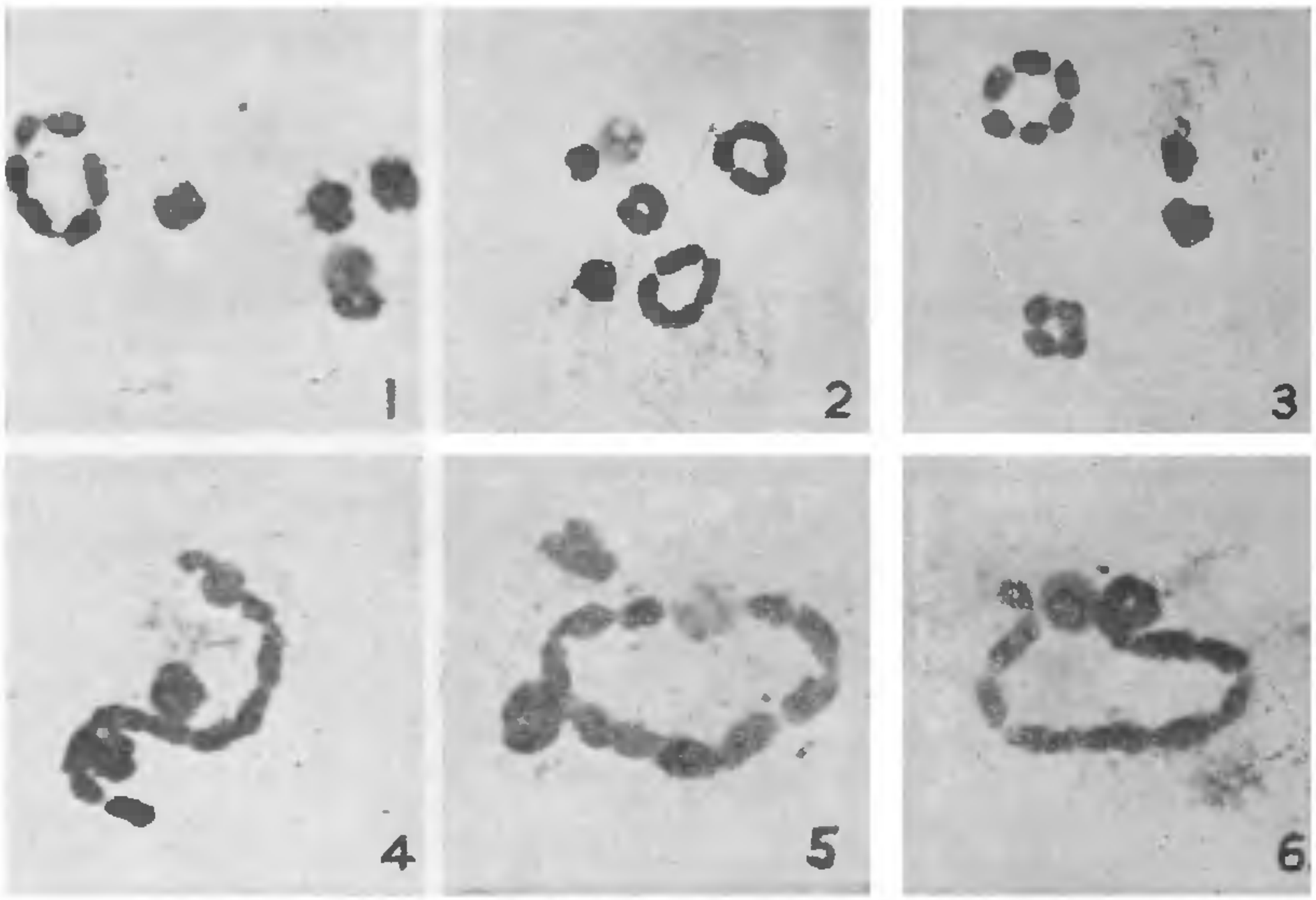

FIGS. 1–6. Chromosome associations in different interchange complexes, × 1,200. Fig. 1. ⊙6 + 4 II; Fig. 2. 2⊙4 + 3 II; Fig. 3. ⊙6 + ⊙4 + 2 II; Fig. 4. Chain of 10 + 2 II; Fig. 5. ⊂12 + 1 II; Fig. 6. ⊙14.

Seed from a translocation heterozygote (2⊙4 + 3 II) were radiated with 20 k R gamma radiation. From the irradiated population plants showing ⊙12 (Fig. 5) and ⊙14 (Fig. 6) were obtained. These plants were completely seed sterile, and hence could not be maintained.

In pearl millet high sterility of translocation heterozygotes, particularly of larger rings, seems to be a major problem in establishing stocks involving all the chromosomes in one or more rings and also in the exploitation of this technique in developing homozygous lines. Multiple interchange stocks involving all the chromosomes in a single complex in barley[5] are also reported to be highly seed sterile. Thus multiple translocation method for establishing homozygous lines can be used only if methods are found to increase the fertility of the complex interchange stocks.

