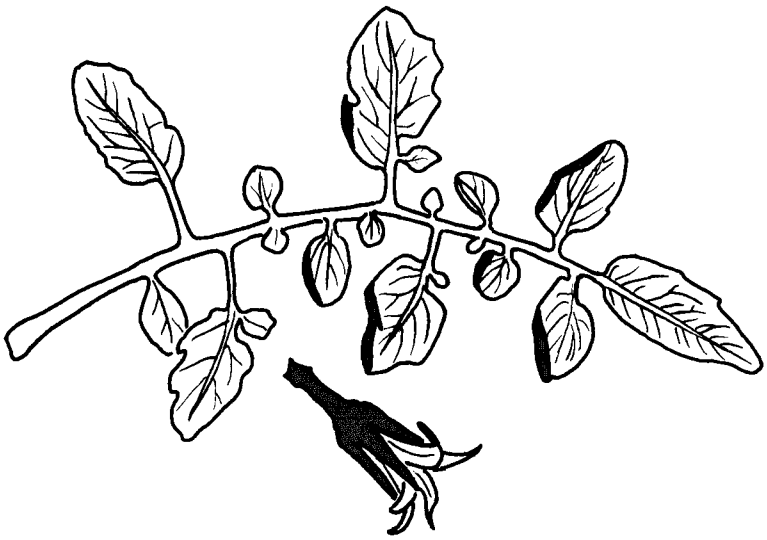
REPORT
of the
TOMATO GENETICS COOPERATIVE



NUMBER 14 FEBRUARY 1964

DEPARTMENT OF VEGETABLE CROPS
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

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TOMATO GENETICS COOPERATIVE

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Department of Vegetable Crops
University of California
Davis, California

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Cover design is a representation of a leaf and flower of the Lapageria (Lpg) 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.

It is always pleasant to report gains if they are of the proper kinds. We are proud to report an increase in membership from 263 to 281 as of January 1, 1964. No significant gain in our financial balance of $285.97 is noted, and it should be kept in mind that this figure includes triennial renewals already paid by many members.

The regular annual meeting was held under the auspices of AIBS at the University of Massachusetts in August, 1963. Minutes appear on the following page. Arrangements are being made for the 1964 meeting at Boulder, Colorado. We hope to see you there.

The New Mutant Program is a new activity being undertaken by the TGC. Details are presented on page 3. Interested members are urged to participate.

The advancement of Dr. Alan Burdick to the post of a dean at the American University of Beirut required a replacement on the Coordinating Committee. Dr. R. (Dick) W. Robinson has kindly agreed to fill the open position. We were sorry to receive Dr. Burdick's resignation, particularly because he was an organizer (with Dr. D. W. Barton) of the TGC.

The attention of those members who might be attending the Botanical Congress at Edinburgh in August is called to the following kind invitation from L. A. Darby of the Glasshouse Crops Research Institute at Littlehampton, Sussex, England. Mr. Darby states that they would be highly pleased to have TGC members visit their establishment and to make necessary local arrangements for visitors. They have extensive projects in progress concerned with plant habit, earliness, fruit number, size, shape, color, and resistance to several diseases. Other breeding work is concerned with cucumber, glasshouse lettuce, mushrooms, and anemone. Littlehampton is located on the South Coast and is less than two hours by train from London.

This year the TGC owes an unusual debt of gratitude to Dora Hunt. Although she has always assumed a large share of the work, Dora has been in charge of all membership arrangements and of the preparation of TGC 14 as a result of several extended absences of C. M. Rick. Credit for the expert stencil typing again goes to Virginia Borelli. Graduate students and colleagues assisted with various details. We would also like to express our appreciation to the many members who contributed interesting and valuable Research Notes for this issue.

Five hundred copies of this Report have been issued.

Minutes of the Amherst Meeting

August 26, 1963

The meeting took place at 4:30 p.m., Monday afternoon, August 26, in the School of Education Building, University of Massachusetts, with 12 members and four visitors present. In the absence of the Chairman, Dr. C. M. Rick, a letter from him was cited with the following information:

Status on August 21, 1963 - Paid up members - 270 (a new high)
Treasury balance - $218.30

A brief discussion was held concerning the possibility of having back issues of the Tomato Genetics Cooperative Report re-issued for sale individually or perhaps as a group. Comments were favorable with the suggestion that it be done if continued requests are received for early issues. It was also suggested that a larger number of copies be made up in the future.

The resignation of Dr. Burdick was noted, but a successor has not as yet been chosen for the Coordinating Committee.

C. B. Reynard
Secretary, pro tem.

NEW MUTANT PROGRAM

In their studies of mutagenesis in the tomato Dr. Kay Verkerk and Ir. G. J. Hildering of the University of Agriculture, Wageningen, The Netherlands have produced a large collection of interesting mutants. In response to their generous offer to share seeds of these mutants for genetic investigations, we have accepted and shall proceed with the research according to the following plan.

