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WHEAT STREAK MOSAIC VIRUS IN NORTHERN AND SOUTHERN REGIONS OF YUGOSLAVIA

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Introduction

In April 1977 streak mosaic virus symptoms were found on wheat in the fields near Valandovo (Macedonia). The symptoms consisted of pale green or yellowish stripes and streaks (Fig. 1), i. e. the symptoms were similar to the ones earlier described on wheat in Yugoslavia (Tošić 1971a) which were caused by wheat streak mosaic virus (WSMV). In May of the same year similar symptoms on wheat were observed in the fields around Zagreb (Croatia).

For the first time WSMV was found in Yugoslavia by Šutić and Tošić (1964). According to Šutić (1974) this virus is widely spread in Serbia. However, this virus has not been recorded in northern and southern regions of Yugoslavia so far. To determine wheather streak mosaic symptoms on wheat in these parts of Yugoslavia are caused by WSMV some identification experiments were done and the results are presented here.

Material and Methods

Wheat plants with streak mosaic symptoms were collected in two localities: near Valandovo, Macedonia and near Zagreb, Croatia. The virus isolate found in Macedonia was denoted M isolate and that found in Croatia C isolate.

Virus transmission was performed by mechanical inoculation and by the vector eriophyid mite *Aceria tulipae*. The mites' colony was kindly supplied by Dr. M. Tošić (Faculty of Agriculture, Belgrade).

Electron microscope investigations were done by dipping method and by analysis of ultrathin sections of infected tissue. For the latter, stripes of leaf tissue of infected plants were fixed for 30 min in 1% (v/v)

glutaraldehyde in cacodylate buffer and after washing in buffer were postfixed for 2 hr in 1% (w/v) osmium tetraoxide. After that, samples of tissue were dehydrated in ethanol and embedded in Araldite. The sections were stained with uranyl acetate and lead citrate.

Results and Discussion

Test plant reactions

Both M and C isolates were inoculated onto more test plants mostly belonging to family *Gramineae*. The reactions of test plants are given in Table 1.

Table 1. Symptoms on test plants provoked by M and C isolates found on wheat

Test plant	Virus isolate	
	M	C
Gramineae		
Agropyron repens (L.) Beauv.	0*	0
Avena sativa L.	++**	++
Hordeum sativum Jessen	+++	+++
Oryza sativa L.	+	
Secale cereale L.	++	+++
Triticum vulgare L. (Fig. 1)	+++	+++
Zea mays L.	+	0
Dicotyledones		
Chenopodium amaranticolor Coste et Reyn.	0	0
C. quinoa Willd.	0	0
Nicotiana clevelandii Gray	0	0
N. glutinosa L.	0	0
N. megalosiphon Heurck et Muell.	0	0
N. tabacum, L. cv. Samsun	0	0

*No infection
**Relative severity of symptoms

As shown in Table 1 both isolates could be transmitted on all species of *Gramineae* except on *Agropyron repens*. It should be pointed out that WSMV isolates described earlier could not infect *Agropyron repens* (Pop 1962, Bremer 1973, Brakke 1971). The symptoms were most pronounced in wheat and barley and very mild in oat. Symptoms on infected plants were always systemic and had a form of a streak mosaic and mottling. Usually, yellowish stripes on rice were transformed in the yellowing of the whole leaf. In the some cases stunting of infected wheat plants was observed.

It must be pointed out that none of the inoculated plants from *Dicotyledones* could be infected.

The host range and the reaction of tests plants showed that both isolates were similar to the WSMV isolates described earlier (Slykhuis and Bell 1963, Pop 1962, Bremer 1971, Tošić 1971a).

Properties in vitro

M and C isolates were investigated in respect of thermal inactivation point (TIP) and dilution end point (DEP). The results are given in Table 2.

Table 2. Some properties in vitro of M and C isolates

Source of infected sap		Test plant *Triticum vulgare*	
		M isolate	C isolate
Triticum vulgare	Sap heated at:		
	Nontreated	23/28*	20/22
	40°C	21/24	19/20
	50°C	10/26	7/19
	55°C	0/25	0/17
	60°C	0/28	0/23
	Sap diluted at:		
	Nondiluted	17/19	15/15
	10^{-2}	12/12	10/11
	10^{-3}	8/14	5/13
	10^{-4}	0/16	0/13
	10^{-5}	0/14	0/10

* Infected plants/inoculated plants

Data in Table 2 show that M and C isolates have TIP in the range between 50 and 55° C. The DEP of the isolates was between 10^{-3} and 10^{-4}. The above data correspond to the ones of WSMV (comp. Brakke 1971, Tošić 1971a, Bremer 1973).

