REPORT

of the

TOMATO GENETICS COOPERATIVE

NUMBER 17 FEBRUARY 1967

DEPARTMENT OF VEGETABLE CROPS
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

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Department of Vegetable Crops
University of California
Davis, California

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Cover design represents a mature leaf of the trifoliate (tf) mutant.

FOREWORD

The Tomato Genetics Cooperative is a group of workers who have a common interest in tomato genetics and who are organized informally for the purpose of exchanging information and stocks. Participation is voluntary, and costs of activities are met by assessments to members.

Membership as of December 31, 1966 stood at 307, including 143 (46%) in 35 foreign countries. At that time our financial balance was $188.50.

The regular annual meeting was held under the auspices of AIBS at the University of Maryland on August 15, 1966. Minutes appear below. Arrangements have been made for the 1967 meeting with AIBS at Texas A & M University.

Among TGC activities of the past year, the publication of the third gene list in Journal of Heredity (vol. 57, p. 188-196) deserves special note. After enduring countless frustrations, the Gene List Committee was finally able to bring this project with its summary of 328 genes and linkage map to completion. Carl Clayberg, who bore the brunt of this burden, deserves special commendation. Thanks also to Carl and his committee, a new list with summaries to date has been completed and forms part of this Report.

Many willing workers have assisted in TGC functions during the past year. Dora Hunt again took charge of all membership matters. As Editor and Executive Secretary she assembled the bibliography, stock and membership lists, prepared the financial statement, and edited all copy for TGC 17. Betty Bell again did a masterful job of typing the stencils. To these two faithful workers and to the many students and colleagues who aided in assembling the Report and with other details, we are profoundly grateful.

Five hundred copies of this Report have been issued.

Coordinating Committee

L. Butler
G. B. Reynard
R. W. Robinson
M. L. Tomes

C. M. Rick, Chairman
Department of Vegetable Crops
University of California
Davis, California, 95616

Minutes of the College Park Meeting

The regular annual meeting of the TGC was held at 4:30 PM in Room 103, Skinner Building, University of Maryland, in conjunction with the AIBS meetings and the XVII International Horticultural Congress. Fifteen members attended.

In addition to the usual reports on financial balance and membership, reports were heard from Carl Clayberg on the Gene List Committee, Dick Robinson on Genetic Stocks, and Charley Rick on the New Mutant Program. Ernie Kerr presented an informal report on the deliberations of the Committee on Isogenic Stocks. He reported that the Committee is now facing the particularly knotty problem of selecting acceptable recurrent parents. A helpful discussion was held concerning this and other problems raised by the committees.

Among other items brought up for discussion, the matter of germ plasm reserves was presented by Dr. C. A. John. The usefulness of wild or primitive cultivated forms as sources of disease resistance, genetic adaptation to specific environments, etc. was pointed out. With the introduction of newer varieties into the native regions some of these sources are being lost. Considering the inadequacy of present stocks of tomato germ plasm, the need for additional exploration and effective stock maintainance is evident.

The meeting adjourned at 5:30 PM.

C. M. Rick, Secretary, pro tem.

SUPPLEMENTARY LIST OF TOMATO GENES AS OF JANUARY, 1967

The last gene list, issued in TGC 15, has recently been brought up-to-date by inclusion of Stubbe's IV and V series of L. esculentum mutants and published in Journal of Heredity 57:188-196, 1966. The same article contains a revised linkage map and additional or revised rules of nomenclature felt necessary by the Gene List Committee. The first rule revises symbol notation for mimic series in view of the many mutants that have been described in the past few years as mimics of previously reported alleles. This rule also alters subscripts of symbols to line script so that symbol and epithet notation will be uniform and symbol notation will coincide with that used for Drosophila and other organisms. The second rule brings allelic notation into accord with that for mimics, and the third rule revises chromosomal gene sequence where required by centrome mapping.

All mutants in this Journal of Heredity article and not in the list of TGC 15 are given in the present list, Table I, together with any additional mutants more recently described. In Stubbe's mutants, which are irradiation-induced, plant size is frequently of importance for characterization and has been indicated as small--between normal and one-half normal size; smaller--between one-fourth and one-half normal size; and very small--less than one-fourth normal size. These mutants were induced in several tomato varieties or species which have been designated as follows: C.R.--Condine Red; L.--Lukullus; P.--L. pimpinellifolium; and R.R.--Rheinlands Ruhm. Table II gives revisions of previously reported symbols. Symbol notation follows the revised rules of nomenclature. Because the gene list of TGC 15 was issued so recently, a condensed list of genes for it and the lists of TGC 4, 9, and 12 is not being included this time.

ADDITIONAL AND REVISED RULES OF NOMENCLATURE

1. Mimics. Members of a single mimic series shall be designated either by entirely different names and symbols (e.g. u for uniform and ug for uniform gray-green) or by the same name and symbol followed by a hyphen and a distinguishing number on the same type level, not a subscript as formerly used for symbols. For the first member of the mimic series the "1" shall be understood but not used. Thus, ms instead of ms_1, ms-2 instead of ms_2, etc. The preferred system is to use distinctive names and symbols.

2. Alleles. Alleles at a single locus shall be designated as previously described (Barton et al., 1955), except that, for the first member of a numbered series, the "1" shall be understood but not used. For example, sl instead of sl^1, while sl^2 is unchanged.

3. Locus numbering. As soon as the arm location of a gene is known, the locus numbering shall be revised to reflect that information. The smaller arm of each chromosome is designated as the left arm, and the zero position is the distal or left end of the small arm.

Table I. ADDITIONS TO THE GENE LIST

January, 1965 - January, 1967

Gene symbol	Reference & seed source	Character
acr	Stubbe, 1964	acroxantha. Smaller plant; short internodes; rugose, dull, light green leaves, turn yellow starting at tip. C.R.
adu	Stubbe, 1964	adusta. Small plant, proportionately reduced; progressive necrosis from older to younger leaves. C.R.
afe	Stubbe, 1964	afertilis. Small plant; short internodes, leaves; dainty, yellowish, mostly keeled pinnae; poor fruit set; heterozygote intermediate. R.R.
ag^2	Knowles, TGC 17	anthocyanin gainer^2. Completely free of anthocyanin. Wild form from the Galápagos Islands.
ag^3	Knowles, TGC 17	anthocyanin gainer^3. Indistinguishable from ag. Radiation induced in Money Maker.
ag^4	Knowles, TGC 17	anthocyanin gainer^4. Indistinguishable from ag. Radiation induced in Money Maker.
ala-4	Stringam, TGC 16:36	albina-4. White or cream-colored cotyledons; lethal; irradiation induced in Early Fireball; linked with T2-8 interchange in same stock.
alu	Stubbe, 1963	alutacea. Small plant, yellowish foliage. C.R.
an-2	Stringam, TGC 16:36	anantha-2. Inflorescence highly branched, terminates in very compact ovary-like masses of tissue; aborted flowers. Early Fireball.
avi	Stubbe, 1964	albovirens. Smaller plant, foliage variously figured in yellow, white, green; reduced fruit set. C.R.
aw^2	Knowles, TGC 17	without anthocyanin^2. Completely free of anthocyanin. Radiation induced in Money Maker.
bs	Soressi, TGC 17	brown seed. Brown pigment behaving as endosperm trait. EMS-induced. Hybrid origin?
cb-2	Soressi & Cravedi, TGC 17	cabbage leaf-2. Larger plant parts; leaves epinastic and blistered. X-ray-induced. Dwarf line 59-521.
cfa	Stubbe, 1963	conferta. Very small, compact bush; strongly shortened internodes, young leaves. L.
cg	Stubbe, 1963	congesta. Small, dense bush; late growth retardation; short internodes; pointed primary leaves. L.
ci	Stubbe, 1964	cincta. Small, irregular bush; many sideshoots of equal length from lower leaf axils. C.R.
cjf	Fehleisen, TGC 17	conjunctiflora. Flowers joined in pairs or triplets, otherwise malformed. Platense.

Gene symbol	Reference & seed source	Character
coa	Stubbe, 1964	corrotundata. Small plant; fewer, broad, rounded, darker pinnae; short, broad flower parts. C.R.
cpa	Stubbe, 1963	composita. Large, strongly branched, leafy inflorescence; jointless pedicel. R.R.
Crk	Lesley et al., TGC 17	Crinkled. Leaves like those of Cu but less condensed and segments dentate. Hybrid origin.
cru	Stubbe, 1964	corrupta. Smaller plant, irregular, sometimes distorted growth; spreading necrosis; firm, leathery, involuted, brittle pinnae. L.
cs-2	Stringam, TGC 16:36	corollaless-2. Apetalous; dialytic anthers; exserted stigma; self fertile, rarely sets fruits naturally. Early Fireball.
cta	Stubbe, 1964	contaminata. Smaller, flat, broad bush; many sideshoots; at end of season stems, leaf midribs turn necrotic, brittle; reduced fertility. R.R.
cvl	Stubbe, 1963	convoluta. Small, dense plant; short internodes; pinnae of oldest leaves involuted. R.R.
d-7	Stringam, TGC 16:36	extreme dwarf-7. Plants reduced to 10-12 inches tall; short internodes; leaves highly divided, with strong anthocyanin. Early Fireball.
d-8	Stringam, TGC 16-36	extreme dwarf-8. Plants reduced to 6-8 inches tall, short internodes; normal flowers but no fruit set in field. Early Fireball.
dc	Stubbe, 1963	decomposita. Slender, strongly sinuous and crenate pinnae; more secondary pinnae; micromutation. R.R.
dd	Hernández-Bravo, TGC 17	double dwarf. Extremely retarded and highly modified dwarf. Hybrid origin.
det^2	Stubbe, 1963	detrimentosa^2. Small plant; dainty, pale yellow-green leaves; slender pinnae; less leaf discoloration and premature dying than det. R.R.
dkv	Rick, TGC 17	dark-veined leaf. Seedling leaves yellow-green; veins always darker green. VF145
dlb	Stubbe, 1963	dilabens. Small, compact plant; shortened yellowish leaves. C.R.
dpy	Hernández-Bravo, TGC 17	dumpy. Leaves like those of d^x but internodes longer. Hybrid origin.
dt	Stubbe, 1963	dilatata. Small plant; yellowish pinnae, darker veins, uprolled margins. C.R.
em	Stubbe, 1963	emortua. Small plant; reduced sidebranching; spreading necrosis of older leaves leading to their premature death. R.R.
ep	Verkerk & Contant, TGC 17	easy peeling. Epidermis can be peeled from fruit without pretreatment. Money Maker.

Gene symbol	Reference & seed source	Character
era	Stubbe, 1963	eramosa. Smaller, weakly branched plant; whitish zones in primary and later leaves cause irregular pinnae development. C.R.
ete	Stubbe, 1964	extenuata. Slender shoots; slender, thick pinnae; irregular growth; poor seed set. C.R.
exa	Stubbe, 1963	expassa. Branches partially decumbent; yellowish gray-green older leaves, turning yellow prematurely. R.R.
exs	Stubbe, 1963	excedens. Smaller bush; short internodes, young leaves; older leaves leathery, shiny. C.R.
fa	Stubbe, 1963	falsiflora. Giant, vegetative, highly ramified inflorescence; completely sterile. R.R.
far	Stubbe, 1964	farinosa. Smaller, weakly branched plant; many, deeply crenate, wavy, gray- to yellow-green pinnae. C.R.
fcf	Stubbe, 1964	fucatifolia. Small, spreading plant; yellow or light green cotyledons, primary leaves, lower leaves at later stages. C.R.
fd	Rick, TGC 17	flecked dwarf. Retarded at all stages; leaves flecked with light green. Gamma ray-induced. Budai Korai.
fld	Stubbe, 1964	flaccida. Small, weakly branched, erect plant; darker, involuted, wilty pinnae, dying prematurely. R.R.
fn	Soressi & Cravedi, TGC 17	finely-netted. All true leaves light green with slightly darker veins. X-ray-induced. Prospero.
frg	Stubbe, 1963	fragilis. Smaller, erect, nearly unbranched plant; short, dull light-green leaves, yellowing prematurely. C.R.
ft	Kemp, TGC 16:13	fruiting temperature. Fruits can set at 40 F. Earlinorth.
fua	Stubbe, 1964	fucata. Smaller plant; young pinnae yellow-green, darker veins; older foliage variably lighter colored. C.R.
fug	Stubbe, 1964	fulgida. Small plant; foliage variably whitish or yellow-green, sometimes zonally marked. R.R.
ful^2	Stubbe, 1963	fulgens^2. Foliage at all stages light green to light yellow-green; stems and leaf mid-ribs sometimes purplish. R.R.
fy	Rick, TGC 16:27	field yellow. Bright yellow-green foliage in field. VF 36.
ga	Stubbe, 1963	galbina. Foliage at all stages variably white-gray-yellow-normal green; environmentally sensitive. C.R.

Gene symbol	Reference & seed source	Character
gas	Stubbe, 1964	gamosepala. Small plant; gray- to light-green foliage; wavy, irregularly crenate and rugose pinnae; partly connate sepals. R.R.
Ge^c	Rick, 1966	Gamete eliminator-Condine Red. Most Ge^c gametes abort when interacting with Ge^p. Condine Red.
Ge^n	Rick, 1966	Gamete eliminator-neutral. Neutral allele found in most genotypes.
Ge^p	Rick, 1966	Gamete eliminator-Pearson. Interacts to cause elimination of most gametes bearing Ge^c. Pearson and related cv.
gh-2	Soressi & Cravedi, TGC 17	ghost-2. Cotyledons yellowish; most leaves variegated. EMS-induced. Sioux.
glf	Stubbe, 1964	globiformis. Very small, irregular bush; all plant parts reduced; many sideshoots; multibranched inflorescences; young heterozygotes recognizable. C.R.
glu	Stubbe, 1963	glutinosa. Dark green, shiny fruit with sticky epidermis; poor germination. R.R.
gm	Soressi & Cravedi, TGC 17	gamosepalous. Calyx and corolla segments tending to be connivent. X-ray-induced. Sioux.
grc	Stubbe, 1964	gracillama. Smaller, weakly branched, half-erect plant; yellow-green, slightly involuted pinnae. R.R.
grf	Stubbe, 1964	grandifructa. Broad, lax habit; fewer, large, flattened fruit; heterozygote intermediate. L.
grl	Stubbe, 1964	gracilenta. Smaller, erect, weakly branched plant; large pinnae, close together, irregularly yellow-green, normal green veins. R.R.
gt	Stringam, TGC 17	gametophytic factor. Reduced effectivity of female gametes. Lindstrom's d,p,o,s stock.
Gx	Honma & Bukovac, TGC 16:11	Gibberellin-exserted. Gibberellin-stimulated exsertion of style. Indian River.
hg	Stubbe, 1963	heterogemma. Small, lax plant; first inflorescence abnormal, numerous fasciated buds, elongated, unbranched peduncle. C.R.
hi	Stubbe, 1964	hilara. Small plant, proportionately reduced; irregularly crenate and rugose and light-dark green patterned pinnae. C.R.
hl^2 (Cal)	Stubbe, 1964	hairless^2. Smaller, weakly pubescent plant; dark green leaves, curved upwards to involuted. C.R.
im	Stubbe, 1963	impatiens. Small, lax plant; reduced sideshoots; darker, blue-green foliage wilts in strong sun and wind. R.R.

Gene symbol	Reference & seed source	Character
ina	Stubbe, 1963	inflexa. Lax growth, becoming partially decumbent. L.
ini	Stubbe, 1964	inquieta. Small, proportionately reduced, variable plant; young pinnae involuted, lighter colored. R.R.
ino	Stubbe, 1964	involuta. Smaller, variable, cylindrical bush, short internodes; involuted pinnae. C.R.
ins	Stubbe, 1963	inconstans. Small, weakly branched plant; phenotype, including leaf size, variable from year to year. R.R.
ita	Stubbe, 1963	inquinata. Young leaves in midseason develop small necrotic vlecks, later coalescing into large ones; variable expressivity. R.R.
jug^2	Stubbe, 1963	jugata^2. Fasciated stems, flowers, fruits; more extreme than jug. L.
lap	Stubbe, 1964	lamprochlora. Small, lax plant; short, shiny leaves; end pinnae curved upwards. R.R.
le	Stubbe, 1964	lembiformis. Prostrate, smaller plant, proportionately reduced; keeled or involuted yellowish pinnae, ventrally purplish. R.R.
lep	Stubbe, 1964	leprosa. Smaller, proportionately reduced plant; rapidly spreading necrosis on all older pinnae. R.R.
lop	Stubbe, 1964	longipes. Small, somewhat spreading plant; broad, weak gray-green pinnae; long petioles, variable expression. C.R.
lt	Stubbe, 1963	laeta. Smaller, weakly branched plant; light gray-green foliage; growing points, later entire plant, yellow-green. C.R.
lur	Stubbe, 1964	lurida. Yellow-green cotyledons, primary leaves; dull light green later foliage. R.R.
lz	Stringam, TGC 16:36	lazy. Normal seedlings, 3 weeks later become strongly prostrate; weak branching. Early Fireball.
lz-2	Soressi & Cravedi, TGC 17	lazy-2. Plant prostrate, creeping like 'lazy' maize mutant. EMS-induced. San Marzano.
mac	Stubbe, 1964	maculata. Small plant; necrosis on upper or lower leaf surface spreading from margin. C.R.
mad	Stubbe, 1964	marcida. Small plant; dark green, slightly wilty foliage. C.R.
marm^2	Stubbe, 1963	marmorata^2. Leaves irregularly marbled in whitish yellow-green and then distorted. R.R.
med	Stubbe, 1964	mediocris. Smaller plant, proportionately reduced. C.R.
mel	Stubbe, 1964	melongenoida. Sometimes lax habit; oval fruit. L.

Gene symbol	Reference & seed source	Character
mic	Stubbe, 1963	microcarpa. Leaves, stems marked in gray-green; lighter yellow petals, up-rolled margins; ridged or yellow-fissured fruits. C.R.
mnt	Rick TGC 16:27	miniature. Very small plant; reduced branching and fruit set. Hybrid derivative.
mor	Stubbe, 1963	morata. Smaller plant, reduced widebranching; yellowish light green foliage. R.R.
ms-38	Rick, TGC 17	male-sterile-38. VF36.
ms-39	Rick, TGC 17	male-sterile-39. VF36.
ms-40	Rick, TGC 17	male-sterile-40. VF36.
mta	Stubbe, 1964	mutata. Small, broad bush; short internodes; long leaves; early season growing points light yellow-green. R.R.
mts	Stubbe, 1963	mortalis. Smaller bush; strongly reduced internodes, leaves; no inflorescences, even when grafted on normal stock. R.R.
mua	Stubbe, 1963	multifurcata. Small plant, all parts proportionately reduced; first inflorescence multibranched. C.R.
mun	Stubbe, 1964	multinata. Small bush; many equal sideshoots; short internodes, leaves. C.R.
mup	Stubbe, 1963	multiplicata. Enlarged, multibranched inflorescences; more or fewer whorled flower parts. R.R.
mut	Stubbe, 1963	mutabilis. Small plant, reduced branching; mid-season leaf color weak gray- to dark-green. R.R.
muv-2 (mus_1)	Stubbe, 1964	multivalens-2. Small plant, shiny, shorter leaves; light yellowish growing points. C.R.
mux	Stubbe, 1963	multiplex. Stems often end abruptly in leafy structure; inflorescences irregularly branched to fasciate; jointless pedicels swollen at calyx base; petaloid sepals. C.R.
obl	Verkerk & Contant, TGC 17	oblate fruit shape. Money Maker.
oli^2	Stubbe, 1963	$olivacea^2$. Small plant; pinnea more divided, short, broad, variously light-olive-dark green, wavy margin, dying early. L.
opa	Stubbe, 1964	opacata. Smaller somewhat spreading plant; yellow-green foliage. C.R.
os	Stubbe, 1963	oligosperma. Small, weakly branched, half-erect plant; distorted cotyledons; dark-green leaves, fewer pinnae. C.R.