Members of the TGC are being canvassed for volunteers to carry out the necessary testing of these mutants. Each mutant should be grown for evaluation and comparison with known genes of similar phenotype and allele tests. Distinguishable new mutants of reasonable fertility should then be named, described, and screened into their linkage groups. To facilitate comparison and allele testing, mutants should be assigned in groups according to their primary phenotypic deviations. Any classification of mutants must be to some extent arbitrary because many genes are pleiotropic. But unless some attempt at grouping is made, volunteering members would have to cope with a random group and therefore to be prepared to work with mutants of every category. A tentative classification is being followed; changes will doubtless be required as the work progresses.

Members interested in participating in this program are encouraged to contact C. M. Rick. Please specify the kind and number of mutants that you can assimilate. Seeds of mutants, as received, will be distributed with an attempt to provide the cooperator with the kinds of mutants desired. Members are also encouraged to submit to the program seeds of new mutants that they might not wish to investigate.

PART I

RESEARCH NOTES

Acosta, J. C., and J. C. Gilbert
Resistance to bacterial wilt associated with the indeterminate plant habit.

F_2 progenies of a cross between a bacterial wilt resistant tomato of indeterminate vine habit and a vigorous but determinate bacterial wilt susceptible variety did not show independent segregation for wilt resistance and vine habit in a series of tests in Hawaii.

F_2 plants surviving 17 weeks of exposure to the bacterial wilt disease, Pseudomonas solanacearum E.F.S., showed less than 3% survival of the sp sp segregates in the 474 plants tested. The results obtained by seasons were as follows:

Surviving plants in the F_2 of a cross of a B. W. susceptible, determinate tomato and a B. W. resistant, indeterminate type. (Anahu x Hawaii 5808) after 17 weeks of exposure to bacterial wilt.

Vine type	Total of all seasons	Seasons			
		Summer	Fall	Winter	Spring
Indeterminate sp^+ ___	460	58	187	95	120
Determinate sp sp	14	0	4	2	8

The 5808 parent was an L. pimpinellifolium line selected for resistance to bacterial wilt for eight generations before it was used in this cross. While it is not certain that the indeterminate vine habit confers no survival value in itself when combined with varying degrees of resistance to bacterial wilt, the recovery of a few determinate, wilt resistant segregates suggests that linkage may be involved here. In susceptible varieties, the indeterminate vine habit offers no protection against this disease.

Andersen, R. Evidence of plasmon differentiation in Lycopersicon.

Previously, cytoplasmic male sterility had been detected in crosses between the garden tomato and Solanum pennellii Corr. using the latter as recurrent male parent. Pleiotropic effects of this male sterility include reduction in anther length and size, lengthening of filaments, and increased pollen abortion (Andersen a, b).

Differential cytoplasmic sensitivity to the S. pennellii genome has been detected in various Lycopersicon species. Male sterility associated with the above noted pleiotropic effects segregates in the first backcross lines from crosses between various Lycopersicon species and S. pennellii with S. pennellii as male parent in the backcross. However, intensity of expression varies depending upon the source of cytoplasm.

The following first backcross lines (BC_1) were compared for anther length (mm) and per cent pollen abortion (determined by aceto-carmine smears):

BC_1 line 3-49
(L. esculentum x S. pennellii) x S. pennellii

BC_1 line 3-52
(L. cheesmanii var. minor x S. pennellii) x S. pennellii

BC_1 line 3-53
(L. minutum x S. pennellii) x S. pennellii

BC_1 line 3-56
(L. hirsutum glabratum x S. pennellii) x S. pennellii

BC_1 line 3-50
(S. pennellii x L. hirsutum glabratum) x S. pennellii

Analysis of variance for anther length revealed high within-line error variation but the variance between lines was highly significant. Data comparing mean anther length and per cent pollen abortion are presented in Table 1. The data are for the above BC_1 lines and their respective F_1's and female parents. Measurements were taken on 20 plants from each BC_1 line; each F_1 and P_1 (female) was cloned to five plants. All measurements were based on an average of four flowers per plant. The lines are ranked according to degree of cytoplasmic sensitivity. Duncan's new multiple range test compares means for anther length; means not underlined are significantly different.

Table 1. Anther length and per cent pollen abortion in BC_1 lines from crosses between various Lycopersicon species and Solanum pennellii.

Statistic	Generation	3-52	3-53	3-56	3-49	3-50
Mean anther length mm	BC_1	3.04±.27	3.42±.27	3.57±.17**	5.39±.37	7.61±.13
	F_1	7.00	4.00	6.00	7.00	8.00
	P_1*	6.00	6.00	8.00	7.00	8.00
Average per cent pollen abortion	BC_1	100.00	92.50	81.67	66.64	32.00
	F_1	100.00	50.00	65.00	25.00	28.00
	P_1*	12.00	15.18	20.10	21.16	18.10

*Original female parent
**Underlined means are not significantly different

BC_1 line 3-52 with cytoplasm from L. cheesmanii var. minor shows the highest sensitivity to the S. pennellii genome. Anther reduction and pollen abortion are extreme. Cytoplasm from L. esculentum represented by line 3-49 is least sensitive based on anther reduction and pollen abortion.

The reciprocal crosses represented by lines 3-56 and 3-50 are of interest. Both lines contain the same proportion of S. pennellii genome with line 3-56 containing cytoplasm from L. hirsutum glabratum and line 3-50 containing S. pennellii cytoplasm. Line 3-50 is little affected but line 3-56 is markedly affected by backcrossing.