Mite transmission

The eriophyid mite *Aceria tulipae* was used as an experimental vector. In these tests the virus sources were the infected wheat plants. The experiments were performed in the mode described by Tošić (1971a). Both isolates were easily transmitted by the vector. Efficiency of the vector transmission was checked by mechanical reinoculation. About 75% of tested wheat plants could be infected with the eriophyid mite. Therefore, on the basis of their transmission by *A. tulipae* the isolates M and C did not differ from the WSMV isolates found in other parts of the world (Slykhuis 1955, Pop 1962).

Electron microscopy

Virus particles, about 700 nm long, were found in infected wheat sap by dipping method (Fig. 2b, above right). The concentration of virus particles in sap was extremely low.

Pin-wheel structures with scrolls were revealed in ultrathin sections of infected wheat tissue. As can be seen in Fig. 2 these structures cor-

respond to those of type WSMV (cf. Lee 1965, Shepard and Carroll 1967). On the basis of the type of submicroscope inclusions WSMV belongs to the first subgroup of the viruses producing pin-wheel structures (Edwardson 1974). According to Chamberlain (1977) pin-wheel structures of grass viruses are specific enough and, therefore, can be a criterion for virus identification.

Summary

From wheat plants cultivated in northern and southern regions of Yugoslavia wheat streak mosaic virus (WSMV) was isolated. Two isolates found were transmitted in a mechanical way to several species of *Gramineae* but the transmission failed on some *Dicotyledones* used. The isolates had thermal inactivation point between 50 and 55° C and dilution end point between 10^{-3} and 10^{-4}.

The investigated isolates were easily transmitted by the eriophyid mite *(Aceria tulipae)*. The virus particles of the isolates were about 700 nm long. In ultrathin sections of infected wheat tissue pin-wheel structures with scrolls were found.

*

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Fig. 1. Symptoms on wheat plants caused by M and C isolates: *a* artifical and *b* natural infection with M isolate, *c* artifical infection with C isolate.

Sl. 1. Simptomi na pšenici koje uzrokuju izolati M i C: *a* umjetna i *b* prirodna infekcija s izolatom M, *c* umjetna infekcija s izolatom C.

Fig. 2. Ultrathin sections through wheat leaf tissue infected with isolate M: pin-wheel structures with scrolls in cross section (*a*, *b*) and in tangential or irregular section (*c*). Above right virus particle observed by dipping method in sap of infected wheat.

Sl. 2. Ultratanki presjeci kroz lisno tkivo listova pšenice inficirano s izolatom M: strukture pin-wheel sa smotcima prerezanim poprečno (*a*, *b*) i tangencijalno ili nepravilno (*c*). Desno gore, virusna čestica u soku inficiranog lista pšenice opažena metodom uranjanja.