Gene symbol	Reference & seed source	Character
mic	Stubbe, 1963	microcarpa. Leaves, stems marked in gray-green; lighter yellow petals, up-rolled margins; ridged or yellow-fissured fruits. C.R.
mnt	Rick TGC 16:27	miniature. Very small plant; reduced branching and fruit set. Hybrid derivative.
mor	Stubbe, 1963	morata. Smaller plant, reduced widebranching; yellowish light green foliage. R.R.
ms-38	Rick, TGC 17	male-sterile-38. VF36.
ms-39	Rick, TGC 17	male-sterile-39. VF36.
ms-40	Rick, TGC 17	male-sterile-40. VF36.
mta	Stubbe, 1964	mutata. Small, broad bush; short internodes; long leaves; early season growing points light yellow-green. R.R.
mts	Stubbe, 1963	mortalis. Smaller bush; strongly reduced internodes, leaves; no inflorescences, even when grafted on normal stock. R.R.
mua	Stubbe, 1963	multifurcata. Small plant, all parts proportionately reduced; first inflorescence multibranched. C.R.
mun	Stubbe, 1964	multinata. Small bush; many equal sideshoots; short internodes, leaves. C.R.
mup	Stubbe, 1963	multiplicata. Enlarged, multibranched inflorescences; more or fewer whorled flower parts. R.R.
mut	Stubbe, 1963	mutabilis. Small plant, reduced branching; mid-season leaf color weak gray- to dark-green. R.R.
muv-2 (mus_1)	Stubbe, 1964	multivalens-2. Small plant, shiny, shorter leaves; light yellowish growing points. C.R.
mux	Stubbe, 1963	multiplex. Stems often end abruptly in leafy structure; inflorescences irregularly branched to fasciate; jointless pedicels swollen at calyx base; petaloid sepals. C.R.
obl	Verkerk & Contant, TGC 17	oblate fruit shape. Money Maker.
oli^2	Stubbe, 1963	olivacea[2]. Small plant; pinnea more divided, short, broad, variously light-olive-dark green, wavy margin, dying early. L.
opa	Stubbe, 1964	opacata. Smaller somewhat spreading plant; yellow-green foliage. C.R.
os	Stubbe, 1963	oligosperma. Small, weakly branched, half-erect plant; distorted cotyledons; dark-green leaves, fewer pinnae. C.R.

Gene symbol	Reference & seed source	Character
ovi	Stubbe, 1964	oviformis. Broad, keeled, more crenate pinnae; long oval fruit. L.
pa-2 (pa_1)	Stubbe, 1964	parva-2. Small, nearly unbranched, erect plant; firm leaves, weakly curved upwards. C.R.
par	Stubbe, 1964	parca. Smaller, weakly branched, half-erect plant; fewer, boat-shaped to involuted pinnae, purplish ventrally. C.R.
pas	Stubbe, 1964	pallescens. Small plant; dull light green foliage. C.R.
Pch^+	Daskaloff & Ognjanova, TGC 17	Photoperiodic chlorosis. Chlorosis under constant illumination. Apparently in all L. esculentum. Dominant absence allele in other spp.
pet	Stubbe, 1964	penetrabile. Small plant; stocky shoots; short internodes, leaves; rugose pinnae; heterozygote intermediate at season's end. C.R.
pl	Stubbe, 1963	perlucida. Light green, narrow pinnae, yellowing prematurely. C.R.
pm	Stubbe, 1963	praematura. Small plant; dainty, shorter, sometimes yellowish leaves; fruit ripen early. R.R.
Pn	Rick, TGC 16:27	Punctate. Stippled margins of cotyledons, due to strong anthocyanin in bases of large trichomes. Backcross transfer to L. esculentum from Solanum pennellii.
pp	Stubbe, 1963	polyphylla. Longer, more divided, lighter-colored leaves, micromutation. R.R.
prt	Stubbe, 1964	protea. Smaller plant, variably reduced; keeled, pale yellow pinnae, partly shiny, leathery. C.R.
pst	Rick TGC 16:28	persistent style. Style adnate to fruit throughout development; fruit becomes strongly beaked. Early Santa Clara.
pun	Stubbe, 1964	punctata. Smaller plant, variably branched; narrow, keeled, firm pinnae, mostly finely marked in light to dark green. R.R.
px	Stubbe, 1963	praecox. Lax, spreading plant; small pinnae; larger, earlier fruit. L.
res	Stubbe, 1963	restricta. Smaller, squarrose bush; yellowish light green, boat-shaped pinnae, purplish ventrally. R.R.
ria	Stubbe, 1963	rigidula. Smaller plant; stiff, yellowish young leaves turn dark green later. C.R.
ria^2	Stubbe, 1964	$rigidula^2$. Smaller, stiff, compact plant; erect sideshoots; young pinnae keeled to involuted, light yellow-green, dark veins purplish below. L.
rig^2 (pca)	Stubbe, 1963	$rigida^2$. Small, lax, spreading plant; pinnae keeled, yellowish to light green; early flowering, ripening; heterozygote recognizable. L.

Gene symbol	Reference & seed source	Character
roa	Stubbe, 1964	rotundata. Small plant; short internodes, leaves; broad, rounded, rugose, weak gray-green pinnae. C.R.
rv-2	Soressi & Cravedi, TGC 17	reticulate virescent-2. Cotyledons light green; leaves yellowish with green veins. EMS-induced. Sioux.
sa	Stubbe, 1963	sphacelata. Small plant; light yellowish leaves, developing necrotic lesions ventrally or on pinnae tips; environmentally sensitive. C.R.
sar	Stubbe, 1964	squarrulosa. Small plant, somewhat squarrose and slender branched. C.R.
ses	Stubbe, 1963	semisterilis. Smaller, erect, nearly unbranched plant; thick, yellowish, light gray-green leaves; weakly fertile in greenhouse, unchanged on normal graft stock. L.
sfa	Stubbe, 1963	sufflaminata. Usually smaller, weakly branched plant; yellowish to yellow-green, involuted pinnae, purplish ventrally, slight F_1 seedling heterosis. R.R.
slx	Rick, TGC 17	serrate lax leaf. Drooping, elongate, serrate leaves. Unknown variety from Romania.
spe	Stubbe, 1964	splendida. Small plant; shiny, yellowish foliage; older leaves darker than younger ones. R.R.
spl	Stubbe, 1963	splendens. Shiny, yellowish to light green, boat-shaped, rugose pinnae. L.
ss	Soressi, TGC 17	spongy seed. Smooth but spongy seed surface.
tc	Soressi & Cravedi, TGC 17	turbinate corolla. Plant smaller; petal tips turbinate. EMS-induced. San Marzano.
te	Stubbe, 1963	terminata. Determinate growth; fasciated inflorescences, flowers, fruit. L.
tem	Stubbe, 1964	tempestiva. Small plant, short internodes, leaf midribs; involuted pinnae, lighter with darker veins. C.R.
$Tm\text{-}2^2$	Schroeder et al., TGC 17	TMV resistant-2^2. Alexander's gene. Ex. L. peruvianum.
to^2	Stubbe, 1964	$torosa^2$. Determinate growth; few-flowered inflorescences; fasciated flowers; enlarged, leafy calyx; less extreme than to. L.
uf	Fehleisen, TGC 17	uniflora. Inflorescence with single flower. Platense.
u^G	Rick, TGC 17	Galápagos uniform ripening. Resembles u except for partial dominance. Galápagos accession.

Gene symbol	Reference & seed source	Character
ves-2 (vf_1)	Stubbe, 1963	versiformis-2. Small, compact plant; dainty, shiny, yellowish pinnae, wavy margin. L.
vga	Stubbe, 1963	virgulta. Smaller plant; short internodes; dull green foliage, light yellow-green growing points. R.R.
vra	Stubbe, 1963	viridula. Small plant; boat-shaped, dull light green pinnae, wavy margin. C.R.
yc	Kemp, TGC 16:13	yellow calyx. Calyx turns yellow when fruit ripens. Hybrid derivative.
yv^2 (vel^2)	Stubbe, 1964	yellow virescent^2. Smaller, irregular bush; short internodes; soft yellow, velvety growing points shading to normal green below; smaller than vel. C.R.

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Table II. REVISIONS IN SYMBOLS OF PREVIOUS LISTS

Former symbol	Preferred symbol
acu	cv^2
am	ai^2
ang	ele^2
H	h
inx_1 (intro)	glo^2
rub (1)	l^2
vel	yv^3
ver	yv^4

PART I

RESEARCH NOTES

Butler, L. The effect of environment on the expression of certain genes.

During the summer of 1966 I grew many of my tester stocks at Bologna in Italy where the environmental conditions are different from Toronto. The major differences noted were:

bls syndrome was not compact. The Minicraig variety, which is isogenic with Ailsa Craig except for the bls gene, was no more compact than the Ailsa Craig variety.

exl flowered early and produced an abundance of flowers whereas under Canadian conditions it produces few flowers.

op did not set fruit. The selection 2027 has always been a good fruit setter at Toronto.

Me Wo combinations were earlier and produced larger crops than they do at Toronto.

dv phenotype grew very poorly whereas the combination 2104 grows well and fruits plentifully at Toronto.

dim grew much better than usual and produced ripe fruit 99 days after the seed was planted. This mutant has always produced normal plants at Toronto instead of the expected small plants described by Stubbe.

HC-1, a variety released by T. O. Graham, was planted in the field where the soil became dry and heavily crusted; but in spite of this we had 90% germination of this type compared to less than 20% for the other types, and the plants grew well and produced ripe fruit 90 days after the seed was sown.

dil types grew more slowly than they do at Toronto.

Cu plants grew at less than half the rate that they would have at Toronto. The pollen of many of the testers was not good under these conditions. Ailsa Craig, and the types which Darby has derived from this, produced good pollen and gave excellent sets.

Butler, L. The linkage relationship of narrow cotyledon (nc).

The backcross results of E. A. Kerr indicate that this unplaced gene is linked with a. I have no backcross data for this gene so at Kerr's request I checked my F_2 segregation records. The totals for both coupling and repulsion indicate no linkage, but both sets have poor monogenic ratios and show significant heterogeneity. When the data are grouped to eliminate the heterogeneity we get the following:

Coupling	++	+ a	nc +	nc a	Recombination
5416	228	77	42	31	39%
Rest	1027	276	320	89	49%
Repulsion					
3738	324	127	126	24	40%
Rest	472	85	87	33	57%

These data are inconclusive, but at least two crosses are in agreement with Kerr's findings. The three crosses which are grouped under "rest" in the

repulsion data were made with the newly produced radiation mutant, and if they could have been classified as coupling crosses they would also have given a value of 39%. These findings again emphasize the danger of drawing conclusions from lumped data which exhibit heterogeneity.

Contant, R. B., and Nelly S. Tims Further variety trials at close spacing. Testing of tomato lines at close spacing was continued on the basis of earlier results (TGC 16:7-9). These trials were conducted to evaluate the varieties partly for their usefulness for radiobiological experiments and partly for their horticultural merits. Seed was sown on 26th January 1966 and the following two trials were carried out:

(a) plants in 12 cm pots at 18 x 20 cm spacing on greenhouse benches, at 23 C (16 hours) and 17 C (8 hours during the night) without supplementary light except for the first 3 weeks;
(b) seedlings transplanted into the ground (no pots) in a commercial type glasshouse at 20 C, at a spacing of 20 x 20 cm, light as in (a).

Material: lines br (from N. Kedar), 587-21-1958 (br wf c sp n u f-j from E. A. Kerr), Chanasyk Early (LA657 from C. M. Rick), and No. 522 (a short internode selection of N. Kedar), and the varieties Pygmee, Farthest North, Money Maker (standard variety) and Minimonk.

Trial (a). The small rooting volume restricted all components of vigour, which facilitated handling, pruning and other maintenance. Two clusters developed satisfactorily in all lines. Mean number of viable seeds per fruit was sufficient for radiogenetical purposes in all lines, ranging from 133 for Minimonk and Money Maker to 75 for Farthest North with Chanasyk Early having 88 seeds per fruit. There was considerable variation in the number of days to flowering; Farthest North and Chanasyk Early were the earliest--68 and 72 days from sowing, and Minimonk latest--86 days from sowing. Differences in vegetative and generative vigour were much smaller in pots (trial a) than in the ground (trial b); the spacing of 18 x 20 cm was adequate for all lines and might be even less for those which showed the smallest difference in vigour between the (a) and (b) trials, viz. Farthest North, Chanasyk Early, and 587-21-1958. The number of fruits per plant ranged from 4.8 in line br to 22.3 in Farthest North; Chanasyk Early had 16.6, and 587-21-1958 averaged 7.9 fruits per plant.

Trial (b). Flowering time differed very little from that in trial (a), but vegetative vigour was much greater, so that more flower clusters were grown and 60 to 100% more fruits harvested per plant. Average seed set per fruit was 10 to 35% lower than in (a). The ratio of reproductive to vegetative development was much lower in the ground trial (b) than in pot trial (a); considerable pruning was necessary.

Chanasyk Early has a developmental pattern very similar to Farthest North but possesses greater vigour, yielding twice as much and bearing much larger fruit. Most plants forked below the first inflorescence, which often led to 2 equally strong branches, each forming a cluster. When performance in both trials was taken into account, this self-topping variety proved suitable for our large-scale radiobiological experiments, in addition to certain dwarf mutants of Money Maker (TGC 17:14). Of all material tested, Chanasyk Early also seems to be the most promising line for the commercial use for early season cultivation at close spacing in beds. Total yield from 1 m^2 plots (25 plants) was 73.6% of that of Money Maker, the latter grown at 9 plants/m^2. The fruit is more watery than desirable. The problem of seeds germinating within the fruit, observed in hydroponics (TGC 16:9-10), was not

encountered in soil culture. The large inflorescences, averaging 26 flowers, need to be shortened to improve fruit size. A breeding program has been initiated by crossing Chanasyk Early with Money Maker.

Line 587-21-1958 has an attractive fruit flavour but its irregular clusters and bad fruit shape are undesirable traits. It is, however, very successful as a parent of multi-recessive hybrids which are used in radiobiological studies by the Association EURATOM - ITAL (G. T. Scarascia Mugnozza and co-workers, CNEN, Roma).

In trial (b), at 20 x 20 cm spacing, Kedar's No. 522 and br, to a lesser extent, showed very abnormal development, characterized by extreme internode reduction, thickening of stems and petioles, brittleness of the leaves, weak attachment of leaves to stem, degeneration of the main shoot apex followed by heavy growth of laterals, and absence of flowering in most plants. Some border-plants ultimately flowered (89 to 95 days after sowing) while only one row of plants close to the plain-glass side windows developed as normal short-internode type. These abnormalities are probably mainly due to low light intensity, possibly aggravated by a spectral difference between plain-glass and the "hammered" light-diffusing glass of the greenhouse roof. It is striking that some of the reactions of No. 522 and br to inadequate light were the opposite of those known in other varieties. This will be further investigated.

Contant, R. B., and Miss W. Meerdink

Performance of dwarf mutants of 'Money Maker' in small pots at close spacing.

Previous work (TGC 16:7-9 and TGC 17:13) on finding suitable tomato lines to replace 'Money Maker' in the large scale radiobiological studies of the Association EURATOM - ITAL has been continued.

Material and conditions of growth: Seeds of four of Verkerk's most fertile dwarf mutants of 'Money Maker'--MM705-15, MM705-66, MM706-9 and MM708-23--were sown in seed-pans at 4 x 4 cm spacing and incubated in the dark at 27 C. At the emergence of the first seedlings, they were transferred to a growth chamber at 23 C during the day (16 hours) and 17 C at night, at a relative humidity of 70% and under 12,000 lux of Philips TL33RS. The seedlings were transplanted 24 days after sowing into 12 cm plastic pots which were placed on benches at 18 cm spacing in a triangular layout. Four topdressings of NPK fertilizer were applied, at 2-weekly intervals. Pollination was aided with an electric vibrator.

Results: Mean ± S.D. (based on 25 plants per mutant line).

Mutant line	Diam. Stem at base (mm)	Diam. stem above 1st cluster (mm)	Height to 1st cluster (cm)	Development of axillary shoots	Days to flowering	
					1st cluster	2nd cluster
MM705-15	9.4±1.3	6.0±0.8	24.3±8.9	+	57.6±5.9	69.9±6.2
MM705-66	12.6±1.3	8.8±1.0	20.0±2.8	+	53.2±2.2	63.7±1.5
MM706-9	12.4±0.8	8.6±0.3	18.0±4.2	+	54.9±2.2	64.8±2.8
MM708-23	11.6±0.8	6.5±1.0	18.8±2.7	+++	51.3±3.0	63.2±5.6

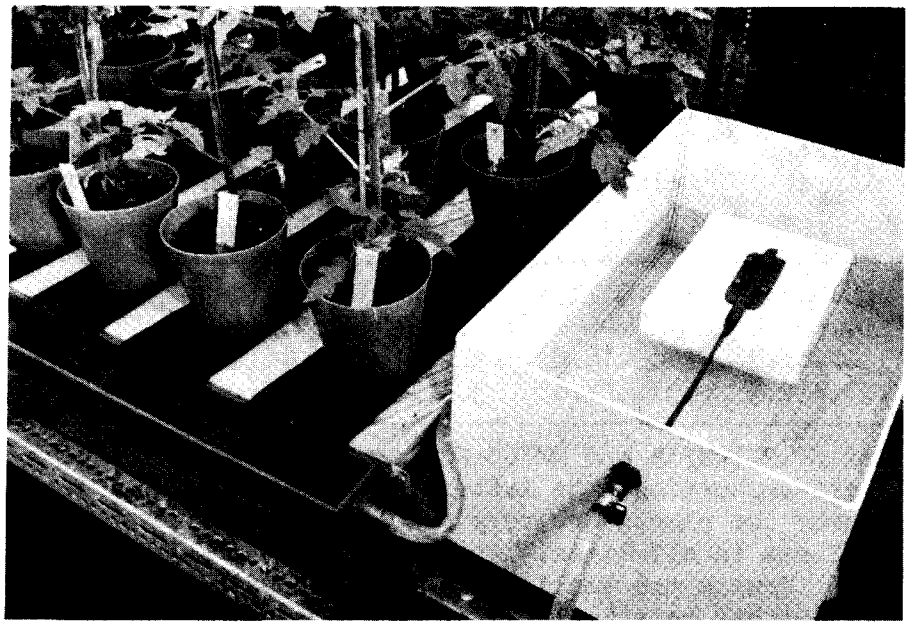
Mutant line	Days to ripening		Average number of fruits		Average number of seeds in 1st fruit	Weight 1st fruit (g)
	1st cluster	2nd cluster	1st cluster	2nd cluster		
			(range in brackets)			
MM705-15	106.8±6.8	131.0±11.4	2.9(2-4)	2.3(0-4)	94±14	31.5±12.0
MM705-66	104.8±1.0	-	3.7(3-4)	0.1(0-1)	135±46	40.1±11.7
MM706-9	106.0±1.3	128.4±8.8	3.9(3-6)	0.6(0-2)	100±31	42.2±9.8
MM708-23	105.4±2.3	131.5±7.6	3.4(2-5)	2.0(0-5)	47±23	38.5±10.5

The stems of MM705-15 and MM708-23 need support. Both MM705-66 and MM706-9 are self-supporting; the latter is the shortest line and has straight and sturdy stems; the plants are very homogeneous in appearance. The first cluster is well set in all lines. In most plants of MM705-15, the second cluster has set; fruits are small; this line has dark and slightly drooping foliage. MM705-66 has relatively large fruits containing many seeds; the second cluster is aborted in most plants. The same applies to MM706-9. In MM708-23 both clusters are rather well developed. Seed set is good in all lines, though means must be found to reduce the variance.