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PARTIAL INHIBITION OF *FUSARIUM* WILT SYMPTOMS IN PIGEON PEA BY NON-PATHOGENIC FORMAE OF *FUSARIUM OXYSPORUM*

THERE are many instances of plants developing protection against their pathogens by previous inoculation with the avirulent or mildly virulent races of the latter, or even with non-pathogens. Vascular wilts constitute a very specialized group of plant diseases in which the pathogen mostly colonizes the non-living xylem elements and therefrom induces characteristic symptoms in the host. Protective responses have also been induced in some plants against vascular wilt pathogens such as *Fusarium oxysporum*[1-7] and *Verticillium dahliae*[8]. In most of these cases, only the onset of symptoms was delayed for a short or long period of time.

Occasionally, the development of symptoms was slowed down. The results of our attempts to induce resistance in pigeon pea plants to the wilt pathogen, *F. oxysporum*, along the lines mentioned above, and some of the observations made in this connection are briefly reported here.

The materials included a highly susceptible variety of pigeon pea, T_1 (Kanpur), and one virulent isolate each of *F. oxysporum* f. sp. *udum*, a pathogen, and *F. oxysporum* f. sp. *ciceri* and *F. oxysporum* f. sp. *vasinfectum*, two non-pathogens.

Initial studies were made with plants grown in pots in sterilized garden soil supplemented with farmyard manure. Plants were inoculated with non-pathogens either by germinating seeds in inoculated soil or by adding inoculum to the soil around the base of 2-week-old seedlings. At the age of 3 weeks, these plants and also healthy ones were inoculated with the pathogen by transplanting to inoculated soil in pots. There were uninoculated controls too. Plants in all the treatments, particularly those previously inoculated with *F. oxysporum* f. sp. *ciceri*, suffered damage as a result of transplanting to soil inoculated with *F. oxysporum* f. sp. *udum*, and that made the interpretations of our observations a little difficult. There was, however, a strong suggestion in the observations that a previous inoculation with either of the two non-pathogens delayed the onset of wilt symptoms.

In some experiments, plants were grown in washed sand to which Long Ashton nutrient solution was added at regular intervals. Inoculation was done by dipping the washed roots in spore suspension (c. 10^6 conidia/ml), and this was followed by replanting in sand. Plants were inoculated with the non-pathogen when 2 weeks old and with the pathogen a week later. Symptoms appeared in inoculated control plants 10–12 days after inoculation with *F. oxysporum* f. sp. *udum*. As compared to this, symptoms started appearing in doubly inoculated plants 3–4 days later, but in these treatments the progress of symptoms was as rapid as in the control plants.

A clearer picture emerged from the subsequent experiments for which plants were grown in Long Ashton nutrient solution in amber-coloured bottles. For inoculation, the root system was kept dipped in spore suspension (10^6/ml) for 24 hours, and later plants were transferred to nutrient solution. Inoculation with the non-pathogen preceded the second inoculation with the pathogen at the age of 3 weeks by 6–7 days. It appeared from the observations that an earlier inoculation with *F. oxysporum* f. sp. *ciceri* or *F. oxysporum* f. sp. *vasinfectum* always delayed the onset of wilt symptoms, the inhibitory effect being slightly more pronounced with the former. In plants previously inoculated with *F. oxysporum* f. sp. *ciceri*, the progress of symptoms was comparatively slower than in the inoculated controls or in those previously inoculated with *F. oxysporum* f. sp. *vasinfectum*. While all the singly inoculated plants in the control series almost completely wilted within 21 days, the doubly inoculated plants took longer time to wilt completely, and some of them survived with slight or only moderate damage even upto 35 days. At this stage, the surviving plants were sectioned at 2·5 cm below the cotyledonary node, and the presence of fungus could be detected in a very low proportion of vessels as compared to extensive colonization in the diseased plants. This suggests the development of protective responses in pigeon pea plants as a result of infection with its non-pathogens.

Subsequent studies with plants grown in nutrient solution, while confirming the earlier conclusions, also led to some interesting observations. The magnitude of protection induced by the non-pathogenic formae speciales of *F. oxysporum* appeared to have some relation to time interval between the two successive inoculations. Both the non-pathogens induced greater protective responses when the interval was reduced from 6 to 3 days. Root injury (trimming of eight secondary roots) at the time of second inoculation generally caused symptoms to appear earlier as compared to those in the uninjured plants, irrespective of time interval. With both the non-pathogens, root injury resulted in a slower development of symptoms, when there was an interval of 6 days, and made plants survive considerably longer than those with uninjured roots. With the shorter interval of 3 days, however, the results were not so conclusive. In course of histological studies with both singly and doubly inoculated plants, it was revealed that inoculation with *F. oxysporum* f. sp. *ciceri* led to deposition of gummy, brown coloured substances in their vessels, and that such vessels never showed any hyphae. Generally the proportion of vessels with gum deposit was higher in plants developing greater protective responses against *F. oxysporum* f. sp. *udum*. But the true relation between such a response to infection with *F. oxysporum* f. sp. *ciceri* on the part of pigeon pea plants and the resistance induced in them to their pathogen, if there is any, is yet to be clarified. It is not to be denied, however, that gum deposition in vessels certainly indicated a host defence response being induced by a non-pathogen.