It appears that a complex of cytoplasmic differences exists in Lycopersicon. However, not enough work has been done thus far to determine if such cytoplasmic differentiation has discernible evolutionary and taxonomic meaning. Yet it is of considerable interest to note that plasmon differentiation does exist. Similar findings have been noted by Michaelis in Epilobium (1958) and by Grun et al. (1962) in Solanum and by Fukasawa (1959) in Aegilops.

Literature

Andersen, W. R. 1963a. Cytoplasmic sterility in hybrids of Lycopersicon esculentum and Solanum pennellii. TGC 13:7.

Andersen, W. R. 1963b. Cytoplasmic male sterility in hybrids between Solanum pennellii Corr. and various Lycopersicon species. Ph.D. thesis, University of California, Davis.

Fukasawa, H. 1959. Nucleus substitution and restoration in wheat. Jap. Jour. Bot. 17:55.

Grun, R., M. Aubertin, and A. Radlow. 1962. Multiple differentiation of plasmons of diploid species of Solanum. Genetics 47:118.

Michaelis, P. 1958. The genetical interaction between nucleus and cytoplasm in Epilobium. Exptl. Cell Res. 6:236-251.

Bell, W. D. Investigating gene action in the tomato using culture of excised roots.

Tomato root cultures were established in March 1963 of several mutants to determine whether root growth would approximate that of explant clones carrying the + allele at a particular mutant locus. The substrate employed was a modified White's medium containing mineral salts, sucrose, thiamine, nicotinic acid, pyridoxine, glycine and a chelating agent for the iron, HEDTA (N-hydroxyethylethylenediaminetriacetic acid). Prepared solutions were autoclaved before explants were placed in them. Further modifications of the aqueous medium are listed for the l_1 mutant below.

Genotype of root explant	Results
tl/tl	Root growth comparable to that of +/tl or +/+ explants.
pt/pt	Slow but sustained growth through six passages.
chln/chln	Root growth comparable to that of +/+ explants; growth more copious than on intact chln/chln plants.
l_1/l_1	Nearly normal root growth when maintained in the medium described above; growth ceased or was greatly diminished in the second passage when HEDTA was omitted; added NH_4^+ in trace quantities stimulated growth in the absence of HEDTA; asparagine elicited growth comparable to that of +/+ explants; arginine as an additive was found to be ineffective in stimulating growth.
rv/rv and l_2/l_2	Slow growth; inconclusive.

The effect of nitrogen nutrition on the phenotypic classification of lutescent described by Rick (Adv. Genetics 8:284. 1956) prompted the establishment of mutant root cultures for the investigation of nitrogen metabolism. Although glycine and nitrate were present in unchelated White's root culture medium, they are apparently not utilized efficiently by excised l_1/l_1 roots to satisfy total nitrogen nutritional requirements. Some enhancement of growth when traces of NH_4^+ were incorporated into the medium suggests interference with nitrate reduction in l_1/l_1 roots. However, growth is further enhanced by the addition of asparagine indicating a possible involvement of the l_1 locus in ammonia assimilation or in transamination. The beneficial effect of HEDTA when used as a chelating agent suggests that HEDTA may be metabolized as an amine nitrogen source; apparent metabolic breakdown of C^{14}-EDTA was reported by Hill-Cottingham and Lloyd-Jones (Nature 189:312. 1961) using intact tomato plants. The l_1-Roma selection appeared to respond as did l_1 in the above tests.

Bell, W. D. Chromosome count of White's 30-year-subcultured excised tomato root.

Chromosome counts were made of cells near the tips of Bonny Best tomato roots subcultured for 30 years by Dr. Philip R. White. One further transfer was made after receiving the culture from Dr. White before the counts were made. A somatic chromosome complement of approximately 40 was found by several observers using the oxy-quinoline technique. This suggested triploidy although no information is available on the original chromosome complement of the germinated seed from which the culture had been established.

Bostdorff, R., and C. C. Wyatt A genetic disorder of E.S. 24 tomato.

Atypical growth of several E.S. 24 tomato plants was observed in several locations of a fifty acre tomato field growing near Weston, Ohio during 1961. The growing point of severely-affected plants was blasted and accompanied by russeting which extended down the stem. Unexpanded leaves of less severely-affected plants had numerous irregular dark brown necrotic areas on the leaflets. Generally the plants were stunted in growth and about one-half of normal size, and the fruit were smaller than normal. Some of the fruit on affected plants were russeted.

Bulked seed from disordered E.S. 24 plants was planted in a greenhouse at Ohio State University. The same disorder appeared in approximately 11 weeks from the time of seeding, and 100% of the plants from the bulked seed became affected.

Transmission of sap by mechanical means as well as wedge grafts failed to transfer the incitant of the disorder to healthy tomato plants. Four rows of direct-seeded tomatoes planted in the spring of 1962 from individual disordered E.S. 24 plants showed 100% symptoms approximately 11 weeks from the date of field seeding.