Of all introductions so far, MM706-9 and MM705-66 are probably the most attractive alternatives to 'Money Maker' for large scale radiobiological experimentation. Further work will aim at improving fruit set of the second cluster under the same experimental conditions (possibly by earlier NPK top-dressings). This will be followed by radiosensitivity comparisons with 'Money Maker'. Although the second cluster usually carries the same mutations as the first after seed irradiation, in contrast to EMS treatment (K. VERKERK and G. J. HILDERING), it is nevertheless considered desirable to aim at a test variety with good set of the second cluster.

Contant, R. B. Time-saving by automatic watering of pots.

In TGC 16:9-10, reference was made to automatic watering to increase the efficiency of our radiobiological experiments with tomato. After further experimentation, the following procedure was adopted. Tables or benches are connected to form units of variable length and with a width of approximately 80 cm; a U-shaped gutter 5 cm deep is fixed on either side of these units and extends the length; one end of each gutter (in our experiments made of polypropylene) is connected to a constant-level tank by means of black PVC tubing. The height of the gutters and of the tank is adjustable. Strips of water-absorbing carpet under-lay (non-woven mixture of cotton-, wool- and synthetic fibers impregnated with synthetic rubber), 90 cm long, 10 cm wide and 6 mm thick, are laid across the table 16 cm apart from center to center with the ends hanging down in the respective gutters; the strips must be soaked with water before being placed on the table. Three tomato plants in 12 cm plastic pots are placed on each strip. Experiments have shown that in this way plants can be grown to maturity (2 clusters) in a well ventilated air-conditioned greenhouse without other watering or any other maintenance except slight pruning. It is essential that the drainage holes in the bottoms of the pots be in close contact with the surface of the water-absorbing strips. Topdressings with a NPK fertilizer are required at 2-weekly intervals. Algae are avoided by means of 'Panacide' (British Drughouses Ltd.).



Automatic watering of tomato plants

An experiment carried out in early spring (additional illumination with 60 watt/m^2 of Philips TL33RS) yielded the following data for 2 replications each of 9 plants:

Replication number	Average number of fruits/plant (range in brackets)	Mean yield per plant ± S.D. (g)	Mean weight per fruit (g)	Average number of seeds/fruit
1	7.6(6-10)	358.9±59.3	46.15	122
2	8.2(6-12)	418.3±97.5	50.87	119

Contant, R. B. and K. Verkerk An approach to selection and breeding in irradiated plant populations.

At the symposium 'Induced Mutations and their Utilization' held at Gatersleben (E. Germany) in June 1966, S. I. Alikhanian stressed the importance of alternating selection for major and minor mutations in the search for strains of micro-organisms with improved antibiotics production. The induction of major mutations, which drastically affects genetic balance, leads to increased genetic variability for quantitative traits and an increase in the selection response. Other workers have observed similar phenomena, also after virus infection.

This approach might prove valuable to mutation breeding in higher plants and has been followed by the present authors since 1965 in their mutation breeding work on tomato. As a part of extensive radiosensitivity studies, several 100,000 M_2 seedlings are screened annually for visible mutations, most of which are deleterious. Only those mutants are retained which have approximately normal vigour at the seedling stage. Subsequently, all mutants

with unsatisfactory flowering or fruit development are discarded. Seed is produced on the M_2 plants retained. The M_3 lines are compared with their respective mother varieties in replicated performance trials under commercial glasshouse conditions, in pots on benches, and whenever possible in the field.

In the 1966 glasshouse trial, 2 out of 4 mutant lines from 'Glorie' exceeded the control in fruit yield, the other two produced only 42% and 59% of the control yield. On the 15 'Money Maker' mutants tested, one exceeded the control by 11.5%, whereas the other produced 56-96% of the control, during the first month of harvesting. As yields were not recorded beyond that period, it is more appropriate to express these results in terms of earliness which is 5 to 6 days for the most promising lines. Some mutants were also attractive for other reasons. Distinctive features of the best mutant lines are briefly described:

Mutant line 'L': from 'Glorie'; vigorous, good fruit set in higher clusters, good fruit shape; in the field 5 to 6 days earlier than control.

Mutant line 'M': from 'Glorie'; at first described as being similar to 'L'; earlier than 'Glorie' (figure 1); vigorous with very good fruit set; leaves somewhat drooping, giving attractive cylindrical growth habit.

Mutant line'S': from 'Money Maker'; light green foliage and large leaves, possibly of interest for low-light winter conditions; fruits somewhat flattened; yield 95% of control after 1 month of harvesting (figure 1).

Mutant line 'V': from 'Money Maker'; dark green foliage, possibly of interest for low-light winter conditions (physiological study in progress at Institute for Horticultural Plant Breeding, Wageningen); highest yield of all 3 dark green mutants retained (73% of control); not particularly early; several sterile M_3 plants; short internodes.

Mutant line 'W': from 'Money Maker'; greyish cotyledons; foliage darker than control, later normal; good to mediocre fruit shape and reasonable fruit set; best yielding 'Money Maker' mutant, producing 111.5% of control after 1 month of harvesting (figure 1).

Mutant line 'C': from 'Money Maker'; low and bushy when left unpruned; weak main shoot leads to formation of approximately 4 laterals bearing ripe fruit at the same time; possibly of value for mechanical harvesting (Italy, Israel); low yield of small fruits. Crossing of selected M_3 plants with commercial varieties has started.

Phenotypic variation within mutant M_3 lines was greater than in the control. Selection for earliness and high yield was carried out in M_3 and will be continued in subsequent generations under both winter and summer conditions. In yield trials, each mutant plant is accompanied by a control plant to minimize the non-genetic variance.

It is significant that 6 mutant lines out of 19 tested showed potential interest to breeding even before within-line selection had been practiced; these results underline the possible value of the suggested approach.

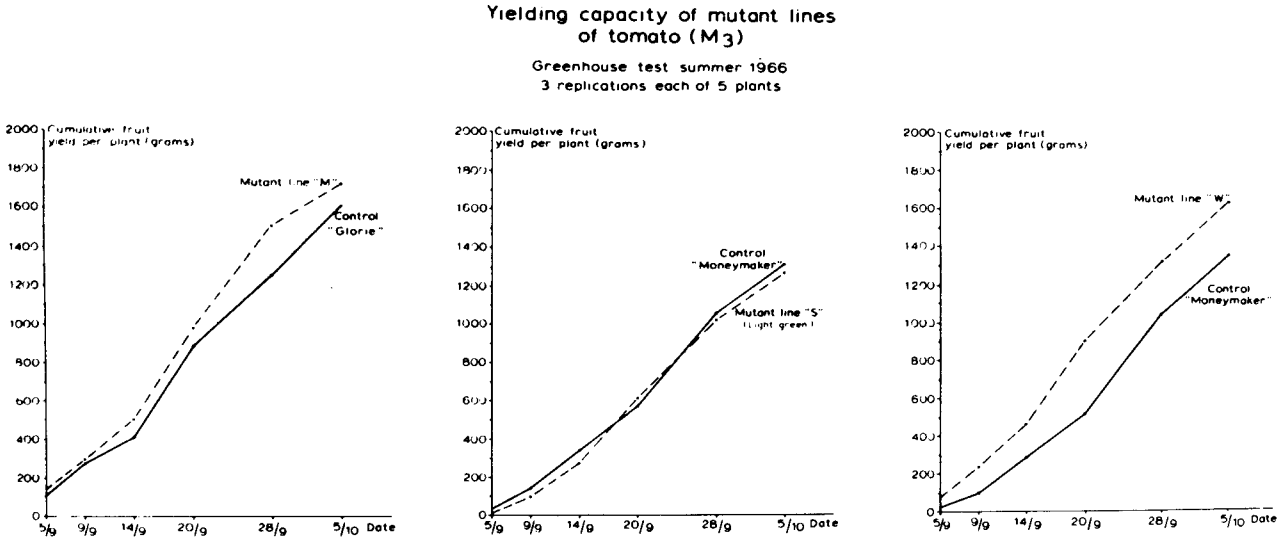


Figure 1

Contant, R. B. and K. Verkerk Responses to chronic thermal neutron irradiation of seeds and seedlings.

In order to study the influence of stage of growth and speed of development during chronic irradiation, thermal neutrons were given at two temperatures, 10 C and 23 C, to pre-soaked seeds (24 hours) and to seedlings at the 2-leaf stage. Exposure time ranged from 0 to 20 days, at a flux density of 4.3×10^7 $N_{th}/cm^2.sec$; all samples were kept at the respective irradiation temperatures till one day after the last sample had been withdrawn from the reactor (B.A.R.N. at Wageningen). Then the climatic regime was changed for all treatments to 20 C during the day (16 hours) and 16 C at night. Very spectacular differences emerged with regard to apical destruction as a function of dose (Table 1). This is not unexpected as at 23 C normal germination and growth takes place, whereas at 10 C germination is virtually inhibited and seedling growth extremely slow.

Seedlings were more sensitive at 10 C than at 23 C; this may be partly related to the dose received per cell cycle. The slope of the linear part of the dose/response curves was similar for the two temperature treatments.

With hydrated seeds, the position was drastically reversed. At 23 C, with germination taking place, the sensitivity did not greatly differ from that of 2-leaf seedlings irradiated at the same temperature. At 10 C, however, no apical damage or even growth retardation occurred, even after 15 days of exposure when the other treatments were severely affected. This cannot be explained by 'dose per cell cycle'; a possible explanation might be that in hydrated seeds which have not yet germinated much stored energy is available for recovery or repair.

On the plants with normal apex, the following characters were studied:

Number of leaves below 1st cluster: this increased with dose in the seedling-irradiated plants, reaching 2.0 extra leaves in the 10 C treatment and 3.5 in the 23 C treatment, both at the sublethal dose. No increase was found in the 'seed·10 C' treatment (in

which, however, a severely damaging dose was not reached). In treatment 'seed·23 C', however, leaf number decreased progressively with dose and led, at the sublethal dose, to plants with an average of 6.0 leaves (control 10.8 leaves); some plants at this dose had only one terminal inflorescence, after which growth was arrested; fruit development was normal.

Flowering: this was delayed by 9 days at the sublethal dose in 'seedling·10 C' plants, by 10 days in the 'seedling·23 C' treatment and by 13 days in the 'seed·23 C' treatment. There was no delay in the plants of the 'seed·10 C' treatment at the highest dose studied.

Average number of seeds per fruit (mean of first 3 fruits): results, expressed as a % of the control, are shown in Table 1. Notwithstanding irregularities, it is apparent from the data that the relative sensitivities of the four treatments with regard to fertility reduction are in good agreement with the sensitivity data for destruction of the shoot apex (Table 1). In the 'seed·10 C' treatment where all plants remained normal at the highest dose, fertility was reduced by only 27%; 'seedlings·10 C' on the other hand was the most sensitive to neutrons with regard to both apical integrity and fertility.

Table 1

Neutron exposure (days)	Av. number of seeds per fruit (% of control)				Surviving plants w.normal apex (% of control)			
	Seedling irrad.		Seed irrad.		Seedling irrad.		Seed irrad.	
	10 C	23 C	10 C	23 C	10 C	23 C	10 C	23 C
Control	100%	100%	100%	100%	100%	100%	100%	100%
1	102	100	94	93	95	100	100	100
3	83	90	101	88	82	98	100	98
5	78	81	85	83	61	98	100	92
8	69	91	92	80	12	82	100	60
11	42	67	77	52	12	15	100	23
15	0	60	73	0	0	3	100	2

Fruit size: unaffected by irradiation except for a slight drop in the 'seedling·10 C' treatment.

Mutation frequency: the study of mutation frequency is in progress. The frequency of M_2 mutations appears to be very much lower in any of the present chronic irradiations than after acute irradiation of dry or soaked seeds. There is also a greater mutant deficit in the segregating progenies of irradiated seedlings than in those of soaked seeds, indicating a reduction in the average size of mutated sectors with seedling development. From the analysis of large progenies of a number of M_1 plants, it appears that the low mutation frequencies are not due to failure of detection but probably by repair or recovery of damage. Other work shows that in tomato (as an example of a seed-propagated self-pollinating species) maximum mutation rates after acute neutron irradiation of dry and 24-hour soaked seeds do not greatly differ (the respective maxima being of course obtained at widely different doses). The practical consequence of the present experiment seems to be that acute irradiation of dry seeds would be more efficient than either acute or chronic irradiation of hydrated seeds or seedlings for the purpose of radiogenetical and mutation breeding studies.

Daskaloff, C., and A. Ognjanova

The photoperiodic chlorosis in several tomato species and its inheritance.

Our observations on photoperiodic chlorosis showed that the tomato species do not react to continuous illumination in the same way (Tagung. Nr. 46, DAL 17-24, 1962; 1965, Ztschr. Pflanz. 54(2):169-181). L. esculentum Mill. (variety Kecskemét 363) develops, as is well known, typical chlorosis and its growth is suppressed (Withrow and Withrow, 1949, Plant Physiol. 24:657-663; Hillman, 1956, Amer. J. Bot. 43:89-96). L. racemigerum Lange (L. pimpinellifolium Mill.) on the other hand shows no signs of photoperiodic chlorosis and grows vigorously. The same is true for L. pimpinellifolium Sta. Cruz Galápagos (the seeds obtained from Prof. Rick). L. hirsutum Humb. et Bonpl. has chlorosis on the first four leaves, but later this vanishes and the plants grow vigorously. L. chilense Dun. shows signs of chlorosis after the third leaf, which later almost vanish, but the growth of the plants is slow. In our experiments we also observed all F_1 crosses of L. esc. with the other mentioned species, two F_2 generations and two backcrosses. The plants were grown from germination to bud formation (or to anthesis) under continuous illumination and at normal winter day conditions of 9 to 10 hours day length. Each experiment was repeated twice. The results of the experiments are presented in Tables 1-3.

It appears that the photoperiodic chlorosis of L. esc. due to continuous illumination is caused by a single recessive gene Pch^+/Pch^+, which reveals itself only under these circumstances (similar to cm/cm or sd/sd). L. racem. and L. pim. evidently possess the wild genotype Pch/Pch. The F_1 cross L. esc. x L. racem. (and that of L. esc. x L. pim.) shows no signs of photoperiodic chlorosis and grows vigorously. The F_2 generation and both BC's clearly demonstrate single gene segregation. L. hirs. has a slightly different reaction to continuous illumination than does L. esc. or L. racem. The F_1 cross L. esc. x L. hirs. reacts to this kind of illumination more than either parent. The photoperiodic chlorosis appears on the first leaves then vanishes, but the growth of the plants is highly depressed. The control F_1 plants at 10 hours day length do not show these responses. It is possible that L. hirs. possesses another recessive gene and that the combination with L. esc. gives a negative effect. The F_2 segregation points to a possible difference of recessives in one locus. Further observations on F_2 and BC are under way.

Table 1

L. esc. x L. racem.	Reaction to continuous illumination				
	Number of plants				
	Observed		Expected		
	P_1 type	P_2 type	P_1 type	P_2 type	χ^2
L. esc. P_1	72	-	72	-	
L. racem. P_2	-	72	-	72	
L. esc. x L. racem. F_1	-	72	-	72	
L. esc. x L. racem. F_2	338	917	314	942	0.94
BC P_1	119	135	127	127	0.50
BC P_2	-	116	-	116	

Table 2

L. esc. x *L. hirs.*	Reaction to continuous illumination						
	Number of plants						
	Observed			Expected			
	P_1 type	F_1 type	P_2 type	P_1 type	F_1 type	P_2 type	χ^2
L. esc. P_1	72	-	-	72	-	-	
L. hirs. P_2	-	-	72	-	-	72	
L. esc. x *L. hirs.* F_1	-	72	-	-	72	-	
L. esc. x *L. hirs.* F_2	174	300	158	158	316	158	0.81

Table 3

L. esc. x *L. pim.*	Reaction to continuous illumination		*L. esc.* x *L. chil.*	Reaction to continuous illumination	
	Number of plants			Number of plants	
	P_1 type	P_2 type		P_1 type	P_2 type
L. esc. P_1	72	-	*L. esc.* P_1	72	-
L. pim. P_2	-	72	*L. chil.* P_2	-	24
L. esc. x *L. pim.* F_1	-	72	*L. esc.* x *L. chil.* F_1	-	6

Daskaloff, C., and A. Ognjanova The heterosis effect in some interspecific tomato crosses under ten hours day length and continuous illumination.

The data from our experiments concerning photoperiodic chlorosis due to continuous illumination present also the opportunity for the estimation of the early heterosis effect in two different environments. The plants were grown from germination to bud formation (or to anthesis) under nine to ten hours day length (winter day) or under continuous illumination. Every parent species or F_1 cross (with the exception of *L. esculentum* x *L. chilense*, of which we had only 12 plants) was represented at the beginning of each experiment by 72 plants, but later due to lack of space their number was reduced to 12. Every experiment was repeated twice, the data given in the table representing the mean values. The height, weight and dry weight of the plants were measured at intervals of 10 days, and the heterosis effect was estimated as the per cent relation between the hybrid and the mean value of the two parents or between the hybrid and each parent. The results obtained from the last measurement are presented in the table.

The following conclusions have been derived from these results:

1. At the early stages of development (prior to bud formation) the

highest heterosis effect is demonstrated in the cross L. esc. x L. racem. The reciprocal L. racem. x L. esc. showed very little heterosis in the first measurements (data not given) but heterosis increased by the last measurement and the difference between these two crosses was not so striking. The same is true for L. esc. x L. pim. and L. esc. x L. chil. (only for height measurements). The least heterosis effect is observed in the cross L. esc. x L. hirs.

2. Heterosis effect of all F_1 crosses (except L. esc. x L. hirs.) is higher under continuous illumination than it is under 10 hours day length, but this is only because of the different reaction of the parent species to this environment. L. esc. does not thrive well under these circumstances which lowers the value of the parental mean. On the other hand, the F_1 inherits the reaction of the wild genotype and grows vigorously showing high value for the hybrid. The cross L. esc. x L. hirs., on the contrary, because of its genotypically negative reaction to continuous illumination, not only shows lack of heterosis but hardly survives under these conditions. In this case heterosis is higher or lower in a given environment not because of better adaptability of the hybrid (as was observed by D. Lewis, 1955), but because the different genotypes of the parents and F_1 determine different reactions at this environment.

Crosses	Heterosis effect (%)								
	Height of plants			Weight of plants			Dry weight of plants		
	$\frac{P_1+P_2}{2}=100$	$P_1=100$	$P_2=100$	$\frac{P_1+P_2}{2}=100$	$P_1=100$	$P_2=100$	$\frac{P_1+P_2}{2}=100$	$P_1=100$	$P_2=100$
10 hrs day lgth									
L.esc. x L. rac.	167	164	169	183	165	203	184	150	240
L.rac. x L.esc.	144	145	141	161	178	145	147	106	120
L.esc. x L.pim.	158	99	392	182	127	138	180	112	450
L.esc. x L.hirs.	116	112	121	117	87	175	134	87	280
L.esc. x L.chil.	193	153	200	-	-	-	-	-	-
Continuous illumination									
L.esc. x L.rac.	200	263	162	410	632	304	398	599	299
L.rac. x L.esc.	183	147	238	327	243	505	282	212	424
L.esc. x L.pim.	175	136	245	417	363	489	409	332	532
L.esc. x L.hirs.	67	55	85	45	32	73	23	15	58
L.esc. x L.chil.	177	133	266	-	-	-	-	-	-

P_1 = female parent

de la Roche, I. A., and W. H. Lachman
Genetic interrelationships among yg, yg-2, yg-3, yg-4, yg-5, and yg-6.