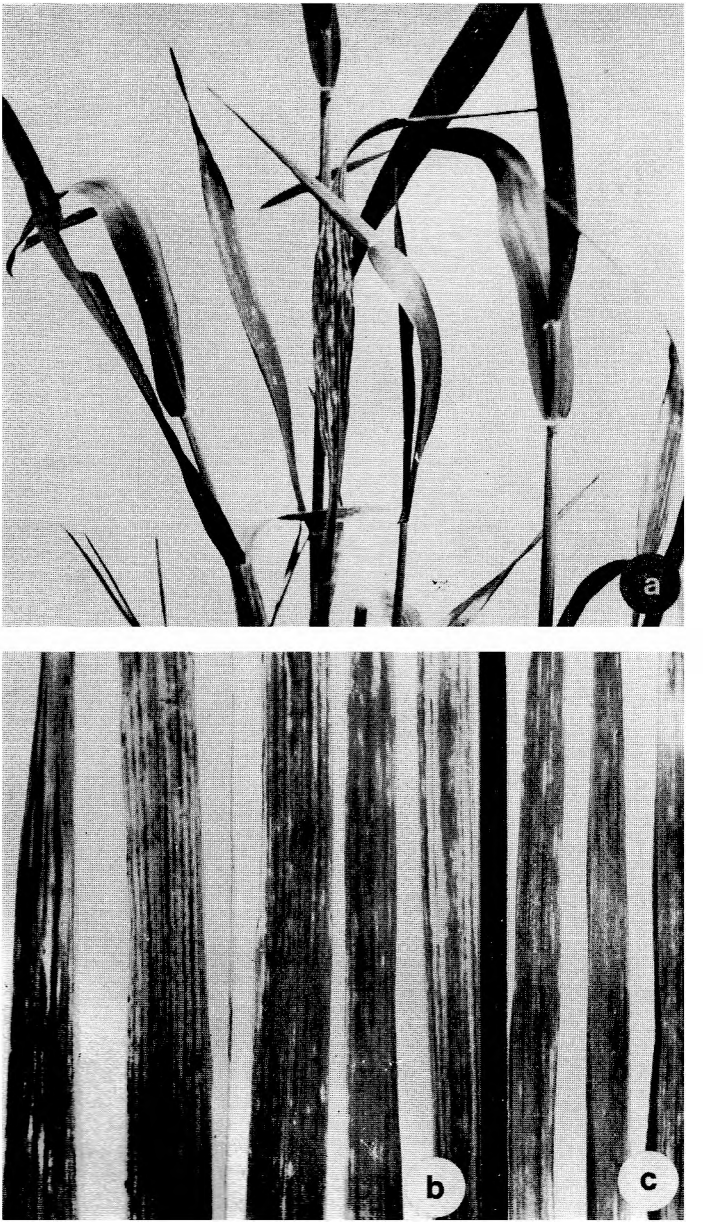

Fig. 1. — Sl. 1.

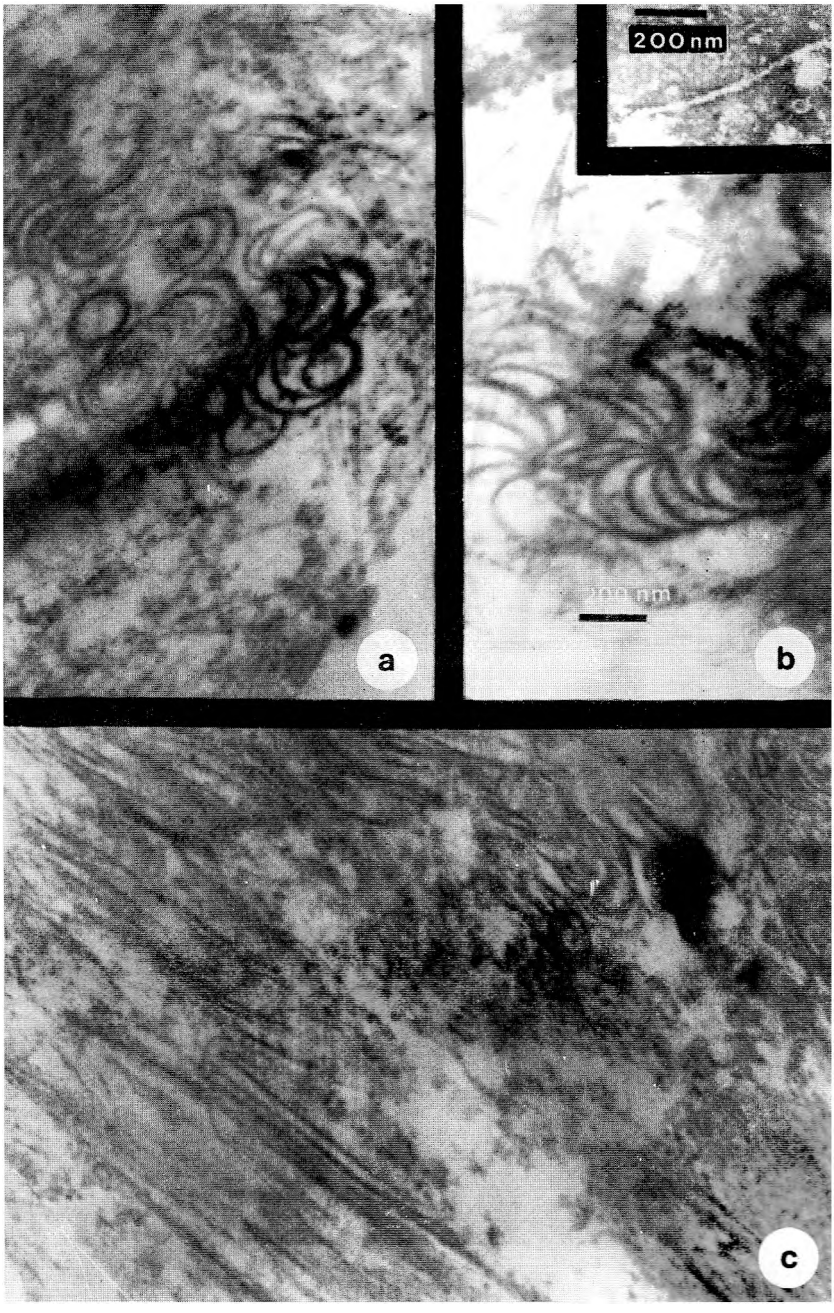

Fig. 2. — Sl. 2.