To determine if the disorder was genetic, reciprocal crosses were undertaken between the affected E.S. 24 and a breeding line 19ABX, but only the cross affected E.S. 24♀ x 19ABX♂ was successful. F_1 plants from the completed cross resulted in all normal progeny. The backcross affected

E.S. 24 x F_1(19ABX x Disordered E.S. 24) was made and progeny from the backcross resulted in 24 affected, 26 normal. From the study to date the described disorder found in the tomato variety E.S. 24 is apparently caused by a single recessive gene. During the 1963 study, seed was collected from plants classified as having slight and severe russeting of the tomato and additional crosses have been made to continue the study. The name "scurf" is suggested for the disorder.

Butler, L. Estimates of the double reduction value for tetraploid tomatoes.

The parameter, alpha, is used as a combined estimate of double reduction and quadrivalent formation in tetraploids. It can be estimated most efficiently by a testcross to a triplex individual. In order to obtain a triplex wv, 51 + plants from an F_2 were progeny tested. The results showed that 21 were simplex, 20 were duplex, and 10 were either triplex or quadriplex. Because of the large numbers required to distinguish between these last two classes, they are grouped together, although three plants have given 1 wv segregate and therefore must be triplex. Our preliminary estimate of alpha is .05, and if we apply this to the duplex segregation we should get .033 nulliplex, .233 simplex, .233 triplex, .468 duplex, and .044 quadriplex. For the 51 plants divided into three classes we would expect approximately 13:25:14 as compared to the observed 21:20:10. This has a chi square of 7.5, most of which is caused by the excessive number of plants in the simplex class. If we take alpha as 0.1 then the expected becomes 15:23:13 with a chi square of 3.5. The observed and expected segregation ratios for the different classes are given below:

	Observed			Expected ratio	
	+	wv	Ratio	alpha 0.05	alpha 0.1
Simplex	3361	878	3.8:1	2.8	2.6
Duplex	3349	118	28.4:1	28.8	24.0
Triplex				6409.0	1599.0
Quadriplex	1900	3	633:1	No recessives	

These segregations give a better fit with the lower value of alpha, but no decision can be reached until we have made a test cross to the triplex individuals.

Brock, R. D., and I. Franklin Radiation intensity and mutation rate in tomato.

An apparent dose-rate effect showing chronic Co^{60} gamma irradiation (0.426 rads per min) to be six times more effective than acute Co^{60} gamma irradiation (360 rads per min) was obtained using the marker genes aw, a and hl.

Pollen of homozygous wild type L. pimpinellifolium was irradiated with approximately LD40 doses of chronic and acute gamma rays and used to pollinate aw/aw, a/a, hl/hl L. esculentum tester stocks. Mutations were detected in the seedling plants. Green mutants are being test crossed to determine the mutation rates for a and aw. The mutation rate expressed as per rad per locus assumes equal mutation rate of the three loci.

Mutation frequencies

Treat-ment	Dose (rads)	No. of plants	No. and phenotype of mutants: Green hairy	Red smooth	Green smooth	Mutation rate per plant/rad/locus ($\times 10^{-3}$)	($\times 10^{-8}$)
Acute	6000	29,964	148	47	13	6.9	40.5
Chronic	1200	32,150	176	78	14	8.3	231.6
Control	0	28,085	3	0	3	0.2	-

This apparent enhancement of the mutation rate at low radiation intensity has been shown to be directly related to the radiation sensitivity of the pollen. Increased radiation sensitivity results in an increase of zygotic lethals (reduced seed set per fruit) and also an increase in mutation of the marker genes. Most of the mutations are chromosome deletions.

The increased sensitivity of the pollen is not associated with the reduced dose-rate of the chronic irradiation, but is due to the storage conditions during the extended time of irradiation. Both desiccation and ageing increase the sensitivity of the pollen and result in increased mutation.

Corbeil, R. An analysis of maturation in tomatoes in terms of components of earliness. (Submitted by L. Butler)

The plant was considered mature with the first fully ripened tomato fruit. The time in days from seeding to first ripe fruit was divided into five components: a) from seeding to first anthesis of a flower of the first inflorescence, b) time for the flower in (a) to set, c) days from first anthesis in (a) to first anthesis of a flower on the second inflorescence, d) time for the earliest flower of the second inflorescence to set, and e) days from set to ripe fruit--this being corrected to be equivalent to the first proximal flower position on the first truss.

Each component was examined first on its own in terms of variation due to fixed heritability, denoted by D; unfixed heritability, H; environment, E_i; and interaction of factors within a component explained by linkage, L. The two parents, tangerine (L. esculentum var.) and Red Currant (L. pimpinellifolium), with the F_1, F_2, and F_3 were used for partitioning the variance. The method of partitioning used was as that developed by Mather (1949, BIOMETRICAL GENETICS, Methuen and Co. Ltd., London).

The components were then studied by use of regression techniques involving seven varieties of tomatoes and all possible hybrids. Though the techniques were modified they were primarily those of Griffing (1950, Genetics 35, 303-21).

Finally, the components were compared with one another as well as examined individually by observing the segregation of earliness in relation to a list of genetic markers.

