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Occurrence of Genetic Tumours in *Triticum* Interspecies Hybrids

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Summary. F_1 interspecific hybrids involving nine tetraploid *Triticum* species were studied. Some developed leaf tumours at the seedling stage. Tumorous hybrids were restricted to crosses involving either *T. timopheevi* or *T. araraticum* as one parent. The hybrids from the rest of the crosses, including those of *T. timopheevi* × *T. araraticum*, were non-tumorous. Genetically divergent and non-integrated parental species appeared to be inducing spontaneous tumour formation in their hybrids.

Introduction

Genetic tumours in inter-specific hybrids have been reported in *Nicotiana* by Kostoff (1930), Kehr and Smith (1954) and Smith and Stevenson (1961), in *Brassica* and *Lycopersicon* as reviewed by Ahuja (1965), and in hexaploid *Triticums* by Srinivas (1966). The restriction of tumour-forming hybrids to certain interspecific crosses could be evidence of their genetic origin and might indicate wider evolutionary divergence between the parental species of such hybrids (Smith, 1965).

This paper reports the spontaneous occurrence of tumours of genetic origin in the interspecific *Triticum* hybrids.

Material and Methods

The F_1 hybrids of 27 interspecific crosses were raised in pots of 35 cm diameter. The crosses involved *Triticum turgidum*, *T. timopheevi*, *T. durum*, *T. dicoccum*, *T. pyramidale*, *T. polonicum* and *T. carthlicum* in diallel combinations, those of *T. araraticum* with *T. timopheevi*, *T. turgidum* and *T. durum*, and those of *T. turanicum* with *T. turgidum*, *T. durum* and *T. dicoccum*. The seedlings were given artificial illumination throughout the night till the first spike emerged because the material included winter species, viz. *T. araraticum* and *T. timopheevi*, which require long-day treatment under the conditions prevailing in Delhi during the wheat season. Five seedlings were raised per pot; observations were made on the basis of one pot per cross, except for the crosses of *T. timopheevi* with *T. turgidum* and *T. durum*, each of which covered two pots.

Leaf samples of tumorous and normal hybrids of *T. timopheevi* × *T. turgidum* were fixed in F.A.A. (Formaline:acetic acid:alcohol 5:5:90 V/V/V). After over-night fixation they were transferred to 70% alcohol. The material was dehydrated in alcohol-xylol series and embedded in paraffin. Transverse sections of 20/μ thickness were cut by a rotatory microtome. The sections were stained with saffranine and counter-stained with fast green, and mounted in euparal. Later, photomicrographs were taken.

Results and Discussion

It was interesting that only those hybrids with either *T. timopheevi* or *T. araraticum* as one parent developed leaf tumours, as listed in the following table. All the hybrids of the rest of the crosses were normal i. e. non-tumorous.

Sl. No.	F_1 hybrids of the cross	Number of hybrid seedlings		
		Tumorous	Non-tumorous	Total
1	*T. timopheevi* × *T. turgidum*	2	3	5
2	*T. turgidum* × *T. timopheevi*	2	8	10
3	*T. timopheevi* × *T. durum*	2	7	9
4	*T. timopheevi* × *T. dicoccum*	1	3	4
5	*T. dicoccum* × *T. timopheevi*	1	4	5
6	*T. timopheevi* × *T. carthlicum*	1	4	5
7	*T. timopheevi* × *T. pyramidale*	2	3	5
8	*T. timopheevi* × *T. polonicum*	1	4	5
9	*T. dicoccum* × *T. araraticum*	1	3	4
10	*T. turgidum* × *T. araraticum*	1	3	4

Initially, the tumours appeared as minute protuberances. Later these developed into large tumours, some being 3 mm wide. A few grew into the shape of small thorns, especially along the margin of the leaf (Fig. 1). The tumours began to wither when the plants started maturing.

Suitable tests were made to trace the pathogenic origin, if any, of such leaf tumours. The tests included: sap-transmission and vector (aphids) transmission tests for virus infection; examination of sections of tumorous tissue for the presence of any fungal mycelium; checking of root tip cuttings for nematode infection; and tissue isolation tests for bacterial or fungal infection. But no pathogenic agents could be detected in the tumorous tissues.