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SAŽETAK

VIRUS CRTIČAVOG MOZAIKA PŠENICE U SJEVERNIM I JUŽNIM PODRUČJIMA JUGOSLAVIJE

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U travnju 1977. godine opazio sam na listovima pšenice kod Valandova u Makedoniji virusne simptome u obliku crtičavosti i prugavosti (sl. 1). Simptomi su nalikovali onima koje na pšenici uzrokuje virus crtičava mozaika pšenice (wheat streak mosaic virus, WSMV). U svibnju iste godine slične sam simptome zapazio na listovima pšenice u okolici Zagreba.

Dolaženje WSMV na području Srbije opisali su Šutić i Tošić (1964). Prema Šutiću (1974) taj je virus u tom dijelu Jugoslavije prilično raširen. Međutim, dolaženje WSMV na području Makedonije i Hrvatske nije bilo poznato. Zbog toga sam u ovom radu nastojao ustanoviti da li opažene simptome na pšenici u sjevernim i najjužnijim područjima Jugoslavije uzrokuje WSMV. Pokuse sam vršio jednim izolatom nađenim u Hrvatskoj (izolat C) i jednim izolatom nađenim u Makedoniji (izolat M).

Istraživane izolate sam prenosio mehaničkom inokulacijom na nekoliko pokusnih biljaka iz porodice *Gramineae*, ali ih nisam uspio prenijeti niti na jednu korištenu dikotiledonsku vrstu. Točka termalne inaktivacije za oba izolata bila je između 50 i 55° C, a krajnja točka razrijeđenosti između 10^{-3} i 10^{-4}.

Ispitivane viruse sam eksperimentalno prenosio i s pomoću grinje *Aceria tulipae*, za koju se zna da je vektor WSMV-a (S l y k h u i s 1955). U mojim se pokusima uspješnost prijenosa tom grinjom kretala oko 75%.

Metodom uranjanja ustanovio sam da ispitivani izolati imaju produžene virusne čestice dužine oko 700 nm (sl. 2b, gore desno). Na ultratankim presjecima kroz inficirano lisno tkivo pšenice našao sam submikroskopske strukture pin-wheel sa smotcima. Kako se na sl. 2 vidi, te strukture po svemu odgovaraju onima koje stvara tipični WSMV. Kako je poznato, WSMV na osnovi tipa submikroskopskih inkluzija pripada prvoj podskupini virusa, za koje su karakteristične strukture pin-wheel (S h e p a r d i C a r r o l l 1967, E d w a r d s o n 1974).

WSMV (R/1 : 2,8/+ : E/E : S/Ac) ima mnogo zajedničkog s potyvirusima. Od tih se virusa razlikuje po tome što mu je čestica duga samo oko 700 nm. Isto je tako za WSMV karakteristično da se, za razliku od potyvirusa, prenosi grinjama, i to u prvom redu vrstom *Aceria tulipae*. Budući da se u prirodi grinje šire pasivno, nošene vjetrom, pojava zaraza pšenice s WSMV ovisi o učestalosti i smjeru vjetra (G i b b s i H a r r i s o n 1976).

WSMV može znatno smanjiti urod pšenice (A t k i n s o n i G r a n t 1967). Prema T o š i ć u (1971b) na pojedinim sortama pšenice prinos se može smanjiti i do 47%. Izvor WSMV u prirodi su divlje višegodišnje biljke iz porodice *Gramineae* kao i samonikle žitarice zaostale od prethodnog usjeva (S l y k h u i s i B e l l 1963). B r e m e r (1971) je utvrdila da je glavni izvor WSMV u Turskoj trava *Cynodon dactylon*. Korisno je spomenuti da zasad nema podataka da se WSMV prenosi sjemenom.

WSMV je sličan virusu mozaika pirike (agropyron mosaic virus), virusu mozaika raži (ryegrass mosaic virus) i virusu mozaika ječma (hordeum mosaic virus). Na osnovi simptoma te je viruse teško razlikovati. Međutim, prva dva virusa prenose se, za razliku od WSMV, drugom vrstom grinje *(Abacarus hystrix)*, dok se virus mozaika ječma razlikuje od WSMV po krugu domaćina (B r a k k e 1971).

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