The statistics acquired by the partitioning of variance are summarized in Table 1. As four of the five residuals are significant their consideration cannot be weighed lightly though they need not completely invalidate the other statistics. Transforming the original data to logarithms had no effect in lessening the residuals, and judging from the relationship of the parents and F_1's with their variances no simple transformation exists. However, it is hopefully expected that the components used as multiple measurements of one basic character and employed to develop a discriminant function will finally yield a transformation. This sort of transformation will allow only one estimate of each statistic over all components combined but will minimize experimental error confounded within the experimental design and thus elucidate the nature of the residual or possibly reduce it effectively. In any case the residual may simply be the expression of the interaction of the genomes of the two species in reference to the quantitative trait under study.

It should be noted that although the evidence for linkage is weak, Mather suggests the difficulty of detecting such is inherent to quantitative inheritance.

With the analysis of a wide range of varieties of tomatoes in their expression of earliness, gene action can readily be determined. In referring to Table 2, we can see that there is a consistent, but partial, expression of potence of earliness in all components, though it is only moderate in (a) and (b) where blooming of the flowers is involved. This action is well substantiated by the H statistics in Table 1.

While analyzing the inheritance of earliness in relation to a number of genetic markers, it quickly became obvious that all components acted quite similarly to the number 2 chromosome markers, and the major effects were certainly within this chromosome. The "d to p" region of the chromosome was twice as influential in promoting earliness as was the "s" region. While the "d to p" region appeared to give consistent results regardless of other markers present, the "s" region was more influential with the presence of other markers, especially d, when in coupling as though effecting a reinforcement. The four late lines introduced with the genetic markers were procured from Prof. L. Butler. These were crossed in all permutations with Yellow Cherry and Fireball, Y. C. being very early and Fireball moderately so. All were varieties of *L. esculentum*.

From preliminary calculations it appeared that some markers outside of the number 2 chromosome may have had effects on earliness. Fasciated fruit delayed setting and ripening, and self pruning decreased the time between inflorescences. Other markers outside chromosome 2 had little or no influence on any of the components. These were *al*, *wt*, *br*, *H*, *j*, *r*, *y*, *u*, *t*, *c*, *wf*, and *gs*. However, the data available were not yet completely analysed.

To date the data suggest that there are two or three major areas on chromosome 2 controlling maturation and that there are also less influential areas throughout the genome. Other than the factors on chromosome number 2, however, none of the markers appears to have its effect on all components.

Table 1. Statistics derived from the partitioning of variance.

Statistic	Component				
	a	b	c	d	e
D	14.85±1.99	-0.198±0.108	2.406±0.470	0.015±0.164	34.91± 3.72
H	-0.30±6.38	2.322±0.344	-0.093±1.504	1.051±0.524	-61.88±11.92
E_1	2.90±0.54	0.528±0.030	2.316±0.141	0.702±0.045	7.76± 1.01
E_2	2.16±0.55	0.220±0.030	0.874±0.128	0.187±0.045	6.21± 1.02
L	1.28 n.s.	0.005 n.s.	2.149 sig.	0.005 n.s.	0.76 n.s.
R	41.66 sig.	0.095 sig.	1.373 sig.	0.002 n.s.	245.35 sig.

n.s. = not significant at chosen α = .05
sig. = significant beyond .01 level
R = residual effects

Table 2. Observed and expected means of 7 tomato varieties and 21 hybrids.

Components	Days				
	a	b	c	d	e
Mean of parents	15.91	4.21	6.13	3.83	20.01
Mean of F_1	14.99	3.64	5.66	3.44	15.02
Expected F_1*	13.98	3.48	5.08	3.14	14.80

*Expected F_1 calculations were based on complete potence of earliness.

Emery, G. C., and H. M. Munger

Soluble solids differences in indeterminate (+) and determinate (sp) lines approaching isogenic condition.

The development of isogenic lines of determinate (sp) and indeterminate (+) tomatoes via backcrossing of these alleles into three varietal backgrounds is now approaching a point where certain comparisons may be made. A brief study of the soluble solids in these six respective genotypes in the F_2 generation following the 6th backcross this past summer has revealed a rather striking difference between the two genotypes. The three varieties involved have been derived from quite distinct ancestries and thus show a great many morphological diversities while still remaining adapted to New York growing conditions. Consistent dissimilarities in behavior between opposing-allelic genotypes would indicate allelic differences alone rather than chance interactions of the alleles with their genetic backgrounds.

Each figure in Table 1 is the mean of six individual samples. The refractometer readings of fruit from the original varieties were collected at the same time. The variety genotypes are as indicated just after the varietal designation in Table 1. In 5 of the 6 comparisons between the original variety and plants carrying the same allele but derived from the backcross series, soluble solids are very similar. The one exception is

in Sample 1 of the Fireball variety. The overall similarity between the variety readings and their related backcross genotype is one indication of the degree of restoration of the genetic background of the original variety.