The yg series of mutants were crossed in all possible combinations, and the resulting F_2 progeny were analyzed. A two-point backcross study was also done on yg-2 and yg-3. The results are shown in the following tables.

Table 1

Analysis of the dihybrid crosses from all combinations of the yellow-green series of mutants.

A x B	F_2 Phenotypes: + +	+b	a+	ab	χ^2_L [b]	% Co.
yg x yg-2	208	92	88	25	0.52	50
yg-3 x yg	281	74	85	16	0	50
yg x yg-4	335	55	107	12	1.29	50
yg-5 x yg [a]	295	97	86	19	2.05	50
yg-6 x yg [a]	405	142	146	36	2.78	50
yg-3 x yg-2	367	110	78	27	0.34	50
yg-4 x yg-2	576	205	95	18	5.61*	41.15 ± 4.07
yg-5 x yg-2	596	202	161	55	0	50
yg-6 x yg-2 [a]	645	214	214	63	0.56	50
yg-4 x yg-3 [a]	359	98	28	0	6.25*	50
yg-5 x yg-3 [a]	362	88	87	21	0	50
yg-6 x yg-3 [a]	423	129	89	20	1.31	50
yg-4 x yg-5 [a]	946	305	12	1	1.15	50
yg-4 x yg-6 [a]	511	72	26	4	0.02	50
yg-6 x yg-5	453	176	143	38	3.60	50

[a] Reciprocal crosses.
[b] Adjusted contingency chi-square where applicable.

All individual F_2 lots from each cross gave positive results when tested for homogeneity.

Table 2

Analysis of yg-3 x yg-2 double backcross data.

A x B	Backcross Phenotypes: ++	+yg-2	yg-3+	yg-2 yg-3	χ^2_L	% Co.
yg-3 x yg-2	29	30	32	25	0.55	50

It appears that the yg mutants are non-allelic and except for yg-4 and yg-2 exhibit no linkage. This confirms in part the results obtained by Chiscom (TGC 10) and Burdick (TGC 9).

A recombination value could not be determined for the yg-4 x yg-3 cross because of failure to observe any double recessive recombinants. Nevertheless, it appears that these two mutants are independently inherited, since Burdick (TGC 9) has shown that yg-4 is loosely linked to al on chromosome 8. Both the F_2 and backcross data indicate that yg-2 and yg-3 are not linked. Since yg-2 was assigned to chromosome 6 because of apparent linkage to yg-3, further consideration might be given to this assignment in light of the above data. The yg-4 and yg-2 genes consistently exhibited loose linkage. Considering that yg-4 may be associated with chromosome 8, yg-2 may merit further analysis with markers from this chromosome.

de la Roche, I. A., and W. H. Lachman
Linkage relations of neg.

Rick and Martin (TGC 10) obtained approximately 26% recombination between neg and a indicating that neg is located on chromosome 11. These data and linkage results we obtained from neg crossed to hl and j suggest that neg is located at locus 29.

Table 1

F_2 repulsion data for neg linkage studies.

Observed F_2 Frequencies

A x B	++	+b	a+	ab	Total
neg x hl	649	279	263	3	1194
neg x j	672	256	264	2	1194
neg x a*	590	242	197	11	1040

* Dr. C. M. Rick's preliminary data (TGC 10:38).

Table 2

Summary of neg linkage data.

A x B	χ^2_A [a]	χ^2_B [b]	χ^2_L [c]	% Co.
neg x hl	4.57*	1.14	94.36**	11.33 ± 4.15
neg x j	4.57*	7.15**	86.31**	9.85 ± 3.43
neg x a	13.60**	0.22	49.91**	24.21 ± 4.14

[a] Adjusted chi-square for single factor A disturbance.
[b] Adjusted chi-square for single factor B disturbance.
[c] Adjusted contingency chi-square for linkage.

It is noted that neg exhibits rather tight linkage with the three genes under consideration. Using the crossover values in Table 2, it is found that the range common to all these values is from locus positions 28.65 to 30.28, inclusive. It, therefore, appears that neg is located at approximately locus 29 of chromosome 11.

de la Roche, I. A., and W. H. Lachman
Linkage relations of yg-6.

Whalen (TGC 14) has indicated that yg-6 is located at locus 24 on chromosome 11. Further linkage studies on yg-6 with hl and j suggest that yg-6 may be located at locus 50 rather than at 24.

Table 1

F_2 repulsion data for yg-6 linkage studies.

Observed F_2 Frequencies

A x B	++	+b	a+	ab	Total
yg-6 x hl	632	207	264	5	1108
yg-6 x j	635	204	252	17	1108

Table 2

Summary of yg-6 linkage data.

A x B	χ^2_A [a]	χ^2_B [b]	χ^2_L [c]	% Co.
yg-6 x hl	0.27	20.03**	67.08**	16.43 ± 4.51
yg-6 x j	0.27	14.83**	40.19**	29.06 ± 5.09

[a] Adjusted chi-square for single factor A disturbance.
[b] Adjusted chi-square for single factor B disturbance.
[c] Adjusted contingency chi-square for linkage.

The 16.43 ± 4.51% recombination between yg-6 and hl (Table 2) is in agreement with the 13% crossover value obtained by Whalen, but the 29.06 ± 5.09 value between yg-6 and j (Table 2) is inconsistent with 7% recombination expected when yg-6 is positioned at locus 24. If, however, yg-6 is positioned on the other side of hl, 13 crossover units away, the resulting 33% recombination value between yg-6 and j would fit the above data (Table 2). Since the F_2 data from this particular cross show an efficiency equivalent to analyzing a population of 318 backcross segregates, it seems likely that yg-6 is 33 rather than 7 crossover units from j. Hence, it is suggested that yg-6 is located at locus 50 on chromosome 11.

de la Roche, I. A., and W. H. Lachman

Pleiotropism in the yg-6 syndrome.

Whalen (TGC 14) observed that the yg-6 mutant comprised a syndrome of three characters: yellow-green first true leaves, elongated hypocotyl, and a greatly reduced amount of anthocyanin development. In analyzing more than 10,000 segregates from heterozygous yg-6 plants, no recombination of these three characters with wild types was observed, suggesting that yg-6 may be a case of pleiotropism rather than a complex locus. We looked at 11,284 yg-6/+ segregates for possible recombination within the yg-6 syndrome. In several instances it was found that yg-6 segregates had accumulated a small amount of anthocyanin in the hypocotyl, but none of these approached the wild type in intensity of the pigment. Several of these yg-6 types containing anthocyanin were selfed, but the resulting progenies all exhibited colorless hypocotyls.

Considering that no recombination within the yg-6 syndrome has been observed in more than 21,000 yg-6/+ segregates, the yg-6 phenotype must still be considered a case of pleiotropism rather than independent effects of a complex locus.

Emery, G. C., and H. M. Munger Comparison of patterns of harvest and fruit characteristics in lines of tomato differing only in habit of growth.

Alleles for the determinate (sp), indeterminate (sp^+), jointless (j) and dwarf (d) habits of growth were backcrossed from six to eight times into the varietal backgrounds of Gardener, Fireball, and 54-149. Preliminary comparisons of the growth habits were made in segregating F_2 progenies from these backcrosses. An extensive comparison was carried out in a factorial experiment utilizing primarily the F_3 lines homozygous for these alleles. Only an overall summary of the results will be listed here; more complete details of the study will be found in papers awaiting publication.

In each of the varieties the determinate habit regularly had only 1 to 2 leaves between inflorescences and terminated apical growth after 3 to 4 inflorescences; the indeterminate plants in all varieties had three leaves between inflorescences and unrestricted apical growth. In terms of the number of leaf nodes between inflorescences or in the degree of apical extension, no difference was observed between dwarf and non-dwarf plants--determinate and indeterminate plants were differentiated the same way in the dwarf as in the non-dwarf condition. The dwarf plants in all varieties were generally slower in growth and showed a diminution of the size of plant parts compared to non-dwarf plants. Jointless plants had an increased number of leaves before the first inflorescence as well as between subsequent inflorescences and fewer flowers per inflorescence compared to normal plants. Determinate jointless plants had 2 to 3 leaves between inflorescences and unrestricted apical growth while indeterminate jointless plants had 3 to 4 leaves between inflorescences, unrestricted apical growth, and added vegetative growth arising from floral apices.

Determinate and indeterminate plants were not differentiated in the time of setting and ripening their first fruit; but with determinate plants accumulating a larger fruit set and number of ripe fruits per unit of time compared to the indeterminate plants, the determinate plants did have a larger early yield. The indeterminate plants were able to set fruit over a longer period of time and with an extended season would outyield determinate vines. As a result of slower growth, the dwarf plants generally were later in maturing their fruit compared to non-dwarf plants. The jointless plants were delayed in maturing their first ripe fruit, apparently as a result of an increased number of leaves before the first inflorescence, and had a slower rate of accumulating ripe fruit compared with jointed plants.

The determinate plants produced smaller fruit with a lower percentage of soluble solids compared to indeterminate plants. Dwarf plants had smaller fruits than non-dwarf plants but with no difference in soluble solids content. The size and soluble solids content were higher in fruits of jointless vines compared to their jointed counterparts. Fruit size and soluble solids increased as the number of leaves between inflorescences increased.

Fehleisen, S. Uniflora and conjunctiflora: two new mutants in tomato.

The two mutants discovered in 'Platense', the principal tomato variety cultivated in Argentina for fresh fruit demand, represent two extreme changes affecting the inflorescence.

Uniflora phenotype: The gene responsible for this character makes one important modification: the side branches of the inflorescence are suppressed and there persists only one axis that ends in only one flower. This flower forms normally and its pollen is fertile;

however, in outdoor cultivation the fruit set is very poor. Uniflora is the name proposed for this mutant and uf the gene designation. The phenotype has a very good expression in outdoor and indoor cultivation.

Inheritance: The F_1 plants had normal phenotype and they were derived from two different crossings; one was the mutant uniflora x purple plant, the latter a recessive mutant which has normal inflorescence, and the other was positional sterile x uniflora. Recessive purple (proposed name) and positional sterile are also derived from a Platense variety.

In Tables 1 and 2 are presented the results obtained in seven F_2 families and three families in backcross.

Table 1

Phenotypic classes in seven F_2 families.

Family	Phenotype		χ^2	P
	+	uf		
65.86[1/]	102	31	0.202	0.50-0.70
65.89	75	18	1.580	0.20-0.30
65.91	82	29	0.750	0.30-0.50
65.93	33	14	0.574	0.30-0.50
65.94	25	9	0.039	0.80-0.90
65.95	23	8	0.010	0.90-0.95
65.96	25	10	0.238	0.50-0.70
Total	365	119	0.044	0.80-0.90

[1/] This family was derived from positional sterile x uniflora.

Table 2

Phenotypic classes of F_1 x uniflora test cross.

Family	Phenotype		χ^2	P
	+	uf		
65.97	10	9	0.052	0.80-0.90
65.98	20	18	0.105	0.70-0.80
65.99	16	12	0.571	0.30-0.50
Total	46	39	0.576	0.30-0.50

The segregations for the alternative normal versus mutant show monohybrid ratios, expected when a single pair of genes are involved; the backcross results also conform to this expectation. The χ^2's for F_2 deviations are not significant (P=0.80-0.90) and the heterogeneity χ^2 also has not a significant probability (P=0.80-0.90). The same holds for the two χ^2 backcrosses.

Conjunctiflora phenotype: In this mutant the inflorescence branching is normal, but the flowers are joined in couples and sometimes in triplets at the end of each pedicel. The twin flowers so formed are not normal because the flower parts are not properly formed at the union. Some anthers are dialytic and twisted and do not form the normal anther tube. When only two flowers are present the ovaries can be identified, but when more than two flowers are joined they form a complex structure that is common to all the flowers. The same is true for styles; calyx and corolla are also malformed at the junction. The fruits are irregular in form as a consequence of the ovary abnormalities and have noticeable scars in the surface from the style deformity. In general, only one fruit is developed from the joined flowers, but sometimes two fruit are formed. The poor fruit set under both indoor and outdoor cultivation is probably due to the improper formation of anther tube and styles.

Inheritance: The F_2 plants analyzed were derived from normal F_1 plants of positional sterile x conjunctiflora mutants. The available phenotypic classification of F_2 population is presented in Table 3.

Table 3

Phenotypic F_2 classes from positional sterile x conjunctiflora cross.

Family	Phenotype		χ^2	P
	+	cjf		
65.103	44	13	0.146	0.70-0.80
65.105	36	10	0.261	0.50-0.70
65.107	78	17	2.557	0.10-0.20
65.109	43	10	1.062	0.30-0.50
65.111	81	29	0.109	0.70-0.80
Total	282	79	1.869	0.10-0.20

The F_2 segregations indicate that one pair of genes is involved in this case also, and the phenotype is recessive. Conjunctiflora* is the name proposed for this mutant and cjf the gene symbol. The χ^2's for deviation and heterogeneity (0.10-0.20 and 0.50-0.70) are not significant.

* This very expressive name was proposed by Dr. C. M. Rick, for whose advice I am very grateful.

Hagemann, R. Somatic conversion at the sulf locus in trisomics, triploids and tetraploids.

Experiments with trisomics have shown that the sulfurea (sulf) locus is in chromosome 2--thus confirming our preliminary results reported in TGC 14:14.

We have used trisomics (triplo-2), triploids and tetraploids to study the effects of different doses of $sulf^+$ and sulf alleles on the frequency of somatic conversion (= somatic allele-induced instability) in sulf heterozygotes.

The following results have been obtained:

trisomics
+ + sulf no variegation, i.e. all plants entirely green
+ sulf sulf high percentage of variegated plants
triploids
+ + sulf no variegation
(+ sulf sulf not studied so far)
tetraploids
+ + + sulf no variegation
+ + sulf sulf low percentage of variegated plants
+ sulf sulf sulf very high percentage of variegated plants

The study of the somatic conversion in trisomics, triploids and tetraploids has thus revealed characteristic dosage effects in the action of the sulf alleles: The frequency of somatic conversion (measured by the percentage of variegated plants) is dependent upon the ratio between the number of sensitive, normal alleles ($sulf^+$) and the number of conversion-active, mutant alleles (sulf) within the heterozygotes. In trisomics and triploids one conversion-active sulf allele--acting against two $sulf^+$ alleles--is not able to induce conversion; whereas two sulf alleles--acting against one normal allele--induce somatic conversion ($sulf^+ \rightarrow$ sulf) in a high percentage of plants. In tetraploids of the simplex type (+ sulf sulf sulf), conversion takes place in a very high percentage of plants; in the duplex type conversion does occur, but rather seldom; in tetraploids of the triplex type conversion has never been found.

Of particular interest is the variegation of plants of the duplex type. In these plants areas of mutant tissue (yellow or yellow-green speckled) occur by mutation (conversion) of the $sulf^+$ alleles of two chromosomes. Studies are in progress to find out whether the mutant areas occur by a one-step event (simultaneous conversion of $sulf^+$ in both chromosomes: + + sulf sulf $\rightarrow$ sulf sulf sulf sulf) or by two independent successive events (+ + sulf sulf $\rightarrow$ + sulf sulf sulf $\rightarrow$ sulf sulf sulf sulf) which would produce a heterogeneity among the progenies of different green branches of variegated plants. The decision of this alternative may have interesting consequences regarding the genetic mechanism which underlies the process of somatic conversion at the sulf locus.

Hernández-Bravo, Guillermo Pseudoallelism at the dwarf locus.

A study of pseudoallelism was conducted between the allelic genes d (dwarf) and d^{cr} (dwarf crispata). The outside marker genes used in the original cross were m, located 2 units distal to the dwarf locus, and aw, located on the opposite side of the dwarf locus at 19 units from it. The F_1 had the genetic constitution m d + aw/++ d^{cr}+. Forty-nine F_1 plants were grown in the field, and F_2 seed was mass-collected. Seedlings were grown and scored under greenhouse conditions. Two separate scorings were made, the first one included 63,497 seedlings among which only one normal plant carrying the outside marker aw was observed. A second scoring was made of 92,933 seedlings, and again only one normal plant was observed with the marker gene aw. All the dwarf mutant seedlings suspected to be the double mutant combination d d^{cr} were saved for further observations. Progeny tests of the two exceptional individuals gave only aw / aw plants segregating for the genes m and d, indicating that the exceptional individuals were of genotype + + aw / m d aw. These results indicate that the + aw individuals came from

a single crossing-over between d and d^{cr}, locating d^{cr} to the right of d with a recombination value of 0.00127% (4/312,860 gametes). Since no plant that could be recognized as the double mutant combination was recovered, gene conversion might explain the results; however, this would also presuppose that d and d^{cr} constitute two separate loci. A reverse mutation might explain the results but this would require both mutation of the allele and crossing-over between an outside marker. A frequency of 0.00127% would also be given to the reverse mutation either from d^{cr} to + or from d to + . Since crossing-over in the intervals d - aw and m - d would be respectively 0.02% and 0.0004% on the probability basis, the reverse mutation event might be 0.02% or 0.0004% as probable as the conventional crossing-over between d and d^{cr}. Although probabilities are that d and d^{cr} constitute two separate loci, pseudoallelism is not fully demonstrated since the double mutant combination has not been recovered.

Hernández-Bravo, G. Two new dwarf mutants and their linkage relations.

Genetic studies were made on two new dwarf mutants provided by Dr. C. M. Rick. One "double dwarf" (dd), appeared spontaneously in the F_2 of the cross between cv Ace and VF36. By far the most extreme dwarf yet encountered, dd is so reduced in stature that the total growth in one year of pot culture in the greenhouse does not amount to more than 6-8 cm. In respect to the usual symptoms of genes of the d complex, dd shows more extreme manifestations: shortened internodes, broad, dark, rugose, brittle leaves, etc. Since it seldom flowers, dd must be transmitted through heterozygotes. The other mutant, "dumpy" (dpy), also of spontaneous origin, arose in the trisomic F_2 of triplo-7 x a diploid stock of mixed origin. The phenotypic resemblance is closest to d^x, especially in respect to leaf characters. Internodes of dpy are considerably longer than those of d^x, roughly approximating those of d^c. The general aspect of dpy with its greatly condensed, downcurled leaves well spaced along the stems is somewhat reminiscent of Cu.

Both dd and dpy are inherited as recessives, the fit to 3:1 being reasonably good for the latter, but the yield of dd homozygotes always falling far below expectation, probably because of lower viability, especially obstetric problems in germination. Linkage relations were studied in F_2 data. The study involved stocks homozygous for dd and dpy which were independently crossed with a homozygous stock carrying the genes aw, d and m located on chromosome 2. The F_2 seed was obtained from individual plants. In the case of the mutant dd, two families were studied.

Linkage data and genetic recombination of the mutant dd and the marker genes m and aw.

Family	Combination	++	+t	m+	mt	Total	Adj.cont. chi-square	Crossover Value (%)
65H262	dd-m	2479	732	395	64	3670	18.01	41.6±0.9
65H495	dd-m	1951	583	146	25	2705	5.99	42.2±1.5
65H262	dd-aw	2417	794	368	91	3670	5.01	46.4±0.9
65H495	dd-aw	1940	594	132	39	2705	0.0092	49.4±1.0

In the family 65H262, linkage was detected between dd and the genes m, aw and d. In the family 65H495, similar results were found, except that dd

did not show any linkage with aw. The combination dd-d was not identified, consequently a direct calculation of this interval was not made. It can also be observed that in the two families tested, the interval dd-m was found to be shorter than the interval dd-aw; therefore, dd should be located to the left of m. Due to the fact that the recombination values between dd and m in both families are practically the same, it can be concluded that the gene dd is located at about 42 units from m on the long arm of chromosome 2.

In regards with the mutant gene dpy, four families were studied.