It was clear that an initial inoculation of individual pigeon pea plants with one of the two non-

pathogens tested could not give them complete protection against a challenge inoculation with the pathogen. It only delayed the onset of wilt symptoms and in some treatments slowed down the progress of symptoms too. The fact that a few plants in some treatments survived the challenge inoculation for a considerable period of time with only minor damages did not unequivocally indicate any acquired protection of permanent nature.

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A NOTE ON THE REVISION OF SOME GRAPHIDACEOUS LICHEN TAXA

AWASTHI[1] enumerated 109 species of the lichen genera *Graphis, Graphina, Phaeographis,* and *Phaeographina* from the Indian sub-continent. Many of these species are based on the Indian material and have not been re-examined or reported again. In order to authenticate our collection of these genera from the different parts of India, we have undertaken a revision of the type specimens preserved in the various European herbaria. Some of the salient observations on the specimens examined so far are noted below :

1. *Graphina oligospora* (Müll. Arg.) Awasthi *et* K. Singh, stat. *et* comb. nov.
   —*Graphina obtecta* var. *oligospora* Müll. Arg. J. Linn. Soc. Bot. 29 : 227, 1892.
   Type collection : Manipur, G. Watt, 6955 pr.p. [Lectotype : BM (K)].

The variety *oligospora* was distinguished by Müller Argoviensis "sporae in ascus 1–4 nae (in planta normali specie solitariae), 120–180 μ longae, 23–25 μ latae ; epithecium nigricans (hypothecium deficiens)". In our examination of the type materials of *Graphina obtecta* (Nyl.) Müll. Arg. [Hooker No. 2264 in BM(K)] and the variety *oligospora* Müll. Arg. (cited above), the latter was found to exhibit important differences from *G. obtecta,* in the possession of a smooth thallus lacking crystals, thallus P —, exciple convergent with multi-striate labia, I + blue, spores larger. These differences have been considered to entitle the variety to an independent status of the species. It belongs to the section *Platygrammina* Müll. Arg. like *G. obtecta,* but the exciple is much better developed.

2. *Graphina obtecta* (Nyl.) Müll. Arg. var. *tuberculosa* (Stirt.) Awasthi *et* K. Singh, stat. *et* comb. nov.
   —*Graphis tuberculosa* Stirt. *Proc. Phil. Soc. Glasgow,* 11 : 317, 1879. Type collection : Nilgiri Hills, G. Watt. [Lectotype : BM(K)].

The type specimen of *Graphis tuberculosa* Stirt. is almost identical to the type of *Graphina obtecta* (Nyl.) Müll. Arg., except that there is a slight variation in the somewhat tuberculose condition of the thallus, P + yellow to orange (in *G. obtecta* it is P + yellow) and slightly larger spores (95–171 × 32–50 μ) than the spores of *G. obtecta* [76–140 (161) × 24–40 μ]. These minor variations are distinctly within the variability of the species of the varietal rank.

3. *Graphina boschiana* var. *concolor* (Nyl.) Awasthi *et* K. Singh, stat. *et* comb. nov.
   —*Graphis concolor* Nyl. *Acta Soc. Sci. Fenn.* 26 (10) : 22, 1900. Type collection : Ceylon, Peradeniya, 1879, Almquist (Lectotype : H—Herb. Nyl. 6814).

Zahlbruckner[2] placed *Graphis concolor* Nyl. as a synonym of *Graphina boschiana* Müll. Arg. Examination of the type specimen of *Graphis concolor* Nyl. shows that it has a much thicker hymenium (114–200 μ), and larger spores (110–171 × 28–38 μ), and has therefore been separated as a variety.

4. *Graphina dimorphodes* (Nyl.) Zahlbr. *Catal. Lich. Univ.,* 2 : 404, 1923.
   —*Graphis dimorphodes* Nyl. in Leight. *Trans. Linn. Soc. London,* 27 : 176, 1869. Type collection : Ceylon, Central Prov. Thwaites C-23 [Lectotype : H—Herb. Nyl. 6812 ; isotypes ; BM, and BM(K)].
   —*Graphis intortula* Stirt. *Proc. Phil. Soc. Glasgow,* 13 : 186, 1881. Type collection : Assam, A. Watt [Lectotype : BM(K)].
   —*Graphina intortula* (Stirt.) *Zahlbr. Catal. Lich. Univ.,* 2 : 411, 1923.

The type specimens of the taxa cited above were examined and were found to be identical in the nature of the thallus, its chemistry (K + red, P + yellow), the nature of exciple, and the spores. The only variation found in *G. intortula* was a slightly darker thallus and fewer striations in the exciple which are of not much taxonomic significance. The two taxa are thus conspecific and