Two unrelated series of readings, labelled as Sample 1 and Sample 2, were run on two distinct lots of plants. The Sample 1 readings were taken from segregating populations from +/sp plants on August 24, just shortly after the period of fruit ripening began. Sample 2 readings, on the other hand, arose from a spacing-yield trial on September 14 just prior to the end of the growing season. Since effects of spacing were found to be insignificant, the data of the two series of Samples 1 and 2 have been combined into one analysis of variance. The two samples are significantly different; however, variety x sample and genotypes x sample interactions with the two contrasting series are not. This would indicate that despite large environmental effects on percentage of soluble solids, each genotype is reacting with the environment in about the same manner and in the same degree as the other genotype.

The consistently higher soluble solids in the fruit of the indeterminate genotype over that of the determinate genotype is the outstanding feature of the data reported in Table 1. The reduced leaf/fruit ratio of the determinate genotype would logically seem the greater factor in reduced soluble solids in the sp fruit, even though other closely-linked genetic factors cannot be eliminated as being involved without further evidence.

Table 1. Percent soluble solids of ripened fruit of determinate (sp) and indeterminate (+) isogenic lines derived thus far by 6 generations of backcrossing into 3 different varietal backgrounds.

Varietal Background		Variety	+	sp
Gardener (+)	Sample 1	5.63	5.85	4.70
	Sample 2	4.93	5.08	4.33
Fireball (sp)	Sample 1	5.13	5.32	4.67
	Sample 2	3.95	4.52	4.03
54-149 (sp)	Sample 1	4.75	6.00	4.75
	Sample 2	4.22	4.60	4.17

L.S.D. at the .05 level = .34

Gröber, K., and O. Machold
Effect of kinetin and nitrogen on growth and chlorophyll production of the tomato mutant Xanthophyllic$_3$.

The heterozygote genotype of the chlorophyll mutant Xanthophyllic$_3$ produced yellow to yellowish-green leaves under normal field conditions in May and June as reported in "TGC" 13 and in "Die Kulturpflanze" 11, 1963. In midsummer (August) with high light intensity and high temperature the leaves become largely green. To analyse the factors responsible for this, the mutant was cultivated under controlled vegetation conditions in a greenhouse and a phytotron.

We found also that temperature, light, and N content of the culture solution have a distinct effect on chlorophyll production. It was interesting to find that the heterozygote genotype was still growing in culture solution with high N content (v.d.Crone + 1.5 g NH_4NO_3/l) while the check plant showed damage at this N concentration. Besides the described growing factors, a further effect on chlorophyll production could be observed after delivering kinetin. Quantities of 0.5 mg kinetin/l culture solution increased the chlorophyll content of the mutant about 74% (on an average of all attempts) and of the check only 21%. An evident correlation exists between the quantity of nitrogen and the effect of kinetin. Increasing the N content of the culture solution by constant amounts of kinetin results in enhancement of the chlorophyll content of Xa_3. At the same time kinetin caused an inhibition of growth. The inhibiting effect was decreased the higher the N content of the culture solution.

Hagemann, R. The cytogenetic mechanism of a green-yellow variegation.

In my article "Instability at the yv locus" in TGC 12:27-28, 1962, I have described a mutant line (which arose from "Condine Red" after X-irradiation) which consists of green-yellow variegated and yellow male-sterile plants (homozygous for the new allele yv^{ms}). The instability of the variegated plants has formally been explained by the assumption of a mutable allele yv^{mut} which regularly mutates to yv^{ms}. But I had emphasized: "The event which underlies the hereditary change, formally called mutation of yv^{mut} to yv^{ms}, may be a (a) gene mutation, (b) induction of a deficiency, or (c) loss of a fragment which together with a deficient chromosome 6 gives a normal phenotype." In the meantime cytological studies have shown that possibly (c) proved to be true.

The chromosome No. 6 of the plants of our mutant line carries the allele yv^{ms}. The green parts of the variegated plants contain 24 chromosomes and additionally one or more fragments. The fragments carry either a yv^{+} allele or a complementary factor, which together with the mutated chromosomes No. 6 (yv^{ms} yv^{ms}) gives a normal green phenotype. During ontogenetic development in a portion of cells the fragments are lost. The loss leads to a homozygous yv^{ms} yv^{ms} cell which may produce a yellow spot, a yellow sector, or a yellow (and male-sterile) branch, depending upon the developmental stage in which the loss took place.

In diakinesis, metaphase I, and anaphase I of the p.m.c., the fragment is either attached to a chromosome of a bivalent or is free. The fragment divides in the first or in the second meiotic division. It has been seen lagging in both divisions.

The genetical analysis of reciprocal crosses between normal green and variegated plants has revealed that the fragment is transmitted by the pollen and the egg cell with about the same frequency.

Cytological studies are under way to find out the details of the behavior of the fragment: pairing relations in pachytene, homology (with a part of chromosome 6 ?), frequency of its division in the first and second meiotic division, reasons for different sizes of the fragments in different plants, relation between the number of fragments per nucleus and the occurrence of variegation in ontogenetic development, etc.

Hagemann, R. Trisomic studies with sulf.

The genetic analysis of the multiple sulfurea (sulf) series has proved a particular type of gene instability: a somatic allele-induced instability, termed somatic gene conversion (TGC 8:19, 1958; Ztschr.f.Vererbungsl. 89:587, 1958; Biol. Zbl. 80:477, 549, 717, 1961; Proc. XI Internat. Congr. Genet., The Hague, Vol. I:11, 1963).

