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CHROMOSOME NUMBERS IN POTATO CULTIVARS HYPERSENSITIVE TO LATE BLIGHT

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ABSTRACT

The chromosomes of twenty-four blight resistant potato cultivars produced from *S. demissum* × *S. tuberosum* hybrids were counted. Twenty-two cultivars had 2n = 4x = 48 chromosomes and two cultivars had 2n = 4x + 1 = 49 chromosomes. The implications of these results are discussed briefly in relation to previous studies and to potato breeding methods.

INTRODUCTION

The backcrossing of *Solanum demissum* LINDL. (2n = 6x = 72) by *S. tuberosum* L. (2n = 4x = 48) to produce blight resistant potatoes is hampered by abnormal segregation and sterility caused by aberrant meiosis (SALAMAN, 7; BECKER, 1; SCHNELL, 8). Direct backcrossing of the pentaploid hybrid by tetraploid *S. tuberosum* would be expected to yield many aneuploids and COOPER and HOWARD (3) found that, in fact, blight resistant segregates were hyperploid with one or a few extra chromosomes. Their material, however, had not been highly selected for agronomic characters. By contrast with this material there exist a number of named potato clones which have been bred from *S. demissum* by the backcrossing method and which combine blight resistance with agronomic quality. This note records the chromosome numbers of a sample of them with the aim of testing whether aneuploidy is always associated with blight resistance as the results of COOPER and HOWARD suggest. The only count recorded for such material is for 'Variety 8670' which had 2n = 48 (PUSKAREV, 6).

MATERIAL AND METHODS

Twenty-four blight resistant commercial potatoes derived from direct crosses between *S. demissum* and *S. tuberosum* were studied (Table 1); two pure *S. tuberosum* clones were also examined. Exceptionally clear preparations (Figs. 2 and 3) were regularly obtained in root tip squashes made by the following method. Sprouts with well developed root initials were cut out of the tubers (Fig. 1A) and placed in tubes containing vermiculite saturated with White's standard inorganic nutrient solution (Fig. 1.B). Satisfactory root growth occurred after three days storage at 20 ± 2°C. (Fig. 1.C). The sprouts were then washed free of vermiculite and placed for 5–6 hours in 0.022M aqueous 8-hydroxyquinoline (TJIO and LEVAN, 9) (Fig. 1.D). This was followed by fixation for 18–24 hours in a mixture containing 5 parts ethyl alcohol, 2.5 parts chloroform and 1 part propionic acid, after which the root tips were removed and hydrolysed in N.HCl for 8 minutes at 60 °C and then stained by the Feulgen

method. Squashes were made in 1 % acetic orcein in 45 % acetic acid as this was found to intensify the staining. Slides were made permanent by the liquid carbon dioxide method (BOWEN, 2). In order to reduce subjective error, ten metaphase plates were scored for each variety and the chromosomes were counted in the drawings without reference to the actual preparations.

RESULTS AND CONCLUSIONS

Chromosome numbers and pedigrees are listed in Table 1. Different counts between cells within the same cultivar may be due either to errors of interpretation or to true variation in chromosome number. In squash preparations, even with exceptionally clear and apparently undamaged cells, errors can be expected due to the displacement of one or more chromosomes and to centromere breakage with separation of chromosome arms to give the appearance of two chromosomes. Displacement is likely to be the commonest artefact and, therefore, counts below the mode will be more frequent than those above it. This is borne out by the data in Table 1. Owing to these limitations of the technique chromosome numbers alone are insufficient to detect true variation of the extent of one or two chromosomes. True variation can only be verified by supplementing chromosome counts with evidence on the source of variation such as the observation of lagging or misdividing chromosomes in untreated anaphases. Although the nature of the variation in the present material studied is undetermined, it is correct to take the model number as the true chromosome number.

As shown in Table 1, twenty-two clones are tetraploid ($2n = 4x = 48$); two are hyperploid ($2n = 4x + 1 = 49$). In this material, therefore, blight resistance is not correlated with aneuploidy, a result which differs from that of COOPER and HOWARD (3). The discrepancy may be explained as follows. Rigorous selection for agronomic characters as well as for blight resistance would be expected to eliminate extra *demissum* chromosomes whereas selection primarily for blight resistance – as in COOPER and HOWARDS' material would not only permit the persistence of such extra chromosomes but might even encourage it. Of the two clones listed here with $2n = 49$ chromosomes one – 'Stelzner 40654/5' – is an established cultivar but the other – 'BC 11 – 5' – is not. Thus, although an additional chromosome need not be detrimental at the cultivar level these results suggest that it usually is. Selection for agronomic quality, it seems, eliminates aneuploidy without detriment to blight resistance.

It appears, therefore, that, in a breeding programme using cytologically unbalanced hybrids derived from species crosses, it might be advantageous to increase the rigour of selection for good agronomic characters at the first backcross stage. Chromosome balance would occur as a correlated response and this should reduce the need for many successive backcrosses as well as reduce the numbers of plants that need be grown in the later generations.