Extensive investigations on spontaneous tumour formation in the interspecific hybrids have been made in the genus *Nicotiana*. More than 300 different interspecific hybrids, among 64 *Nicotiana* species, have been reported. Of these, only 30 produced tumours in different parts of the plant (Kehr and Smith, 1954). Tumour formation was the same in the reciprocal hybrids as long as at least one complete set of chromosomes, or even fewer than that of *N. glauca*, was added to the diploid *N. langsdorffii* (Kehr and Smith, 1954; Ahuja, 1963). Genetic studies on tumour formation in the interspecific hybrids in *Nicotiana* have also been reported by Smith and Steven-

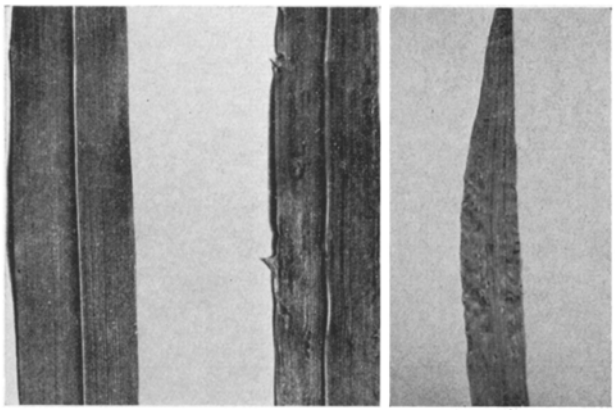

Fig. 1. Leaves of the hybrid (*T. timopheevi* × *T. turgidum*) F_1
A Normal leaf B tumorous leaf

son (1961), and in *Lycopersicon* by Doering and Ahuja (1967).

Only those crosses, including the reciprocals, involving either *T. timopheevi* or *T. araraticum* produced tumorous hybrids; the hybrids of other combinations, including *T. timopheevi* × *T. araraticum*, were non-tumorous. The occurrence of spontaneous tumours only in hybrids of certain interspecific combinations, as observed in the present study, could be evidence of their genetic origin. Such tumour formation appears to be caused by the interaction of certain genes from evolutionarily divergent genotypes (Smith, 1965), such as the *timopheevi* complex (*T. timopheevi* and *T. araraticum*) and the species belonging to the *T. turgidum* group. The tumorous hybrids of hexaploid *Triticum* species, viz., *T. vavilovii* × *T. zhukovski* studied by Srinivas (1966) might also have the same cause. These hybrids showed meiotic anormality and were sterile. A similar case were the hybrids of *T. timopheevi* or of *T. araraticum* with any of the rest of the species in the present study. *T. timopheevi* is reported to be one of the progenitors of *T. zhukovskyi* (Upadhya and Swaminathan, 1963). The histological descriptions of tumorous tissues and their localisation reported by Srinivas (1966), however, differed to some extent from those observed in the present study. For instance, Srinivas observed tumours only along the vein and that the vascular bundles at the tumour site were greatly affected i.e. they were enlarged and bulged at the mesophyll side. In the present material, tumours were observed on the mid-ribs as well. The vascular bundles were slightly affected. The cells of the bundle sheath, mesophyll and of the lower epidermis were considerably elongated and the tumorous growth consisted of an undifferentiated cell-mass (Fig. 2). Irrespective of such histological differences, the combination of genetically divergent and non-integrated genotypes appeared to be inducing the tumour formation in the hybrids. It may be pointed out here that only the centrally situated seedlings in each pot developed leaf tumours. This might be because the crowding of seedlings results in high local humidity which appears to be a pre-requisite for the actual development of the tumours.

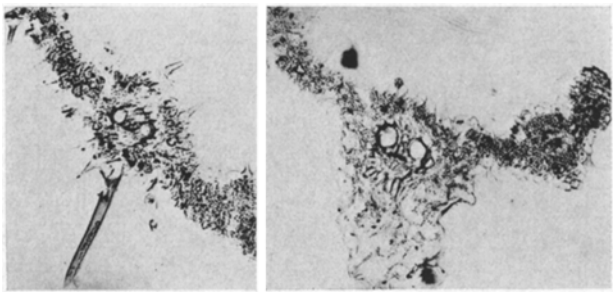

Fig. 2. Transverse section of leaf tissue of (*T. timopheevi* × *T. turgidum*) F_1

The timopheevi complex, which includes *T. timopheevi* and *T. araraticum*, has diverged from the species belonging to the *T. turgidum* group due to a sterility barrier set in the former. This sterility is effected through abnormal F_1 meiosis. Tumour-forming hybrids provide another line of evidence for the evolutionary divergence between these two groups of species.

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