In order to localize sulf, crosses have been made between sulf homozygotes and 7 different primary trisomics (kindly supplied by C. M. Rick): triplo-2, 5, 7, 8, 9, 10, and 12. The following segregation values have been obtained in the different F_2 generations (from trisomic F_1 plants):

						Comp. with 3:1. P:
triplo-2	March '63	74 green :	6 yellow =	12.33 : 1		0.001
	Nov. '63	83 green :	15 yellow =	5.67 : 1		0.03
		157 green :	21 yellow =	7.48 : 1		0.001
triplo-5+	March '63	241 green :	65 yellow =	3.71 : 1		0.14
triplo-7+	March '63	66 green :	21 yellow =	3.14 : 1		0.85
triplo-8	March '63	1208 green :	350 yellow =	3.45 : 1		0.03
triplo-9	March '63	729 green :	222 yellow =	3.28 : 1		0.25
triplo-10	March '63	498 green :	183 yellow =	2.72 : 1		0.25
triplo-12	March '63	224 green :	83 yellow =	2.70 : 1		0.40

(+ Designation of Rick, Nov. 1960; according to Rick, Dempsey, and Khush, TGC 13:23-24, 1963, the numbering of triplo-5 and 7 has to be interchanged.)

Six of the F_2 generations segregated in a normal 3:1 ratio. Only the F_2 from the cross with triplo-2 gave an excess of green seedlings, characteristic for trisomic segregation. The deviation from the 3:1 ratio is highly significant.

In linkage studies, the markers d_1 and aw (lying in the distal part of the long arm of chromosome 2) gave free recombination with sulf.

These results, taken together, indicate the position of sulf on chromosome 2 near its heterochromatic part. Studies are in progress to confirm (or to disprove) this indication. The sulf homozygotes are lethal in the seedling stage if not grafted on green stocks. Therefore, it is difficult to determine the number of trisomics among the sulf homozygotes in the progeny of trisomic F_1 plants.

Ito, P., and T. M. Currence A linkage test involving c sp B^+ md in chromosome 6.

The close linkage between sp and B has been noted in several small segregating populations because no orange-colored fruits developed on self-pruning plants. These observations led to developing a c sp B^+ md line and eventually to growing a few thousand backcross plants. Emphasis was given to establishing the extent of crossing over between sp and B^+. The 2949 plants having c md and the 2748 having c^+ md^+, being mainly parental types, were discarded as small seedlings. Obviously, with c and md being the terminal loci, double but

not single crossovers were thereby eliminated. The remaining 1218 plants were grown to fruit maturity. The data obtained are as follows:

Parental & Double	Region 1	Region 2	Region 3	Region 1, 2 & 3
+ + B + 2748	+ sp + md 25	+ + + md 10	+ + B md 534	c + + + 1
c sp + md 2949	c + B + 21	c sp B + 11	c sp + + 616	+ sp B md 0
5697	46	21	1150	1

The one plant which appears as a triple crossover can only be considered an unusual incidence or possibly a misclassification of the self-pruning character. A map distance of 0.3 between sp and B is suggested by the data. Calculating double crossovers from the map distances of 0.7 for c sp, 17 for sp md, and 0.3 for sp B^+ suggests that there might have been about 4 double crossovers occurring in the second region which would increase the percentage to approximately 0.4. The crossover percentages are lower than those shown by the linkage map in TGC 13. Separate records were kept on the crossing over between c and md in the backcross progenies of 10 different F_1 plants. Smallest of these progenies was 65 plants and the largest was 2962. The percentages varied from 11 to 25 with a mean of 18. Heterogeneity tests indicate these as significantly different. Since both parents have complex pedigrees with little inbreeding, it is thought probable that F_1 plants were genotypically variable. The stock used may be one of low crossover percentage with considerable segregation present for this characteristic. It is considered possible that the high and low crossover percentages noted may be transmitted to later generations.

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Kedar, N., N. Retig, and J. Katan

Segregation in crosses involving gene I for resistance to fusarium wilt.

It has been observed earlier that the resistant class in crosses between susceptible and resistant varieties usually exceeded the expected number.

In order to test the occurrence of preferential fertilization of pollen of type + as compared to i a number of crosses were made. Seedlings at the first true leaf stage were infected by dipping them into a Fusarium spore suspension and then were planted in the greenhouse. Results:

Material:	Number of plants Susceptible	Number of plants Resistant	Expected ratio	Chi square
Homestead (++)	0	70	0:1	
Marmande (ii)	70	0	1:0	
F_1 (Hom. x Mar.)	9	71	0:1	
F_1 (Mar. x Hom.)	6	74	0:1	
F_2 (Hom. x Mar.)	41	239	1:3	16.02***
F_2 (Mar. x Hom.)	41	239	1:3	16.02***
Bc_1 (Mar. x (Hom. x Mar.)	74	206	1:1	62.23***
Bc_1 (Mar. x (Mar. x Hom.)	83	162	1:1	25.74***
Bc_1 (Hom. x Mar.) x Mar.	170	150	1:1	1.25

In spite of the possibility that, as a result of the severe test, some of the heterozygous plants were falsely classified as susceptible

(see F_1), the F_2 segregations show a surplus of resistant plants. Even backcrosses with the susceptible Marmande as a female parent show a highly significant surplus of resistant plants. The only segregating population consistent with the single dominant gene explanation of resistance is the backcross ♀ (Hom. x Mar.) x ♂ Mar. In this cross, all male gametes are of the i type. Other backcrosses as well as the F_2 segregations are produced by i and by + male gametes. The results may be best explained by postulating preferential fertilization by + ♂ gametes in competition with i. The results will be further tested by different techniques. Consequences for breeders interested in high proportions of resistant plants are obvious.