Linkage data and genetic recombination of the mutant dpy and the marker genes m and aw.

Family	Combination	++	+t	m+	mt	Total	Adj-cont. chi-square	Crossover value (%)
64L1962	dpy-m	232	127	94	1	454	42.10	9.8±3.1
65L38	dpy-m	432	181	194	3	810	64.79	13.3±2.3
65H215	dpy-m	910	286	337	1	1534	95.09	6.8±1.7
65H263	dpy-m	2280	1011	991	22	4304	334.90	15.4±1.0
64L1962	dpy-aw	235	124	94	1(?)	454	40.27	---
65L38	dpy-aw	436	177	197	0	810	71.10	---
65H215	dpy-aw	867	329	338	0	1534	116.73	---
65H263	dpy-aw	2214	1077	1013	0	4304	---	---
64L1962	m-aw	297	32	29	96	454	---	13.8
65L38	m-aw	582	51	44	133	810	---	13.2
65H215	m-aw	1131	74	116	213	1534	---	14.4
65H263	m-aw	2893	334	378	699	4304	---	18.4

In the four families studied, the gene dpy showed to be linked to m, aw and d; however, the recombination between dpy and d is not indicated because the combination dpy-d was not detected. No recombination was observed between dpy and aw in any of the tests for which 7513 plants were scored. These results indicate that the genes dpy and aw are tightly linked. Since the four linkage tests showed that the interval m-dpy is shorter than the interval m-aw, the gene dpy should be located to the left of aw with a calculated upper limit to the recombination fraction of 0.03% for the probability level of 0.01.

Kerr, E. A. Linkage tests in 1966 with unlocated genes.

Only one gene has been assigned to a specific chromosome with a high degree of confidence. F_2 repulsion data for ne-2 and a indicate a distance of about 14 units between these genes. Seed of ne-2 has been sent to W. H. Lachman for more critical study.

Suggestions of linkage were obtained for at-gs, at-e, dp-hp, dp-u, glau-br, mon-r, nc-a, nc-ah, ni-gs and yg-4-ah. Obviously, some of these linkages are fortuitous. Further tests are planned with all of these genes. They are reported here so others working with them may compare information.

at Tomes et al. (TGC 16:39) got a suggestion of linkage with crn on chromosome 6. This may be where at is really located since the suggestions of linkage in chromosomes 4 and 7 are based primarily on a deficiency of the double recessive.

dp The suggested linkage with hp is especially intriguing in view of the negative tests that hp has given with many other genes.

mon The backcross data look promising, but several previous F_2 tests did not suggest linkage.

nc This gene has been around since 1929 and it seems unlikely that linkage with a would remain undetected. The data for ah suggest that somebody goofed in the development of the marker used in the a tests. A notation in 1960 records indicate that a plant mixture was possible, but the other genes in the marker indicate that no mixture occurred.

Gene pair	Chromosome	Phase	++	+ t	m +	mt	co.
at-e	4	R	84	20	37	3	35
at-gs	7	R	87	27	27	3	37
dp-hp	-	R	143	32	37	2	31
dp-u	10	C	176	56	34	15	45
glau-br	1	BC	41	29	16	25	41
mon-r	3	BC	39	35	33	40	46
nc-ah	9	BC	54	33	19	41	35
nc-a	11	BC	64	34	16	35	34
ne-2-a	11	R	165	66	65	1	14
ni-gs	7	BC	41	32	34	42	44
yg-4-ah	9	BC	41	37	34	38	47

Apparently random recombination was obtained in F_2 or BC populations of approximately 150 plants segregating for the following genes.

Mutant	Chromosome testers												
	1	2	3	4	5	6	7	8	9	10	11	12	Unlocated
afr	y	d	r			c sp inc	gs	l gf		u	a f		
at	y	d	wf		mc		pst	gf		u h	a		
cu-2	y	d	wf r		mc	c sp	gs	dl gf		u h	a		
dp		d	wf r		mc	sp	gs	gf		h	a		
glau							pst	al		h	j		
gra		d	r	e	mc			l		h			
hp	y	d	wf		mc	sp	gs	gf		u h	a		
mon	y					c				h			
nc	y		sf wf	e	mc	sp	pst gs	l					
ne-2	y	d	wf		mc	c sp	gs not	l gf		u h			hp
ni	br		wf	e							a		
yg-4			sf wf										

Kerr, E. A. More mutations at old loci. Mutations are so rare that one cannot make direct counts of the frequency of their occurrence. Also, such mutations would often be valuable as isogenic stocks. Unfortunately, when new mutations have been determined to be alleles of old ones, they are usually discarded and forgotten. The following repeat mutations have been identified.

a In 1954 a green stem plant appeared in the variety Red Jacket. Tests with a, ag, and al showed that it was an allele of a.

aw This green-stem appeared in 1964 in a stabilized breeding line of parentage [(Longred x Pritchard) x PI 223306] x Pocomoke. Tests with a, bls, and aw showed that it was an allele of aw.

c Two mutations of this gene have occurred. The first was in a seed production field of the variety Bounty grown in 1955 by Stokes Seeds Ltd. The second was in a stabilized greenhouse breeding line, of parentage V 594 x Vantage, being grown at the Horticultural Research Institute, Vineland, Ontario in the spring crop 1966.

pst Dr. R. Frankel sent me a mutant in 1965 under the designation "pomodore". This had been induced by neutron irradiation. The fruits were more nearly spherical than most pst lines but the beaked appearance, persistent style and tough pericarp resembled pst. F_1 plants from a cross with a pst breeding line were definitely pst.

y A pink-fruited mutation occurred in a commercial field of the variety Red Jacket in 1953. Subsequent tests showed that it was y.

Kerr, E. A. Position of oli on chromosome 10.

Hansen et al. (TGC 12:28-29) reported that olivacea was 14 units from h. Tests with several other genes on chromosome 10 have confirmed this and suggest that it is about half way between u and h. Further tests will be carried out using backcross material.

Gene pair	Phase	++	+ tester	oli +	oli tester	co.
oli-ag	R	170	52	52	15	49
oli-t	R	170	51	60	7	37
oli-l-2	R	171	50	53	7	39
oli-h	R	305	138	135	7	22
oli-u	R	316	126	105	7	26
oli-lg	R	159	63	42	26	56
oli-pe	R	160	62	40	25	57
h-u	C	348	63	73	70	28

Kerr, E. A. The occurrence of more than 50% crossovers.

Theoretically and traditionally there are not more than 50% crossovers between two genes. If excess crossing over occurs, it is attributed to chance segregation. Probably this is usually the explanation. However, such excess crossing over appears to have occurred in backcross and F_2 generations too frequently to be attributable to chance alone. In another note in this report oli-lg and oli-pe gave 56 and 57% crossovers, respectively. In unreported backcross tests in 1965, I obtained the following segregations: 64 ++, 84 + a, 79 gr +, 69 gr a and 29 ++, 55 + r, 40 speckled fruit +, 25 speckled fruit r. This indicates 55 and 64% crossovers, respectively.

I have been wondering if these data indicate that the genes are on opposite arms of a chromosome. This hypothesis is supported by fragmentary data on ae which has been located on chromosome 8. Burdick (TGC 9:21) reported 59% co between ae and l. Robinson and Mishanec (TGC 16:13) reported ae and dl to be

in the other two families, atv x aw (*) and ag x ah (**), are probably attributable to random deviation in the sample of 30 families.

Only two cases of mutant interaction were observed. The ag al seedlings had splotches on the lower surface of the first leaf--a feature that is not characteristic of either mutant by itself. On the other hand, ai al combinations showed the speckled nature of al in the upper region of hypocotyls superimposed on the masked anthocyanin typical of ai. Since both crosses gave 9:3:3:1 ratios, it is likely that ai, whose linkage group is not known, is probably not linked with al.

Background of mutant stocks studied.

	Gene symbol	Chromosome	Dominance	Stock		Mode of origin	Present background
				Source[a]	Number		
Anthocyanin absent	ae		rec.	3	62-222-n	X-ray	Kokomo
	af		"	3	63-381-n	X-ray	Red Cherry
	ag^2	10	"	2	LA177	spontaneous	hybrid
	ah	9	"	2	LA352	spontaneous	Pearson
	aw	2	"	2	LA271	spontaneous	hybrid
	aw^2	2	"	4	707-1αα	X-ray	Moneymaker
	bls	3	"	2	LA1004	spontaneous	Minibelle
Anthocyanin reduced	a[b]	11	rec.	2	LA159	spontaneous	hybrid
	ai		"	1	^{a}342	X-ray	Kokomo
	ai^2		"	1	^{a}340	unknown	unknown
	al	8	"	2	LA533	spontaneous	Condine Red
Anthocyanin normal	+		dom.	2	LA490		VF-36
Anthocyanin increased	ag_3	10	rec.	2	LA177	spontaneous	hybrid
	ag^3	10	"	4	704-27αα	X-ray	Moneymaker
	ag^4	10	"	4	705-70ββ	X-ray	Moneymaker
	atv		"	2	LA797	spontaneous	hybrid
	hp		"	2	LA279	spontaneous	Webb Special
	Pn	8	dom.	2	LA812	spontaneous	hybrid

[a] 1, A. B. Burdick; 2, C. M. Rick; 3, R. W. Robinson; 4, K. Verkerk.

[b] Produces an abnormal anthocyanin in the hypocotyls under low temperatures.

Fig. 1. Phenotypes of F_1 from crosses between anthocyanin mutants of tomato.

+ = wild type
No symbol = cross not made

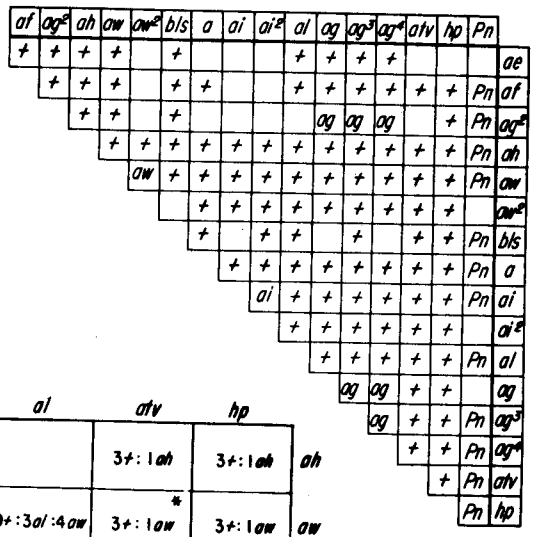
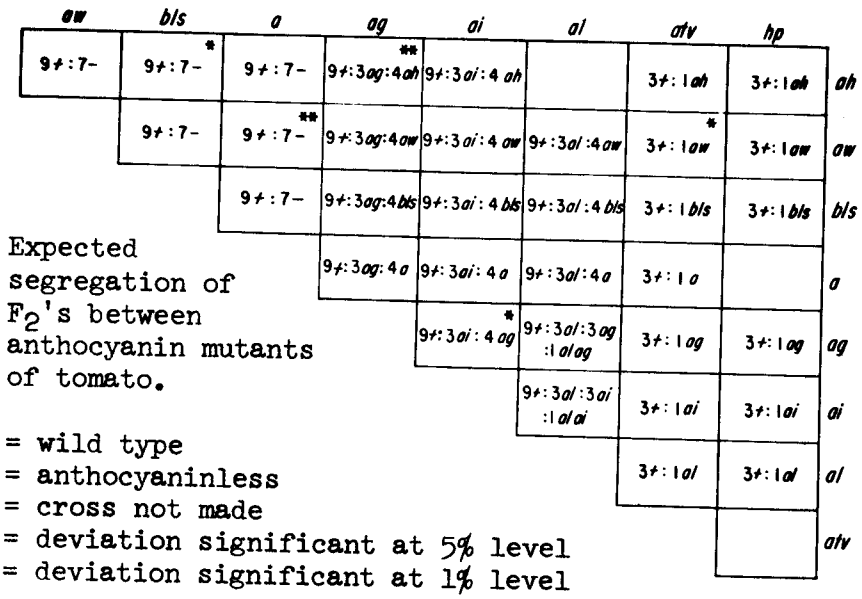


Fig. 2. Expected segregation of F_2's between anthocyanin mutants of tomato.



- = anthocyaninless
No ratio = cross not made
* = deviation significant at 5% level
** = deviation significant at 1% level

Lesley, J. W., Margaret Lesley, and R. K. Soost A dominant mutant resembling Young's Curl, (Cu), obtained from a triploid Woolly.

In the F_1 from crossing a triploid Woolly having crinkled leaves (TGC 16: 16-17) with diploids, a mutant type appeared with crinkled leaves, similar to Curl (Cu) described by P. A. Young (J. Hered. 46:243-244, 1955). For the present, the name Crinkled, symbol Crk, will be used for the mutant, pending a test of allelism with Curly. A comparison of Young's Curly with Crinkled is presented here:

	Cotyledons	Leaves	Leaflets
Young's Curly	nearly normal	curled, rosettes	very small, entire
Crinkled	dark with pale midrib	curled, less rosette-like	small, not entire

	F_2	Fruit	Growth	Flowers	Dominance
Young's Curly	3 : 1	striped	slow	many sterile	complete
Crinkled	2 : 1 or 3 : 1	not striped	slow	few sterile	complete

	Branching	Homozygote
Young's Curly	late, weak	viable
Crinkled	basal	probably lethal

It should be noted that Curly originated as a somatic mutation in a different variety. If not identical, Cu and Crk may be different alleles at the same locus.

The fruits of the triploid Woolly crossed with various diploids contained from 0 to 5 viable seeds. Diploids and trisomics both Crinkled (Crk) and non Crinkled (+) occurred, but with no intermediates, as follows:

			Diploid				Trisomic			
			Crk		+		Crk		+	
			Wo	+	Wo	+	Wo	+	Wo	+
Wo Crk 3n	x	+ + 2n	2	0	1	3	1	0	1	9

Three small F_2 or F_3 families from diploid Crinkled selfed gave the following progenies:

Parent					Progeny	
					Crk	+
65	0.58.5	Crk	Wo	2n	29	18
65	098.3	Crk	Wo	2n	11	9
66	047.8	Crk	Wo	2n	29	8

The combined ratio 69 : 35 is nearer 2 : 1 than 3 : 1, but the heterogeneity is significant ($p < 0.01$). Two outcrosses of diploid Crinkled x diploid non Crinkled contained 75 Crinkled and 81 non Crinkled. Two diploids and one trisomic non Crinkled F_1 selfed gave 99 non Crinkled. Evidently Crinkled is dominant and may be lethal when homozygous.

The original Woolly triploid parent contained a single dose of the dominant Crinkled and of Woolly since some of the trisomics were non Crinkled and some were non Woolly. The 2n gamete required to produce a triploid probably originated in the diploid Wo parent and contained not more than a single dose of Crk. The presence of Crk$^+$ Wo plants in F_1 indicates that Wo and Crk are not at the same locus.

Segregation of Crinkled and Woolly occurred in two small F_2 families as follows:

Parent		Crk Wo	+ Wo	Crk +	++
65	.058.5	22	10	7	7
65	.098.3	7	6	5	2

Recombination occurred between Crk and Wo. The combined ratio is nearer the 4 : 2 : 2 : 1 expected if both Crk and Wo are homozygous lethal ($\chi^2 = 0.9$) than the 6 : 2 : 3 : 1 ratio if Crk is homozygous viable ($\chi^2 = 2.8$). The heterogeneity with 4 : 2 : 2 : 1 ratio is non-significant.

Apparently Wo, in chromosome 2, and Crk are not closely linked. An F_2 segregating for Crk and u (uniform green fruit color) gave:

Family		Crk +	Crk u	++	+ u
65	.058.5	16	10	12	4

Close linkage between Crk and u in the long chromosome 10 is not likely, especially as Crk and u are in repulsion (trans) so that with linkage an excess of Crk + is expected.

Martin, F. W. A scheme for the development of cytoplasmic male-sterility in the tomato.

The possibility of utilizing cytoplasmic male-sterility in the tomato as a tool in the utilization of heterosis and the production of hybrid seed continues to hold interest among investigators. A search for genic-cytoplasmic interactions involving the genome of L. esculentum and three cytoplasmic donors was reported last year in these notes. That search continues, although progress is slow due to the failure of the bridge species, L. hirsutum, to bloom during most of the year. A second route to male-sterility could possibly be utilized, as suggested by Andersen's finding cytoplasmic male-sterility in the cross L. esculentum x Solanum pennellii (TGC 13).

No one needs a male-sterile S. pennellii. But depending on the complexity of control of sterility in the above cross, it should be possible to transfer all the controlling elements to an L. esculentum system by a controlled series of crosses. The steps to develop such a system are suggested as follows:

Scheme for developing cytoplasmic male-sterility from L. esculentum x S. pennellii*

Derivation of genetic male-sterile line (ms ms E, L. esculentum)

1. L. esculentum (Ms Ms E) x S. pennellii (ms ms P).
2. L. esculentum (Ms Ms E) x hybrid (Ms ms E).
3. Self pollinate all (Ms Ms E, Ms ms E).
4. Select sterile plants in F_2 (ms ms E).
5. Genetic male-sterile (ms ms E) x L. esculentum (Ms Ms E).
6. Continue with one blind backcross, production of F_2's, selection, etc.

Derivation of maintainer line (ms ms P)

1. Develop by backcrossing L. esculentum donors of S. pennellii cytoplasm (Ms Ms P, L. esculentum).
2. Transfer desired genotype to S. pennellii cytoplasm (Ms Ms P x Ms Ms E).
3. Transfer ms to maintainer line (Ms Ms P x Ms ms E).
   Other maintainer lines (ms ms P) can be used as male, once available.
4. Self pollinate progeny (Ms Ms P, Ms ms P).
5. Test cross to find maintainer (ms ms E x ms ms P).
6. Multiply maintainer line (ms ms P) by self-pollination.

Restorer line. Any L. esculentum variety (Ms Ms E).

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* Notes: Females always appear at left. Genes are designated by underlined letters, and cytoplasm by E (esculentum) and P (pennellii). All steps proceed on the assumption that male-sterility is caused by an interaction of 1 or 2 pairs of recessive genes from S. pennellii with cytoplasm of L. esculentum.

Genic-cytoplasmic interaction. If the sterility of L. esculentum x S. pennellii is determined by a small number of recessive genes from S. pennellii interacting with cytoplasm of L. esculentum, after one or two backcrosses of L. esculentum x hybrid, it should be possible to self-pollinate, produce F_2's, and select sterile plants with L. esculentum cytoplasm and with male-sterility genes from S. pennellii. The male-sterility would be genic in inheritance and not unlike genetic male-sterility now found in the tomato. It could be transferred to any variety by conventional back-crossing.

