

Inheritance of russeting in cultivated diploid potatoes

H. DE JONG

Agriculture Canada Research Station, P.O. Box 20280, Fredericton, New Brunswick, Canada

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Zusammenfassung, Résumé p. 312

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Summary

A genetic analysis of the russet trait was made of 22 progenies from cultivated diploid parents. The observed segregation ratios fit a hypothesis of complementary action by three independently segregating dominant genes. No differences were found between reciprocal crosses. The genotypes of nine russet and eight nonrusset parents were determined.

Introduction

Russet skin is a much sought-after trait in potato cultivars in North America, perhaps because of the popularity of the relatively old and widely grown cv. Russet Burbank (syn. Netted Gem in Canada). The number of recently released russet cultivars can be taken as an indication of its present popularity in North America. Of 28 new cultivars which were described in the American Potato Journal during the decade January 1971 to December 1980, seven (25 %) have russet tubers.

Several russet cultivars are known to have originated from nonrusset cultivars (Swaminathan & Howard, 1953) and such mutants have been investigated (Asseyeva & Yashina, 1971; Howard, 1970). A linkage between russeting and scab resistance has been suggested (Clark et al., 1938; Rieman et al., 1955) and in a genetic study with tetraploid parents, Clark (1933) concluded that russeting is 'the result of the action of complementary factors', but he did not indicate the number of genes involved. The investigation reported here was initiated to analyze the genetics of the russet trait by using the disomic inheritance pattern of cultivated diploid potatoes.

Materials and methods

Two heavily russeted cultivated diploid hybrid clones (US-W 8030.8 and US-W 9290.3) were obtained from the Potato Introduction Station, Sturgeon Bay, Wisconsin, USA and intermated with nonrusset cultivated diploid selections from the Canadian breeding program. From their progenies several russet clones were selected for their male and female fertility and subsequently used as parents in further crosses. In addition, a cultivated diploid russet selection from the Canadian breeding program (7248-2), which is not related to the US-W sources of russeting, was used as a russet parent. In classifying individual clones no distinction was made between different

types of russeting (i.e., heavy versus light). Since a classification of greenhouse-grown progenies sometimes resulted in an underestimate of the proportion of russet clones, the classification is based on field-grown tubers.

Results and discussion

The segregations of progenies from crosses with neither, one, or both parents classified as russet are listed in Table 1. Since the initial sources of russeting genes were completely or nearly male sterile, russet parents were used predominantly as female parents. Nevertheless, some reciprocal crosses involving male fertile russet selections were successful (progeny numbers 6908 and 6928; 8107 and 8108). No reciprocal differences were found in these progenies. The observed segregation ratios fit a hypothesis of complementary action by three independently segregating dominant genes. Only progeny 7303 produced an χ^2 value which fell below the 5 % probability level. However, neither parent of this progeny, when used in other cross combinations, produced progenies which disagreed with the expected segregation ratios based on the same postulated genotypes for these parents.

With the exception of 7248-1, which was found to be homozygous dominant for one of the loci for russeting, all russet clones used as parents in this study were heterozygous at all three loci. This was not surprising since most russet parents were derived from $AaBbCc \times aabbcc$ crosses. One nonrusset clone (320-7) was found to carry one gene for russeting; such clones, which are heterozygous for only one of the three loci for russeting, may be useful in establishing possible linkage relationships between the genes for russeting and other marker genes.

The hypothesis of three independently segregating complementary dominant genes is supported by observations made on diploid progenies by Pavek (1980 and personal communication). It also enhances the conclusions reached by Clark (1933) which were based on tetraploid progenies. Under this hypothesis mutations from russet to nonrusset and vice versa can occur as a result of a change at only one of the three loci. For example, a mutation from $A-B-Cc$ to $A-B-cc$ would result in a change from russet to nonrusset. Progenies from nonrusset parents will contain some russet clones when all three complementary genes are present among both parents. Clark (1933) found that the nonrusset cultivar Katahdin carries one or more genes for russeting. A re-examination of the data obtained by Clark et al. (1938) indicates that the hypothesis presented here also fits the segregation pattern of most tetraploid progenies observed in that study.

In a trait which is determined by more than one gene a genetic analysis on the tetraploid level is very difficult. Since it is necessary to consider both chromosome and chromatid segregation for each of the loci involved, it is extremely difficult to determine which of several hypotheses would best fit the data (Hougas & Peloquin, unpublished). This analysis demonstrates how a greater utilization of diploid germplasm for genetic research should provide an increasing amount of useable genetic information and thus facilitate future potato breeding achievements.

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Zusammenfassung

Vererbung der Rauhschaligkeit in diploiden Kulturkartoffeln

Rauhschaligkeit ist ein sehr gefragtes Merkmal bei Kartoffelzüchtungen in Nordamerika. Während der Dekade 1971-1980 waren 25 % aller im American Potato Journal beschriebenen neuen Sorten rauhschalig. Neun stark rauhschalige und acht nicht rauhschalige, diploide Kulturkartoffelklone wurden als Eltern in einer genetischen Analyse des Rauhschaligwerdens bei 22 Nachkommenschaften gebraucht (Tabelle 1). Die beobachteten Aufspaltungsverhältnisse passten zu einer Hypothese der Komplementäraktion durch drei unabhängig aufspaltende, dominante Gene.

Keine Unterschiede wurden zwischen reziproken Kreuzungen gefunden. Von allen 17 Eltern wurden die Genotypen bestimmt. Bei einem Merkmal, das von mehr als einem Gen kontrolliert wird, ist eine genetische Analyse auf tetraploidem Niveau sehr schwierig. Die Analyse demonstriert, wie eine grössere Verwendung von diploidem Keimplasma für die genetische Forschung eine zunehmende Menge von brauchbaren genetischen Informationen liefern und dadurch zukünftige Erfolge in der Kartoffelzüchtung erleichtern könnte.

Résumé

Transmission du caractère 'couleur roussâtre' des pommes de terre cultivées diploïdes

L'épiderme roux est une caractéristique très recherchée dans les cultivars de pommes de terre d'Amérique du Nord. Durant la décennie 1971-1980, 25 % des nouveaux cultivars décrits dans American Potato Journal ont l'épiderme roux. 9 clones de pommes de terre cultivés diploïdes fortement roussâtres et 8 non roussâtres sont utilisés comme parents dans une analyse génétique pour ce caractère sur 22 descendants (tableau 1). Les proportions de ségrégation observées s'ajustent à l'hypothèse d'une action complémentaire de 3 gènes dominants indépendants. Aucune dif-

férence n'est trouvée entre croisement réciproque. Les génotypes des 17 parents sont déterminés. Dans un caractère qui est contrôlé par plus d'un gène, une analyse génétique au niveau tétraploïde est très difficile. Cette analyse démontre comment une plus grande utilisation des protoplasmes diploïdes pour des recherches génétiques pourrait fournir une quantité importante d'informations génétiques utilisables, et ainsi faciliter la réalisation future d'hybridation sur la pomme de terre.

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