TABLE 1. CHROMOSOME NUMBERS AND PEDIGREES OF POTATO CULTIVARS

Cultivar	Chromosome number							Pedigree according to HOGEN ESCH a. ZINGSTRA (4)
	Number of cells with:					Mode	Mean (± S.E)	
	46	47	48	49	50			
'B.C. 04'			9	1		48	48.1(0.10)	(DT)?
'B.C. 11–5'			3	7		49	48.7(0.20)	(DT)?
'Beltsville 862–9'			8	2		48	48.2(0.15)	T × (DT)?
'Canso'		2	8			48	47.8(0.15)	DT^6
'Cornelia'		3	7			48	47.7(0.20)	(DT)? × T
'Electra'	1	1	8			48	47.7(0.24)	T × (DT)?
'Essex'	1	2	5	1	1	48	47.9(0.36)	(DT)? × T
'Falke'	2		7	1		48	47.7(0.30)	(DT)? × T
'Fortuna'		1	8	1		48	48.0(0.15)	T × (DT)?
'Frühnudel'		1	9			48	47.9(0.10)	(DT)? × T
'Kennebec'		4	6			48	47.6(0.16)	T^2 × (DT)?
'Keswick'	1		8	1		48	47.9(0.18)	DT^4
'Maritta'			9	1		48	48.1(0.10)	(DT)? × T
'Monika'		2	7	1		48	47.9(0.18)	(DT)? × T
'Placid'			10			48	48.0(0.0)	T × (DF) × T?*
'Reaal'		2	6	2		48	48.0(0.21)	DT^4
'Rival'			9	1		48	48.1(0.10)	T × (DT)?
'Robusta'			7	3		48	48.3(0.20)	(DT)? × T
'Roswitha'		3	7			48	47.7(0.20)	(DT)? × T
'Stelzner 40654/5'			1	9		49	48.9(0.10)	DT^3*
'Stelzner 40663/21'		2	7	1		48	47.9(0.18)	DT^5*
'Tedria'		2	7	1		48	47.9(0.18)	T × DT^2*
'Virginia'		2	7	1		48	47.9(0.18)	DT^3 or DT^4 × T*
'Z.P.C. 45/2'		2	7	1		48	47.9(0.18)	(DT)? × T
'Arran Pilot'	1		9			48	47.8(0.20)	T
'Eclipse'	1	2	7			48	47.6(0.22)	T

*Personal communication from Dr. H. J. TOXOPEUS.

D = *S. demissum* F = *S. fendleri* T = *S. tuberosum*

(DT)? = *S. demissum* hybrid including "W" race; number of backcross generations unknown although "W" race derivatives are at least DT^4 (MÜLLER, 5).

SAMENVATTING

Het aantal chromosomen in aardappelrassen met overgevoeligheidsresistentie tegen Phytophthora

Van 24 resistente aardappelrassen, ontstaan uit *S. demissum* × *S. tuberosum* terugkruisingen, werd het aantal chromosomen geteld. Twee en twintig van deze cultivars hadden 2n = 4x = 48 chromosomen en slechts twee waren aneuploiden met 2n = 4x + 1 = 49 chromosomen.

Geconcludeerd wordt dat selectie op landbouwkundig waardevolle eigenschappen aneuploidie schijnt uit te schakelen zonder dat de *phytophthora*-resistentie verloren

FIG. 1A–D. STAGES IN METHOD FOR GROWING ROOT TIPS. EXPLANATION IN TEXT

FIG. 2.

ROOT TIP METAPHASE OF CULTIVAR 'PLACID' WITH 2N = 4X = 48 CHROMOSOMES. × 2,125

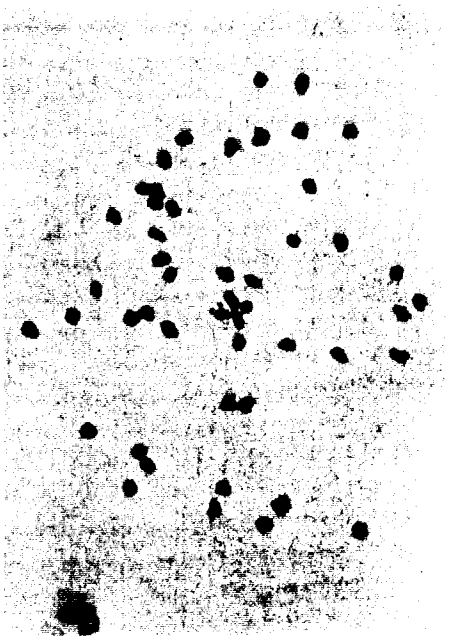

FIG. 3.

ROOT TIP METAPHASE OF CULTIVAR 'STELZNER 40654/5' WITH 2n = 4× + 1 = 49 CHROMOSOMES. × 2,125

Figs. 2 and 3 photographed from permanent preparations.