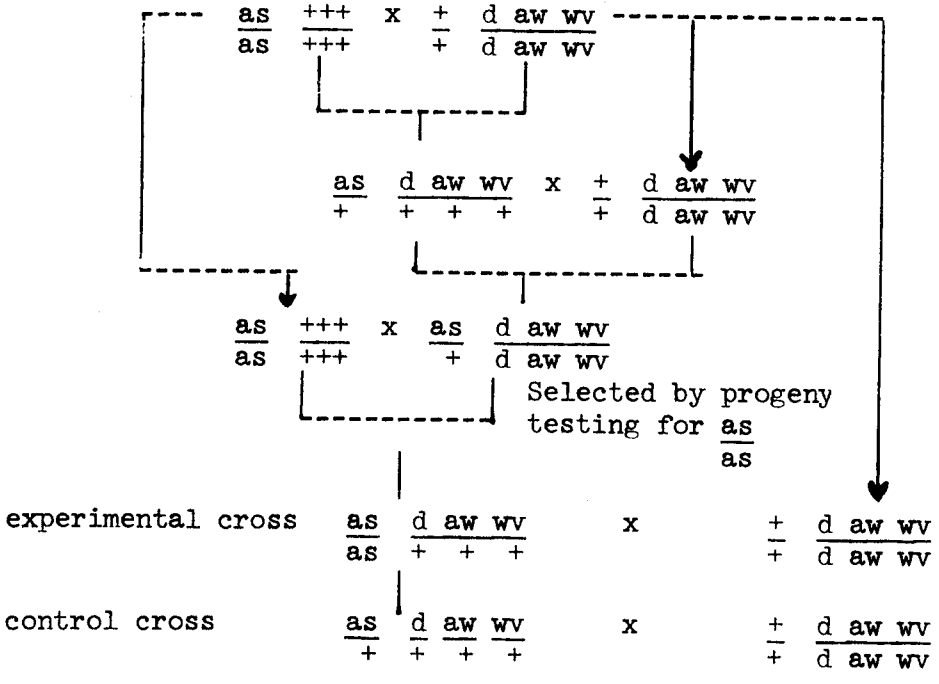
Maintenance of 100 per cent sterile lines. Presumably the genes interacting with Lycopersicon cytoplasm would not interact with cytoplasm of S. pennellii. Thus, fertile siblings of the backcrossing series described above could be crossed as males to a stock donating S. pennellii cytoplasm. Such stocks are now being developed. Several crosses with heterozygotes for male-sterility would yield fertile homozygotes carrying the recessive Ms genes. These would be plants identical in genotype with male-sterile L. esculentum, but not male-sterile, because of the presence of S. pennellii cytoplasm. Such lines could be maintained by self-pollination and used as parents to maintain a corresponding 100 per cent sterile line. The phenotype used to identify such plants would be the ability to produce 100 per cent male-sterile offspring in crosses to the genetic male-sterile type.

Fertility restoration. Any fertile variety in L. esculentum cytoplasm would not be carrying S. pennellii sterility genes and could be used as a fertility restoring line. All F_1 progeny would be fertile.

A visionary scheme? Perhaps, but we hope to carry the various crosses far enough to determine whether the scheme is possible.

Moens, Peter B. The effect of asynaptic genes on linkage.

From four asynaptics, as, as-2, as-5 and as-6, from Bounty, provided by Dr. Soost, heterozygotes for three genes of chromosome 2 were produced as follows:



The experiment is not completed, but the results so far are:

For $\frac{as}{as}$ $\frac{d\ aw\ wv}{+\ +\ +}$ x $\frac{+}{+}$ $\frac{d\ aw\ wv}{d\ aw\ wv}$

+ + +	135	+ aw wv	16	+ + wv	38	+ aw +	4
d aw wv	124	d + +	18	d aw +	36	d + wv	3

Genetic distance d - aw = 11, aw - wv = 22.

Control has not been completed. This asynaptic does set fruit with a fairly good number of seeds--about thirty per fruit.

For $\frac{as\text{-}4}{+}$ $\frac{d\ aw\ wv}{+\ +\ +}$ x $\frac{d\ aw\ wv}{d\ aw\ wv}$

+ + +	167	+ aw wv	11	+ + wv	21	+ aw +	5
d aw wv	181	d + +	20	d aw +	30	d + wv	1

(average seeds per oval fruit 43)

d - aw = 8.5, aw wv = 13.

In the experimental cross $\frac{as\text{-}4}{as\text{-}4}$, the following results were obtained:

+ + +	18	+ aw wv	5	+ + wv	3	+ aw +	8
d aw wv	10	d + +	4	d aw +	11	d + wv	2

(average seeds per fruit 2)

d - aw = 32 ± 6 !

d - wv = 37 ± 6 !

Experimental and control crosses are now being made with as-6, but I have given up as-5. For each asynaptic the behavior of chromosome 2 is studied at meiosis. The extraordinary values for as-4 will be checked by repeating the experiment. If the different cross-over values are found to be real, conclusions may be possible regarding the connection between cytological pairing behavior and genetic exchange.

Moens, Peter B. The fine structure of pachytene chromosomes in the tomato.

In previous reports (TGC 15 and Chromosoma 15) it was shown that early meiotic prophase chromosomes are in the paired condition, and it was suggested that pairing and crossing-over may occur prior to or during interphase. Similar conditions have been suggested in other organisms, most recently in female Drosophila melonogaster by R. Grell using simultaneous heat treatment and radioactive labelling of chromosomes (PNAS, 1965).

One of the arguments against the above scheme is that only at pachytene appears the structure in the nuclei of germ cells referred to as the synaptinemal complex which has been associated with pairing of homologous chromosomes and crossing over by Moses, Meyer and others. Pachytene then would remain as the time of crossing over.

To test the assumption that complexes and crossing over are related, electron microscope studies of diploid and haploid pollen mother cells were

undertaken. In the haploid, no legitimate bivalents can be formed and, in the absence of crossing over, no complexes were expected. Complexes were found to occur regularly in the haploid, but less frequently than in the diploid. These findings tend to support the suggestion that complexes and crossing over are not necessarily related. (Some reports in the literature tend also in this direction). However, several alternative explanations must be considered before any definite conclusions can be made. The recent work by Hotta et al. (PNAS 56:1184, 1966) with Lilium, favors pachytene as the time of crossing over. Conversely, the work by Sueoka et al. (J. Mol. Biol., in press) with Chlamydomonas, suggests that synapsis and crossing over occur prior to DNA replication.

The E.M. work on the tomato p.m.c. indicates that the material is extremely favorable for fine structure studies of meiotic chromosomes, not in the least because meiotic stages in the tomato are better defined (!) than in some other organisms. It is also possible to identify chromosome #2, its satellites, nucleolar attachment, the centromere, heterochromatin and euchromatin on electron micrographs. The haploid cells have a wealth of detail that needs to be compared with that of the diploid. The synaptinemal complexes have been identified recently in both the diploid and haploid tomato by Margaret Menzel (Amer. J. Bot., in press).

Mohanakumaran, N., J. C. Gilbert, and R. L. Young Bacterial wilt resistant tomato lines with unusually high content of the alkaloid, tomatin.

The tomatin content of a bacterial wilt selection (Hawaii 5808-2) derived from L. pimpinellifolium PI 127805A was found to be much higher than B.W. susceptible tomatoes. Wilt resistant selections in the breeding program derived from crosses to commercial type B.W. susceptible varieties were also found to have much higher tomatin levels than their B.W. susceptible parent. After infection with the bacteria, Pseudomonas solanacearum, the concentration of tomatin in the resistant lines increased to still higher levels--over 1000 ppm in most cases. Following inoculation of the susceptible lines, tomatin decreased from 250 ppm to 40 to 60 ppm. This was followed by the death of such plants.

In vitro studies with virulent isolates of the bacteria showed that levels of 350 ppm of tomatin effectively inhibited growth of this pathogen. The high tomatin content (400-800 ppm) of bacterial wilt resistant tomatoes was found in both the roots and the shoots.

In one line, derived in part from North Carolina material, the high tomatin content also occurred in ripe fruits, imparting a bitter flavor to them. This appeared to result from failure of enzyme action which normally prevents retention of noticeable tomatin concentration in ripening fruit. Sister lines of this selection (Hawaii 7284) had similar resistance to bacterial wilt and similar high tomatin levels in roots and shoots but did not have the high tomatin content (280 ppm) in the fruit and were free of the bitter flavor of HES 7284. We assume that this bitter flavor in HES 7284 is the same as that reported by Borchers and Nevin from North Carolina in their line, T414 (Proc. Amer. Soc. Hort. Sci. 63:420-426, 1954).

Although the genetics of this variation in tomatin content of roots and shoots of tomatoes and their reaction in this respect to infection with bacterial wilt has not been worked out in detail, we did find an apparent association between the indeterminate plant habit (sp+) and resistance to bacterial wilt (Acosta and Gilbert, TGC 14).

Pecaut, P., and H. Laterrot

Gene Tm : Tests of allelism.

The same expression of tolerance to TMV is shown by 3 different sources of resistant lines which have been studied at the Station d'Amélioration des Plantes Maraichères, Montfavet, France.

a) Holmes, F.O. P.I. 235.673 Line used: 2940-D, received in 1960.
b) Kikuta and Frazier Line used: Hawaii Experiment Station No. 5639-15, received in 1955.
c) Walter, J. M. Line used: 56.6.1.1.BK.BK.ACEMStW, received in 1961.

The gene of tolerance of Holmes P.I. 235.673 has been named Tm. The hypothesis has been formulated that these 3 sources are carrying this same gene Tm. The following results prove the allelism of the 3 factors of tolerance.

Segregation tests are made by inoculating the cotyledons of the 12-days-old seedlings with an aucuba strain of T.M.V. A clear-cut response is read 11 days after the inoculation.

1) Holmes 2940-D x Frazier H.E.S. 5639-15

	Number of seedlings		
	Total	Succeptible	Tolerant
F_2 H.E.S. 5639-15 x 2940-D	539	0	539
(F_1 H.E.S. 5639-15 x 2940-D) x Saint Pierre	566	0	566
H.E.S. 5639-15	86	0	86
F_1 H.E.S. 5639-15 x Saint Pierre	73	0	73
2940-D	401	0	401
Saint Pierre	82	82	0

2) Frazier H.E.S. 5639-15 x Walter 56.6.1.1.BK.BK.ACEMStW

	Number of seedlings		
	Total	Succeptible	Tolerant
F_2 H.E.S. 5639-15 x ACEMStW	275	0	275
H.E.S. 5639-15	44	0	44
F_1 H.E.S. 5639-15 x Saint Pierre	47	0	47
ACEMStW	22	0	22
Saint Pierre	47	47	0

Considering these tests of allelism and regarding the fact that the 3 sources give the same reaction to T.M.V., we can say that these 3 sources possess the same allele Tm.

Reeves, A. F., G. Hernández-Bravo, R. W. Zobel, and C. M. Rick

Additional linkage tests with mutants of Stubbe's series.

In this continuation of our linkage tests, five new relationships have been established, four with hitherto unlocated genes and a reassessment of the position of Cri. The methods followed were the same as those reported previously in this series. In the first of the following tables, linkages are signified by "L"; variable, usually non-significant deviations suggesting linkage by "S"; and apparent random recombination by "X". Data are given in the second table only for segregations that deviated significantly from random recombination; data for other segregations are available on request.

Considering the locations in order of chromosome number, that of Cri is considered first because it deals with chromosome 1. Our previous report on this gene (TGC 15:24) indicated significant associations with chromosomes 1 and 3, the evidence then favoring 3 over 1, but with disturbing contradictions. Our recent data reported below point consistently to chromosome 1. The tests with ru and bls, established markers on 3, were convincingly negative, while those with inv on 1 deviate in all respects expected with linkage. The tests with scf show near independence; if a linkage exists, it must be weak. In reviewing all tests with Cri, the following generalizations seem justified. Deviations from random recombination have been encountered between Cri and many markers (on several chromosomes), most of which are chlorotic mutants. Interactions that might affect phenotypic classification seem to explain most of these deviations. Segregation of the tester genes among the non-Cri fractions therefore seems more reliable. When this criterion is applied to the significant deviations, they either do not suggest linkage or show much less of an excess over the expected 25% tester homozygotes than au, inv and pr do. As mentioned in the preceding report, the problem with a locus on 1 centers on the contradiction between tests with au and y, which are known to be tightly linked. On reviewing the data for the y test, we find that Cri segregants were separated from + in the seedling stage before transplanting to the field,because the classification cannot be made so readily in the field. While we have no reason for doubting the accuracy of this separation, such management does provide more opportunities for errors in labelling, identifications at transplanting, etc.

The assignment of spl to chromosome 4 seems reasonably good, but the data do not afford speculation as to a locus. A somewhat tighter linkage with e than with ful suggests that spl might be distal to e, but the joint classification of ful and spl is difficult because both are chlorotic. Since the tester combination ful-e was used, the ful-e but not ful-+ segregants suffered the same drawback. Further testing with the many excellent markers of 4 should clarify this situation.

The three separate tests of res vs ag-h leave little room to doubt that res belongs in the middle of the trio, the more trustworthy data of the second and third sets averaging: ag - 15 - res - 21.5 - h. The fact that no triple recessive individuals were recovered also supports this conclusion. Results of the same general nature suggest that the relations of hi on 9 are: ah - 22 - hi - 22 - marm.

The new marker for chromosome 11, uni, shows highly significant linkages with a and hl but, though it cannot lie between them, the data do not discriminate between a locus on the short or long arm.

Seeds of the mutants and pertinent hybrids have been sent to the respective linkage cooperators.

Linkage data for significant tests.

Combination	+ +	+ t	m +	m t	Adj. cont. chi-square	Co.
uni-a	109	50	53	4	12.1	26.0
uni-hl	108	51	51	5	10.3	28.0
Cri-scf	60	25	89	20	2.7	45.0
	145	58	179	50	2.3	46.0
Cri-inv	47	38	102	7	35.1	32.5
	110	93	198	31	53.2	32.0
res-ag	187	74	37	3	68.7	29.0
	98	39	52	1	14.7	15.0
	87	47	38	1	14.3	15.0

Combination	+ +	+ t	m +	m t	Adj. cont. chi-square	Co.
res-h	191	70	38	2	81.4	25.0
	101	38	49	2	10.9	22.0
	86	48	37	2	12.4	21.0
	no ag-res-h recombs.					
spl-ful	288	73	96	21	n.s.	48.0
	306	132	97	33	n.s.	46.5
spl-e	275	86	101	15	5.6	40.5
	295	147	108	18	16.2	35.0
hi-ah	269	118	72	3	21.0	22.0
hi-marm	301	86	73	2	14.0	22.0
	no ah-hi-marm recombs.					

Summary of linkage tests.

Chsm.	Tester	Stubbe I	Stubbe III	Stubbe IV		Stubbe V
		uni	Cri	res	spl	hi
1	au	X			X	
	per					X
	scf		S			
	inv		L			
2	Wo^m	X			X	X
	d	X			X	X
3	bls		X			
	ru		X			
	sy			X	X	X
	sf			X	X	S
4	ful	X		X	S	
	e	X		X	L	X
5	tf	X			X	X
6	c	X		X	X	X
	yv	X		X	X	
7	lg-5			X	X	
	La			X	X	
	um					X
	rot					X
8	dl	X		X	X	X
	l	X		X	X	X
9	ah	X		S	X	L
	marm	X				L
10	ag	X		L	X	X
	h	X		L	X	X
11	a	L		X	X	X
	hl	L		X	X	X

Rick, C. M. Male-sterile mutants in var. VF36. Over the past 8 years var. VF36 has proved to be the best available normal or standard tomato for our purposes at Davis. Its resistance to both verticillium and fusarium wilts as well as its sp plant habit are essential for culture here. Also important for our purposes is its excellent yield of seed from spontaneous selfing in the field and greenhouse. Having thus adopted VF36, we soon needed

satisfactory male-sterile mutants in this variety, and they were sought in the usual fashion. From a group of unfruitful plants found in fields of VF36 at harvest time, three yielded male steriles in later generations. Having been distracted by other activities, we have not studied these sufficiently to be certain that they are not allelic or to give a complete report on their phenotype, development, and other features, but, since seeds have already been distributed in reply to requests from several correspondents, it is necessary to symbolize them and present the following summary of information available for them.

ms-38 (2-539) Flowers small; anthers of paler color, approximately matching that of the corolla; no pollen detected macroscopically; stigma submerged. All 7 plants reared from seeds found in the single fruit set by the original plant were fertile and their progeny yielded segregating F_2's. Each of the five small F_2's grown segregated for the original ms type, the pooled segregation being 163+ : 61 ms with no significant deviation from 3:1 and no indication of heterogeneity.

ms-39 (2-549) Flowers possibly more fasciated than normal; stamens pale, slender, with no pollen that can be detected macroscopically; stigma variably exposed; plant tends to be somewhat chlorotic and weak. All 7 plants grown from seed set by the original plant were fertile and heterozygous, as revealed by the segregation in all their progeny. Five small F_2's totalled 204+ : 48 ms, the deviation of steriles below 25% being significant at the 5% level ($\chi^2 = 4.73$). No evidence of heterogeneity.

ms-40 (2-553) Male sterility appeared as a secondary variant in part of the F_2 progenies of this mutant. The original unfruitful plant was notable, particularly for its chartreuse corolla, a character that has never been recovered in the progeny of any generation. The male-sterile phenotype has been consistently expressed as a slight reduction in size and color intensity of the stamen, no pollen being detected macroscopically. Stigmas are submerged.

Eight F_2 families totalled 298 + : 96 ms, and four backcross families, 91 + : 93 ms, no evidence of heterogeneity or deviation from expected ratios existing in either set. Marker genes for chromosomes 2, 6, 8, and 11 also segregated in some of the small F_2 families with no suggestions of linkage with ms-40.

Rick, C. M., G. S. Khush, and A. Andrasfalvy

Flecked dwarf, a marker for 12L.

This mutant was found by Mr. G. Asztalos in I_2 of cv. Budai Korai following treatment of seeds with gamma rays from a Cobalt-60 source. In all stages of growth it is highly retarded, at the end of the season in the field not exceeding a height or spread of 25 cm. In all leaves, particularly those of the seedling, flecks of uniformly light green appear. Mature leaves are smaller, stiffer, and somewhat less dissected than normal. Flowers do not completely unfurl but otherwise appear normal. In the field at Davis, flecked dwarf will self spontaneously, each plant producing a few seedy fruits.

From various crosses with flecked dwarf, all F_1's have had normal phenotype. In more than 10 F_2's of different combinations, it has segregated out clearly with the phenotype summarized above. The sum of six families is 1,000 + : 139 (12.2%) flecked dwarf. The χ^2 for heterogeneity (8.8, 5 df) is not significant, and only one family differs significantly from the mean ($\chi^2 = 5.0^*$). The strong departure from 25% is highly significant, but thus consistent in the material tested thus far. The action of a single major gene (fd) therefore seems indicated, but with a greatly reduced yield of mutant homozygotes. The reasons for this deficiency are not known, but the situation is common to several mutants like rv.

Linkage tests have been completed against the following genes with no indication of non-random association: au (1); d, Wo^m (2); sy, sf (3); ful, e (4); tf (5); La, lg-5 (7); l, dl (8); ah (9); a, hl (11). A test was made against triplo-6 with negative results, but another with triplo-12 yielded the following F_2: 92 2N+, 2 2Nfd, 7 triplo-9+, 0 triplo-9fd. Deviations from 3:1 and the 88:12 ratio observed in diploid lines are both highly significant (χ^2 = 28.1***, 10.1**, respectively).

Two deficiencies induced for fd leave no doubt that its locus is on chromosome 12. One was a tertiary monosomic for 2S-12L, the other a simple terminal deficiency in which 12L was broken at the juncture of the eu- and heterochromatin. The growing list of tomato mutants has thus been augmented by a very useful mutant, for fd, an easily recognized seedling mutant, lies in a hitherto unmarked region of the tomato genome.

Rüdenberg, Lily A somatically unstable aneuploid tomato.

Since culture with nutrients deficient in calcium had induced chromosome breaks in pollen mother cells at meiosis, the selfed F_1 progeny of these treated Marglobe tomatoes were grown in the greenhouse. Among 140 normal plants, one aberrant seedling was found. The present report describes this plant.

After slow germination and slow growth of poorly developed first leaves, the older leaves now are irregularly shaped and much dissected. Some segments are convex, others are twisted and curled with irregular margins. The plant has a typical grayish-green color resembling the lower side of control leaves, with the exception of some small darker green sectors of the upper leaf surfaces. At the border of light and dark sectors, larger trichomes are conspicuous, and it is evident that all pale green leaves are more hairy and have longer trichomes than the controls, while the darker sectors are less hairy.

Because of its abnormal morphology, the plant was tested for virus infection by inoculations of controls and by a touch-graft. These tests proved negative. However, mitotic chromosome counts of root tip cells revealed that the plant is an aneuploid with 26 chromosomes.

The plant branches freely and with time has reached normal height. The branches have two distinct phenotypes. Cuttings of both types were rooted. Type I resembles the main stem with distorted variegated leaves and aborting closed flower buds. Type II has the lighter green leaves of larger dimensions, less dissected and sometimes with lobed margins. The flower buds of type II, which are often lopsided, abort at different stages; they seldom open. However, a few have flowered. The sepals are longer than the petals and the stigmas are exserted. The greatest variation is shown by the relative dimensions of the anthers and the presence or development of p.m.c.'s. Artificial pollination of older buds with pollen of controls was not successful.

Preliminary cytological studies of p.m.c.'s at diakinesis of a bud of a type II plant showed in some cells one trivalent of a chromosome not yet identified, and in most of the cells a chromatic chromosome section attached to the nucleolus and connected by a thin thread to the free end of one short arm of the nucleolar pair. Some cells from another plant of the same type II show at pachytene a double chromatic fragment attached to the chromatic section of chromosome 2. In addition, a translocation seems to be involved. Cells at diakinesis of the same anther carry this fragment either attached to the nucleolar pair or lying free as a relatively long chromatic piece.

It is assumed that the somatic instability of this plant may be explained by the presence or loss of fragments.

Cuttings of this plant are available for investigation.

(The helpful advice of Dr. C. M. Rick is gratefully acknowledged.)

Rüdenberg, Lily Maintenance of phenotypic instability of cuttings from a mutated tomato plant.

The aneuploid tomato plant described in the previous report has been studied further during 1966. Many more cuttings of axillary shoots of the original mutation and of clones derived from it were rooted. These represent the two phenotypes mentioned.

All plants of type I have irregularly shaped leaves with upper leaf surfaces consisting of clearly two different tissues, one of them grayish like all the leaves of type II plants and the other much darker green and less pubescent. The distribution of these two leaf tissues also is very irregular, so that in some plants of this clone the light grayish green predominates, in others the dark green. The irregularity of growth and form and also of sectoring has been maintained through the year. All type I clones at first were not fruitful, most of the flower buds aborted at an early stage. At present a few branches of these plants are bearing fruit on axillary shoots which phenotypically approach the normal "Marglobe."

It was possible to count the chromosomes of some of these rooted cuttings and also of meristematic cells of the shoot apices. The roots had some cells with 26 chromosomes and some with 24 in the same root tip. In shoot tissue one area had 26 and an adjacent one had 22 chromosomes. Since all these plants are relatively slow growing, cell divisions were rarely found in shoots and young leaves.

Additional plants of phenotype II with grayish green leaves were also propagated by cuttings from the original mutation. At first they all had aborted buds, then, later in the season, flowers with aborted stamens and exserted stigmas. During the course of the year these plants have gradually developed more normal looking flowers with better developed anthers and less exserted stigmas. One plant which was conspicuous because of a very distorted growth pattern, and which had only grayish leaves, phenotypically like type II, now has developed an extensive branch system and has constantly borne fruits in the greenhouse for many months.

It is assumed that these and other fruitful branches may have reverted to normal. Further cytological studies of meiosis and mitosis of these plants are in progress.

The puzzling feature of this mutation and its clones is the variability of the expression of aberrant characters within each of the two phenotypes observed.

Schroeder, W. T., R. Provvidenti, and R. W. Robinson Incubation temperature and virus strains important in evaluating tomato genotypes for tobacco mosaic virus reactions.

Temperature, especially that during the incubation period, markedly influenced the symptom expression in tomato plants of different genotypes when inoculated with two different strains of tobacco mosaic virus. The principal genotypes studied were Tm-2 and Tm-2^2 (designation for Alexander's selection from P.I. 128650). Two strains of the virus were used as inoculants, the normal strain, designated TMV, and an aberrant strain, designated (TMV). The latter differs from TMV in producing a brighter mosaic pattern, especially on plants of the susceptible genotype, and in possessing other infectious properties, among them a similarity to Alexander's strain IV. It was derived from some isolates of tobacco mosaic virus by special selection methods. In most instances, inoculations were made once on the cotyledons and the first true leaf with either a glass spatula or cotton swab. A second inoculation was made in some experiments on the stem and

the second true leaf when it became fully expanded. Inoculated plants were incubated in temperature-controlled climate chambers that emitted a light intensity of 2300-2800 foot candles at the cotyledonary level for 14 hours each day. All symptomless plants were subjected to a virus-recovery test, using Chenopodium quinoa, a local lesion host more sensitive to TMV and (TMV) than Nicotiana glutinosa.

The interactions among genotypes, virus strains, and temperatures with respect to symptoms are summarized in Table 1. Recovery tests revealed that all symptomless plants were infected with their respective inoculants.

Tm-2/Tm-2 plants appeared symptomless with TMV at 15, 25, 30, 35, and 40 C; whereas, $Tm\text{-}2^2/Tm\text{-}2^2$ developed necrosis with the same virus strain at 35 and 40 C. F_1 plants of the cross between these two genotypes reacted similarly to Tm-2/Tm-2, particularly at temperatures above 30 C.

Plants of Tm-2/Tm-2 developed a stunting and mosaic with (TMV) at all temperatures studied; whereas, plants of $Tm\text{-}2^2/Tm\text{-}2^2$ were symptomless, except for necrosis that developed in plants incubated above 35 C. F_1 plants of Tm-2 x $Tm\text{-}2^2$ reacted essentially as $Tm\text{-}2^2/Tm\text{-}2^2$.

Inoculation of $Tm\text{-}2^2/+$ plants with TMV and their subsequent maintenance under different temperature regimes indicated that symptom expression is an irreversible function of temperature. Inoculated plants maintained at 30 C for 24, 48, and 72 hours and then moved to 15 C developed necrosis subsequent to their removal, which indicated that infection had occurred at the higher temperature periods and 15 C was not able to prevent symptom expression. Also, inoculated plants of the same population maintained at 15 C for the same periods developed typical symptoms after their removal to 30 C, indicating that infection can occur at 15 C. No symptoms, however, developed on plants that were left for a prolonged period at 15 C, in spite of the fact that some of them received five intermittent inoculations with TMV. Further substantiation of the irreversibility of symptom development in $Tm\text{-}2^2/+$ inoculated with TMV was obtained when inoculated plants incubated at 30 C developed necrosis and failed to recover normal growth when moved to 15 C for extended periods.

All F_2 plants of Tm-2 x $Tm\text{-}2^2$ inoculated with TMV at temperatures of 30 C or lower were symptomless, indicating that $Tm\text{-}2^2$ is on chromosome 9, at or near the Tm-2 locus. Plants of the same F_2 population inoculated with (TMV) and incubated at the same temperature segregated 3 symptomless:1 mosaic; all mosaic plants were nv/nv, and probably Tm-2/Tm-2, providing further evidence that $Tm\text{-}2^2$ is at or near the Tm-2 locus.

Tm-2 and $Tm\text{-}2^2$ are not identical, however, because they respond differently to virus strains and temperature. It is not certain if they are multiple alleles or different, closely-linked genes. However, the following similarities exist: 1) both are on a chromosome with relatively few genes, 2) Tm-2/+ and $Tm\text{-}2^2/+$ both develop necrosis with TMV, altho at different temperature minima, 3) both are incompletely dominant, 4) neither confers immunity with the strains used, and 5) symptoms in both genotypes are an irreversible function of temperature.

Table 1

Temperature reactions of tomato genotypes to strains of tobacco mosaic virus.

Genotype	Virus	Symptoms at following temperatures				
		15 C	25 C	30 C	35 C	40 C
+/+	TMV	M	M	M	M	M
	(TMV)	M	M	M	M	M
Tm-2/Tm-2	TMV	Sl	Sl	Sl	Sl	Sl
	(TMV)	M	M	M	M	M
$Tm\text{-}2^2/Tm\text{-}2^2$	TMV	Sl	Sl	Sl	N	N
	(TMV)	Sl	Sl	Sl	Sl	N
Tm-2/+	TMV	Sl	Sl	N	N	N
	(TMV)	M	M	M	M	M
$Tm\text{-}2^2/+$	TMV	Sl	N	N	N	N
	(TMV)	Sl	Sl	Sl	N	N
$Tm\text{-}2/Tm\text{-}2^2$	TMV	Sl	Sl	Sl	Sl	Sl
	(TMV)	Sl	Sl	Sl	Sl	N

Tobacco mosaic virus strains

TMV = Normal: Alexamder V and Boyle isolates.
(TMV) = Aberrant: NY 66-4, NY 66-5 and Alexander IV isolates.

Symptoms

Sl = Symptomless.
M = Mosaic.
N = Necrosis (a shock reaction, usually followed by a mosaic and leaf distortion).

Soressi, G. P. Spongy seed (ss), a new plant character which modifies the seed hair appearance.

The normal seed hair originates during the final stage of fruit maturation, when parts of the lateral wall between longitudinal bands split, freeing their angular wall thickenings which so acquire a hair appearance. Our mutant seed does not appear to be covered by such hair-like structures, being on the contrary finely spongy and rather smooth. The angular wall thickenings, however, are also present, but they cannot completely separate because the lateral walls keep them from splitting to form the so-called hair layer. Consequently the hair layer appears faveolate as shown by fig. 1.

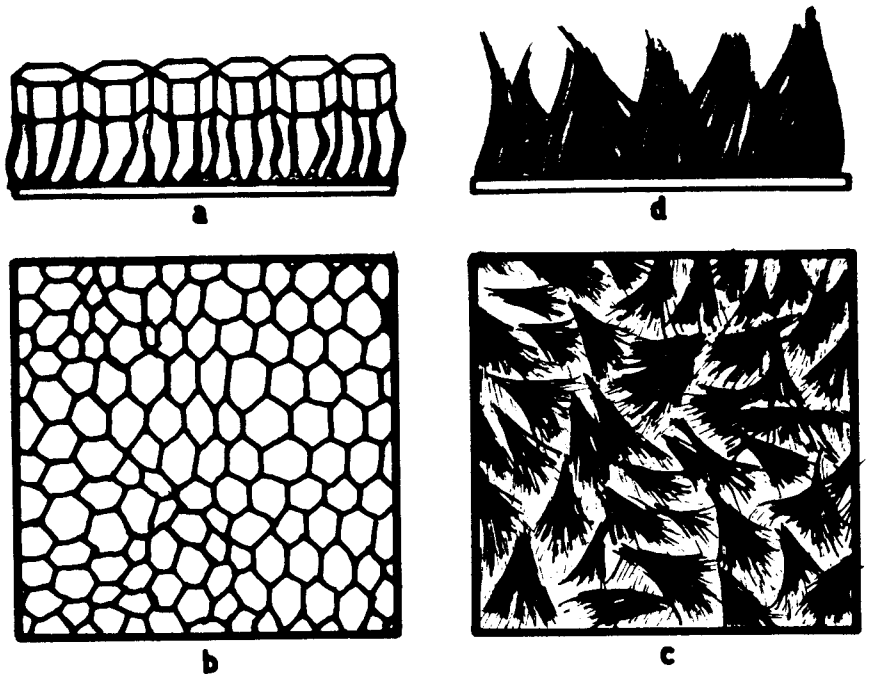


Figure 1

a) Longitudinal section of the spongy seed (ss) hair layer (about x 100).
b) Surface of the spongy seed mutant (ss) (about x 100).
c) Surface of the normal hairy seed about x 100, (cf. with b).
d) Longitudinal section of normal seed hair layer (about x 100).

Soressi, G. P. Brown seed (bs), a tomato seed character which behaves as an endosperm trait.

In an F_2 family, derived from seed treated with ethylmethansulphonate, characteristically brownish seeds were found. This pigmentation occurs in the cuticular layer placed between the seed coat and the endosperm.

With the simple aid of a lens, about 600 normal and 200 brown seeds were counted. About 1/3 of the plants grown from the former group were normal, whereas the remaining ones yielded fruits segregating about 3 normal : 1 brown seed as shown in the following table. There is an excess of the mutant type, possibly due to the inclusion in this class of brownish seeds for causes other than the genotype involved.

χ^2 analysis for segregation of brown seed trait in 41 +/bs selfed fruits

	Total seeds	Normal seeds	bs seeds	Df	χ^2 values	P
Total χ^2 values	-	-	-	41	76.971	>.01
Deviation from the 3:1	9528	6889	2639	1	36.971	>.01
Residual for heterogeneity	-	-	-	40	40.00	<.05

Soressi, G. P., and P. Cravedi Tomato mutants obtained by means of X-ray and ethylmethansulphonate (EMS) treatments.

The following tomato types obtained with mutagenic treatments are being studied.

X-ray induced:

gamosepalous (gm) - cv Sioux - Calyx and corolla with elements joined more than normally. Fruit development forces the calyx to divide into two or three large sepals or sepal-groups. Fertility good. F_2 ratio 3:1.

cabbage leaf-2 (cb-2) - dwarf line 59-521 - All plant parts are increased in size; larger leaves turn out to be epinastic and blistered in interveinal areas as cabbage leaves. Fertility good. F_2 ratio 3:1.

finely netted (fn) - cv Prospero 39 - True leaves slightly paler than normal with veins slightly greener and forming a fine net work evident not only in seedling stage but also later in older leaves, when they are observed against light. Fertility good. F_2 ration 3:1.

EMS - induced:

turbinate corolla (tc) - cv S. Marzano - Plant reduced in size; first leaves twisted; the later ones folded down--mainly in the tip region. Petal tips typically turned as turbine elements. Fertility good. F_2 ratio 3:1.

ghost-2 (gh-2) - cv Sioux - Viability and self fertility reduced in field, good in greenhouse; cotyledons yellowish; primary leaves and frequently all parts of surviving plants characteristically variegated. No response to graft on normal stock. Segregation data of the mutants as follows:

Type of cross	No. of fruit	No. of seedlings	+/gh	gh gh	χ^2 values for 3:1 or 1:1
gh gh (selfed)	2	47	-	47	-
+/gh (selfed)	15	1026	774	252	0.10
+/gh x gh gh	12	352	177	177	0.01
gh gh x +/gh	2	87	39	48	0.93

lazy-2 (lz-2) - cv S. Marzano - At the stage of 1-2 true leaves the stem grows typically prostrate, creeping like the "lazy" maize mutant. Fertility reduced. F_2 ratio 3:1.

reticulate virescent-2 (rv-2) - cv Sioux - Cotyledons light green; leaves always yellowish with green veins. Graft on normal stock without effect. Growth and fertility good in greenhouse, but very poor in field. F_2 ratio 3:1.

Stettler, R. F., and Alice Alldredge Fruit environment affects the phenotypic expression of the lanceolate gene.

Homozygous lanceolate mutants (La/La) appear in three different phenotypes--reduced, modified and narrow (Mathan and Jenkins, Science 131:36). Only narrow plants develop a shoot system, which, however, is sterile; modified seedlings have a cotyledon, whereas reduced seedlings have none. This phenotypic segregation has persisted throughout 15 generations of inbreeding and has shown much variation in the relative proportions of the three phenotypes from seedlot to seedlot, partly as a function of seed age (TGC 12:32).

Lacking a genetic explanation for the phenomenon, we explored the fruit environment as a possible source of variation. Since homozygous mutants can be recovered only from La/+ fruits, we hypothesized two major factors responsible for the phenotypic variation: (a) position of seed within the fruit in relation to fruit anatomy; (b) position of seed within the fruit in relation to surrounding genotypes. A preliminary study was conducted in which 30 La/+ fruits from an F_2 generation (lanceolate x Antimold B) were carefully dissected. Each seed was numbered and its position within the fruit was recorded on two different maps. These maps formed the basis for studying the distribution of phenotypes within the fruit. In all subsequent operations the identity of each seed was carefully maintained. Immediately after extraction the seeds were germinated on filter paper, transferred to soil, grown to seedling size in the greenhouse, and three weeks after transfer they were classified. For simplicity, only two classes of homozygous mutants were distinguished, reduced and non-reduced.

Contrary to our expectation, we found that the two classes were randomly distributed in the fruit; furthermore, there was no difference between reduced and non-reduced seeds as to their surrounding genotypes. However, we found that fruits containing above-average numbers of seeds for their size (crowded fruits) had a markedly higher proportion of reduced phenotypes than fruits with below-average numbers of seeds (non-crowded fruits). At the same time, the segregation of genotypes in either fruit type followed the expected 1:2:1 ratio. The data are summarized in the table below:

Segregation of phenotypes in crowded and non-crowded fruits.

Fruit	Number of fruits analyzed	Total number of seedlings	La/La			La/+	+/+	Chi-square
			Reduced	Non-reduced	Total			
crowded	16	771	114	77	191	379	201	0.478
non-crowded	14	332	31	50	81	172	79	0.458
TOTAL	30	1103	145	127	272	551	280	0.118

The difference between fruit types in the proportions of reduced to non-reduced seedlings was subjected to a contingency test and found to be very highly significant (adj. cont. chi-square = 9.63***). This suggests that, under limiting conditions, the competition for available metabolites in La/+ fruits occurs largely at the expense of the homozygous mutants causing many of them to develop into reduced forms.

Stringam, G. R. Orientation of the linkage map of chromosome 6. Recent isolation of a very unequal reciprocal interchange involving chromosomes 6 and 11 has proven useful in determining the orientation of markers on chromosome 6. Pachytene configurations showed that the breakpoint in chromosome 6 lies in the euchromatin of the long arm between the two large knobs near the centromere, while breakage in 11 is very near the end of the long arm. Cytological examination of a few plants derived from self-pollination of the

interchange heterozygote revealed one plant was tertiary trisomic for the centromere-bearing segment of chromosome 6 and the interchanged piece of 11. Crosses were made between the trisomic and the determinate marker stock c m, and the F_1 was backcrossed reciprocally to the c m stock. These crosses provided information on transmission frequency of the trisomic by male and female gametes and also helped to determine if the markers c and m were located in the chromosome segment covered by the trisomic. The results summarized below indicate there are no consistent differences in gene frequencies in the trisomic vs. normal plants thus demonstrating that these genes are not located in the short arm of chromosome 6 but must lie in the long arm. Furthermore, the good fit of the markers to a 1:1 segregation supports this contention.

Transmission through the female.

Genotypes	12II	12II + I	Unclassified (cytology)	χ^2 (1:1)
++	17	9	9	+:m 0.21 ns
+c	8	1	1	+:c 0.95 ns
m+	6	0	3	
mc	17	4	9	

Transmission through the male.

Genotypes	12II	12II + I	Unclassified (cytology)	χ^2 (1:1)
++	22	1	7	+:m 0.15 ns
+c	5	3	2	+:c 0.01 ns
m+	8	0	5	
mc	18	3	11	

Transmission of the tertiary trisomic through the male and female is 11.7 and 22.6 per cent, respectively.

Backcross data were also obtained from crosses with the original interchange heterozygote and the m c stock [(F m c / S + +) x F m c]*. Since partial sterility serves as a dominant marker for interchange breakpoints, the position of breakpoints with respect to genetic markers can be determined. The backcross data are summarized below.

* F and S refer to normal and interchanged chromosomes, respectively.

		Interval	Per cent Recombination	S. E.
F + + -	52			
F + c -	5			
F m + -	66	S-m	32.4	±6.6
F m c -	128			
S + + -	106	m-c	28.7	±6.4
S + c -	42			
S m + -	32			
S m c -	75			
	506			

Inspection of the data indicates the order of the markers and breakpoint

Stubbe, H. Symbol revisions for genes of previous lists of "Die Kulturpflanze".

Former name	and symbol	Preferred name	and symbol
accumbens	acu	curvata^2	cv^2
angustifolia	ang	elegans^2	ele^2
calva	cal	hairless^2	hl^2
proclinata	pca	rigida^2	rig^2
rubescens	rub	lutescent^2	l^2
velutina^2	vel^2	yellow virescent^2	yv^2
velutina	vel	yellow virescent^3	yv^3
versicolor	ver	yellow virescent^4	yv^4

rava^3 (ra^3) of "Lukullus", which will be published in the dissertation by J. Kruse, is an allele to rava and rava^2.

Tal, Moshe The grafting relations of three wilting tomato mutants--sitiens, flacca, and notabilis.

All three mutants wilt faster than control plants when both are subjected to the same water stress. It was demonstrated that all three have much higher rates of transpiration than the control plants, especially at night. The control plants in which these mutations were induced are the varieties Rheinlands Ruhm for sitiens (sit) and flacca (flc), and Lukullus for notabilis (not). Various facts point to stomata as the main factor responsible for these higher rates of water loss in the mutants. The stomata of the latter tend to open wider and to resist closure under conditions which induce closure in normal plants (Tal, Plant Physiol. 41:1387-1391, 1966).

One aspect of this research included the grafting of mutant and normal plants in all possible combinations. These combinations appear in the first column of the following table. For each of the mutants and the normal plants, a comparison was made between 30 random, mature green leaves developed on grafted plants and 30 leaves developed on ungrafted plants. They were compared in respect to rate of water loss, used as an indicator to opening of stomata, and in dry weight. In case the root system affects the difference in stomatal behavior between mutant and normal plants, it was expected to find different rates of transpiration in these comparisons. The petioles of these leaves were immersed in water in small beakers covered with waxed paper to prevent evaporation, and rate of transpiration was measured by weighing these beakers twice. The dry weight was calculated from the same leaves dried in the oven (100 C) for 24 hrs. The means of groups of 30 leaves of each of the measurements appear in the following table.

Rate of water loss: The results are as expected in two cases. When plants of flc and sit developed on roots of Rheinlands Ruhm, the leaves transpired significantly less than those developed on ungrafted plants. It is difficult to explain the lower rate of transpiration of Rheinlands Ruhm when grafted on flc.

Leaf dry weight: Mutant and normal plants have different values of dry weight/unit area. It was found in all cases that the roots have significant influence on this variable.

At present, an attempt is being made to find whether mutant and normal plants differ in kinetin-like activity in the root exudate. This approach is based on findings of kinetin-like activity in root exudate (Kende, Proc. Nat'l Acad. Sci. U.S. 53:1302-1307, 1965) and the influence of kinetin on the opening of stomata in barley leaves (Livne and Vaadia, Physiol. Plant., 1965).

Rate of water loss and dry weight of leaves in grafted (G) and ungrafted (UG) mutant and normal plants.*

Variety	mg water loss/ cm^2 leaf area/hr		% increase or decrease	mg dry wt/ cm^2 leaf area		% increase or decrease
	G	UG		G	UG	
Rheinlands Ruhm (sit)**	84.0	73.9	+12.0	2.81	***3.56	-12.4
Rheinlands Ruhm (flc)	114.0	***137.9	-17.3	3.41	***3.89	-10.5
flc (Rheinlands Ruhm)	66.2	***115.9	-43.0	3.35	***1.71	+49.0
sit (Rheinlands Ruhm)	75.3	***180.7	-58.4	2.91	***2.01	+31.0
Lukullus (not)	173.5	153.0	+12.0	2.98	***2.72	+ 8.7
not (Lukullus)	87.5	88.0	0.00	2.58	***3.20	-19.0

* Comparisons are made only within rows where light, humidity, and temperature conditions were the same.
** The variety used as the stock in grafting is in parentheses.
*** Significant difference at 95% level.

Verkerk, K. Plasmatic chlorophyll mutations after seed treatment with ethyl-methanesulphonate.

In the M_1 generation, yellow, white and greyish leaf sectors, stripes on stems and clusters, and even yellow sectors on unripe fruit were noticed rather frequently. Seeds from such fruits gave a high percentage (48 to 67) of yellow M_2 seedlings, all dying within fourteen days; exceptionally a green seedling was found with a yellow longitudinal stripe on one of the cotyledons. Seeds from totally yellow fruit gave only yellow seedlings.

In addition, a progeny consisting of only light green seedlings was found; these grow, but more slowly than control seedlings. These light green mutant plants were crossed with the control and vice versa. The mutant as mother resulted in 100% light green seedlings, while the control as mother yielded only normal green seedlings. The factor responsible for the light green mutant type shows maternal inheritance. It is thought that plasmatic chlorophyll mutations are involved in these cases.

Verkerk, K., and R. B. Contant Genetic analysis of two mutants of 'Money Maker'.

The 'easy peeling' mutant (ep) of variety 'Money Maker' (TGC 17:58) was crossed in both directions with an 'oblate fruit' mutant (obl) of the same variety. A comparison was made between the two F_1's, their parents and 'Money Maker' (MM) with regard to the characters underlined below. Segregation ratios were studied in the F_2.

In line ep, the 'easy peeling' character is associated with an anatomical root abnormality resembling that due to infection with the corky root fungus.

F_1 characteristics:

The F_1's resembled MM in most respects. Both obl and ep, but also their F_1 hybrid, started flowering 5.7 days later than MM. The mean number of fruits per plant (5 clusters) was 31.7 in obl whereas ep, the F_1's and MM did not differ significantly and averaged 44.1 fruits per plant. Mean weight per fruit of the F_1 did not differ from MM (79.5 g) whereas it reached only 61.4 in obl and 66.6 in ep. The fruits of F_1 (ep x obl), but not those of F_1 (obl x ep), peeled somewhat more easily than MM. All F_1 plants had round fruit, as in MM or ep. The F_1 also resembled ep in having corky roots; the yield data show that this character does not necessarily affect yielding capacity; the low yield of ep (56% of MM) may be due to the corky root factor in homozygous condition, or to a pleiotropic effect of the 'easy peeling factor'; this is being studied. The number of leaves below the first cluster was 7-8 in all material. Internode length and distance between clusters in the F_1 is as in MM, whereas ep has weaker growth and shorter internodes, and obl is more vigorous and taller (1.3-1.5 x MM in height) with longer internodes.

F_2 analysis:

No reciprocal differences were detected with the exception of 'easy peeling': the F_2 of ep x obl contains a far greater number of easy peeling plants (easy peeling/normal = 30/66) than the F_2 of obl x ep (easy peeling/normal = 18/78); the total for the 2 reciprocal F_2's gives a segregation ratio which is exactly 3:1, suggesting monogenic inheritance. The reciprocal differences suggest one or more plasmatic factors interacting with the easy peeling gene. Segregation ratios for 'oblate fruit' and 'corky root' agreed with a 3:1 expectation (round/oblate = 151/41; corky root/normal = 152/40), suggesting monogenic inheritance, recessive for 'oblate fruit' and dominant for 'corky root'. Mean flowering date of the F_2 was as in F_1, and the frequency distribution was similar. The classification into vigorous and weak plants (vigorous/weak = 132/60) differed significantly from a 3:1 ratio. Further analysis showed that there is a deficit of short-vigorous plants and a surplus of short-weak plants, indicating an association between small size and lack of vigor. An association between 'corky root' and 'weak' was also apparent as all plants with a normal root system were vigorous while 60 out of 152 'corky root' plants were classified as weak. Internode length and distance between clusters which are connected to plant form and plant height show great variation in the F_2.

Out of 41 oblate-fruited F_2 plants, 30 also had drooping leaves; both characteristics are typical for obl. In contrast, only 8 out of 151 round-fruited plants had drooping foliage; this shows considerable linkage between 'oblate fruit' and 'drooping leaves'; the genetics of the latter trait is unknown.

When the F_2's were subdivided into 'normal', 'obl-type', 'ep-type' and 'obl·ep-type' (occurring in the ratio 111:33:40:8 which does not differ significantly from 9:3:3:1), average weight per fruit, which was 66.4 in the F_2 of ep x obl and 73.5 in the F_2 of obl x ep, appears to be highest in the normal appearing plants and lowest in the ep-type plants. Furthermore, weight per fruit is much less (66.8 g) in corky root plants than in plants with normal roots (83.8 g). The number of fruits per plant was 36.4 in the normal and obl-type F_2 plants, 33.3 in the ep-type plants and 32.6 in the obl·ep-type plants. Plants with corky root bear less fruits per plant (34.4) than those with normal roots (40.9). For experimental reasons, these data are not quite comparable to the F_1 data.

There is no evidence of linkage between 'oblate fruit', 'easy peeling' and 'corky root'. 'Plant height' segregates independently from 'corky root',

but there is a strong association between tall plants and oblate fruit (combination of characters of obl and also between short plants and the easy peeling trait (combination of characters of ep). F_2 plants with oblate fruit segregated tall : normal : short = 30:8:3, whereas easy peeling plants in the F_2 (ep x obl) segregated tall : normal : short = 2:13:10, and those in F_2 (obl x ep) segregated tall : normal : short = 43:87:37. The genetics of 'plant height' and 'vigor' in relation to the 'easy peeling' and 'oblate fruit' characters is being studied further.

Verkerk, K., R. B. Contant, F. M. Rombouts, and C. E. M. Berkholst Easy peeling neutronic mutant of tomato.

In 1960, an easy peeling mutant (ep) was found at the Laboratory of Horticulture, Wageningen, in the progeny of thermal neutron irradiated seeds of tomato variety 'Money Maker'. In 1965, the Tomato Study Group of the Association EURATOM-ITAL considered that this mutant might be of potential value to the tomato canning ('pelati') industry in Italy. First results of an evaluation of its characteristics are reported below. Genetic aspects are discussed separately (TGC 17:56).

Description:

General appearance is as 'Money Maker'. The skin of ripe fruit is hand-stripped easily without prior immersion in hot water. The mutant tends to suffer from fruit cracking; it is unknown whether this is a pleiotropic effect of the 'easy peeling' factor.

Biochemical characteristics:

McColloch et al. (Food Technol. 6:197, 1952) mentioned that pectolytic enzymes are mostly localized in the outer part of the fruit wall and absent in the locular mass. In the present study, dark pink fruits of 'Money Maker' and the mutant were sectioned and the distribution and level of pectinase activity determined on low-methoxy-pectin. Results (fig. 1) show the differences

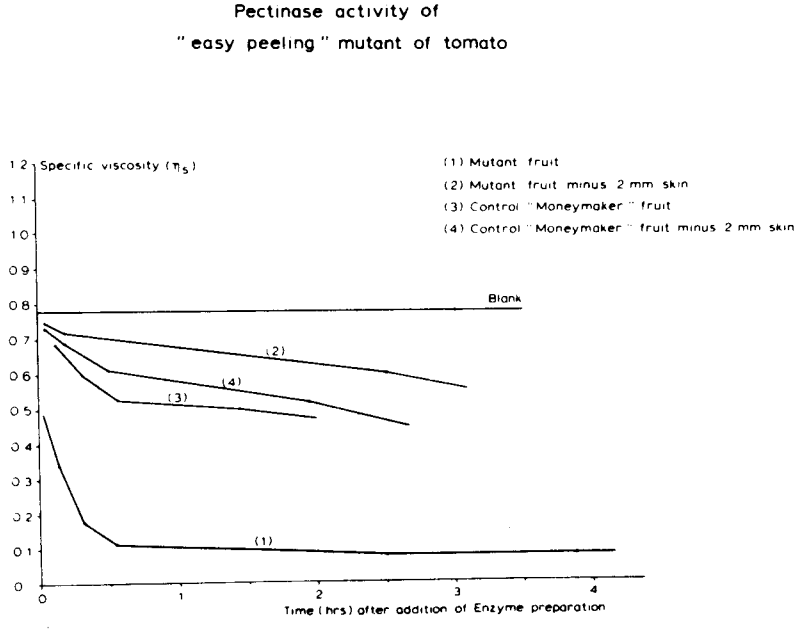


Figure 1

in viscosity-reducing property (pectinase activity) between the sera of comparable parts of 'Money Maker' and mutant fruits. The outer 2 mm 'skin' of the mutant appears to have a far greater pectinase activity than that of 'Money Maker'. However, a repetition of this analysis at a later date and by a somewhat modified method did not reveal any such differences. This discrepancy is being studied further.

In addition, cellulase activity of different fruit sections was determined through incubation of the sera in CMC-7 MP and the results (Table 1) expressed as the viscosity-reducing effect on this substrate.

Table 1

Cellulase activity.
($d\frac{1}{\eta_{sp}}/dt$ per ml)

Fruit sections	'Money Maker'	'Easy peeling' mutant
2 mm 'skin'	7×10^{-6}	33×10^{-6}
wall without 'skin'	20×10^{-6}	35×10^{-6}
locular mass	66×10^{-6}	44×10^{-6}

Cellulase activity in the peripherous 2 mm of the fruit wall is very much higher in ep than in 'Money Maker'.

Fruit wall anatomy:

The pericarp, about 75μ thick, usually consists of the cutinized epidermis and 5 to 6 layers of collenchyma. The outer 1 to 4 layers of collenchyma stain red with safranine. The peeled-off skin is 130-170 μ in unripe fruit, and consists of collenchyma and underlying parenchymatous cells. No consistent differences were found between the mutant and its mother variety in the number of collenchymatous cell layers or in the thickness of the peel.

Prospects for breeding and industrial application:

Breeding has started to incorporate the 'easy peeling' trait into the main 'pelati' varieties; for this, the collaboration is being sought with geneticists in Italy and other countries. This character may be of advantage for fruit used in home consumption and in the catering business; fruit cracking may be avoided by relatively early harvesting and cool storage. In the canning industry, the conventional process of dipping the fruit into hot water for loosening the peel might be omitted or reduced in cost by lowering the temperature required. This would also lead to a considerable reduction in factory hardship. For this application it will be desirable to eliminate the tendency to cracking.

Whalen, R. H. Linkage tests of the 'Baby Lea' syndrome.

The English variety 'Baby Lea', described by L. A. Darby (TGC 15:30-31), possesses anthocyaninless seedlings, a reduced root system, short internodes, and compact fruit clusters. These characters behave as though tightly linked and the entire syndrome is inherited as a monofactorial recessive.

In an attempt to allocate the 'Baby Lea' "gene" to a particular chromosome, seed of this variety was obtained from Darby in 1964 and crosses with a number of seedling mutants were made. The F_2 progenies were scored for the 'Baby Lea' "gene" (hereafter termed bls) by the presence or absence of anthocyanin pigment on the hypocotyls. The F_2 repulsion data were as follows:

Tester mutant	+ +	+ t	bls +	bls t	Total	Adjusted contingency chi-square
hl	763	239	241	84	1327	0.4
yg-4	305	89	95	22	511	0.6
sy	217	91	82	5	395	19.6**
sf	261	71	120	17	469	4.6*
nd	705	189	256	72	1222	0.1
e	691	271	249	105	1316	0.2
c	417	203	120	41	781	2.8
yv	247	93	68	32	440	0.6
Me	159	450	54	187	850	1.1
clau	134	48	44	17	243	0.0
tf	600	158	182	59	999	1.2
m-2	949	331	279	99	1658	0.0

The significant linkages found between bls and the tester genes sunny (sy) and solanifolia (sf) clearly place the locus of bls on chromosome 3. The product method gives an estimate of 25% recombination between bls and sy, and about 41% between bls and sf. The order is evidently sf - bls - sy.

This location of bls on chromosome 3 is in agreement with the simultaneous and independent findings of Pelham, Rick, and Hafen. Their sets of data are as yet unpublished.

PART II

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PART III

ADDITIONS TO STOCK LIST

STOCKS AVAILABLE

Source		Name	Description
Rüdenberg, Lily		Marglobe	Somatically unstable aneuploid.
Univ. of Calif. at Berkeley Dept. of Genetics			Miscellaneous accessions in the collection of the late Dr. J. A. Jenkins.
	152	pimpinellifolium	
	170*	d r y c a l	
	171	a f g lf wt H dm	
	234	d c l u H dm	
	378	d p o s b k r F	
(544)	1130*	2 locules, sl. obl.--'cerasiforme'	Guatemala
"	1134*	" " "	Ciudad Viega (--Guatemala?)
"	1142*	" " "	Guatemala
"	1143*	many locules, rather small, renif., yv	"
"	1164*	" " "	Chichicastenango
"	1174*	"large cerasiforme", oblate, 3 locules	Quelzaltenanzo
(584)	1270*	"large acorn"	San Salvador
(544)	1271*	sl. plum, 5 locules, 70± gr.	"
"	1281*	many locules	Honduras
"	1288*	2 locules, oblate, seg. for frt. size	
"	1307*	many locules, small	Honduras: Tela market
"	1311*	2 " (large considering)	" San Pedro Sula
"	1324*	2 locules cerasiforme	" Copan
"	1325*	" "	" Copan ruins
"	1326	" primitive plum type	Nicaragua
"	1331*	primitive many-loculed, seg. for frt. size	"
"	1348	ex. flavor, large, rough fruits	"
"	1349*	2 locules, larger than some, oblate	Costa Rica
"	1358*	many locules (reniform)	Panama
(554)	1368*	" "	"
"	1384*	5± locules, only 7 grams	Colombia
"	1390*	10± locules, " 24± "	"
"	1400*	5± " " 8± "	"
"	1409*	25± " 200± "	
"	1455*	2 locules, prolate, large	Peru
(614)	1457*	large, deep, many locules	"
(544)	1462*	20 locules, 60 grams, renif.	"
"	1466*	pimpinell. - 2 locules, round, 1.6 grams	" , via Mr. Gosser
"	1471*	" " sl. obl., 1 gram	"

(544)	1474*	pimpinell. - 2.5 locules, sl. obl., 1.8 grams		Peru
"	1476*	" 2 " " 1.2 grams		"
"	1478	cerasiforme - rr		Mexico, via Gutierrez
"	1480	many locules, small		Guatemala
(614)	1599*	small yellow	Papanila (?)	Veracruz
"	1598*	miniature	Kelly	Bombay, India
(594)	1594*	fairly small yell	Kelley	Santa Cruz de la Sierra, Bolwin
"	1593	" " "	"	" " " " " "
"	1592	" " "	"	Nar Yungos (?) Bolivia
"	1591	small elongate red	Castronovo	"Gorrafinha"
"	1590	large, many locules	"	"Platense"
"	1589	fairly large, many locules	"	"Platense laso"
"	1587.3	large, many locules	"	"Orinsano"
"	1586	" " " , but less fasciated		"Potente"
"	1584.1*	oblate, 2-3 loculed	Kelly, Bolivia	Near 'Yuni'
"	1582*	tiny, hairless stems, odd flowers with narrow petals--species??		
"	1581*	small red plum type, Sierra Nevada		Colombia
(544)	1503*	oblate, 2 locules		Costa Rica (via Hunter) - "Tomato chil"
"	1498	yellow-fruited, many flowers not ss		Bolivia via Gallegly
(584)	1581	cerasiforme		Colombia, via Rucker-Dolmatoff
"	1582*	"		Peru, via Inez Haase
"	1584*	small-fruited		La Paz (?), via Isabel Kelly

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PART V

FINANCIAL STATEMENT

(to December 31, 1966)

		Total
Balance from 1965		$279.77
Receipts		
Assessments	$222.15	
Sale, back issues	105.50	
Interest on savings	11.03	338.68
Assets		618.45
Expenditures		
TGC Report No. 16, 1966		
Multilithing and covers	326.19	
Postage and envelopes	46.40	
Miscellaneous		
Postage	45.61	
Newsletter and notices	7.25	
Mailing envelopes	4.50	429.95
Balance		$188.50

MEMBERSHIP STATUS

(to January 31, 1967)

Assessments paid for 1966	83
1967	145
1968	38
1969	22
1970	9
1971	8
1973	1
1978	2
Total members	308