Kerr, E. A. Linkage relations of inc, int, irr, tp, and v_2. Data from F_2 populations indicate that incurva, integerrima, irregularis, tripinnate and virescent-2 are located on chromosomes 5, 6, 1, 8 and 2, respectively. Suggestions of linkage were also obtained for inc - l_1, int - wf, tp - e, tp - y, and v_2 - c, but these were generally based on small populations and were not confirmed by tests with other genes. The cross-over value of 23 units for int - sp is probably more reliable than 35 for int - c because the latter combination is difficult to score. Seeds of the mutants have been sent to the linkage cooperators concerned.

Mutant-Tester	Chromosome	Phase	++	+t	m+	mt	C.O.
inc - mc	5	F_2 rep.	76	21	14	2	41
- mc	5	F_2 coup.	89	24	13	13	33
- tf	5	F_2 rep.	39	18	13	2	35
- l_1	8	F_2 rep.	56	24	22	6	44
- l_1	8	F_2 coup.	87	27	20	12	41
int - c	6	F_2 rep.	41	24	42	8	35
- sp	6	F_2 rep.	72	36	32	2	23
- wf	3	F_2 coup.	46	12	10	6	39
irr - y	1	F_2 rep.	54	34	18	4	36
- y	1	F_2 coup.	56	5	2	10	11
tp - gf	8	F_2 rep.	139	45	29	6	44
- l_1	8	F_2 rep.	163	109	72	3	17
- e	4	F_2 rep.	83	37	25	4	35
- y	1	F_2 rep.	40	21	14	0	24
v_2 - d	2	F_2 rep.	182	74	82	0	12
- bk_1	2	F_2 rep.	35	16	21	2	29
- o	2	F_2 rep.	37	14	22	1	23
- op	2	F_2 rep.	38	17	18	1	23
- p	2	F_2 rep.	40	11	23	0	26
- s	2	F_2 rep.	44	7	22	1	33
- c	6	F_2 rep.	37	21	16	0	22

Kerr, E. A. Veined cotyledon (vc) a distinctive seedling mutant.

Veined cotyledon plants can usually be distinguished from normals before the first true leaves appear. This was done with 95% accuracy on segregating populations of 295 plants. In addition to the usual rather indistinct vein that extends the length of the cotyledon, vc usually has several secondary veins. In seedlings and mature plants the leaflets are slightly convex and the lobes are not as deep as usual. Slight twisting of the leaflets also occurs. Growth is normal but fertility is somewhat reduced. Five F_2 populations gave a total of 438 + :151vc indicating that vc is a simple recessive. There is no close linkage with a bk_2 br c d dl e gf gs h hp j_2 l_1 mc r sf sp wf or y.

Veined cotyledon was first noted in 1961 in a flat of germinating seedlings being grown for leaf mold studies. All plants of one F_3 population from the cross V 501 x Vinequeen possessed the characteristic. V 501 and Vinequeen have complicated ancestries but their resistances trace back to L. hirsutum var. glabratum and L. hirsutum, respectively. The reduced fertility of vc suggests that it may be caused by a small chromosomal aberration.

Lesley, J. W., and M. M. Lesley More data concerning cabbage cb.

An earlier account of cabbage cb appeared in Jour. Heredity 43(6): 273-276, 1952. Additional data concerning this pleitropic mutant and its linkage relations were obtained in 1963. From crosses with different phenotypes, some 500 F_2 and backcross plants were grown to maturity in the field and greenhouse. Compared with the normal, the folioles of cb are stiffer and less dissected and the foliolules are fewer in number. The corolla is more nearly stellate, the tube is shorter and is divided even more of the distance to the base of the corolla. In cabbage little or no wavy tissue occurs in the angle between the petals. Pollen sterility is a third characteristic of cabbage but is not total and allows limited self-fertility. Female fertility is reduced by partial sterility of the ovules which results in more or less limited seed production.

These four characteristics are all quantitative in nature and are influenced by environmental conditions and genetic background. Minor differences in corolla shape may occur in non-cabbage forms of L. esculentum, and at least one other mutant has a stellate corolla. Corolla shape is also modified by virus disease. Tobacco mosaic and high temperatures, as well as many genetic conditions, may cause pollen sterility. Some inbred lines of cabbage, although very fruitful, produced very few seeds, but cb plants in segregating populations were much more fertile. None of the four characters alone is conclusive so that cabbage is not an easy type to identify even in adult plants. The stellate corolla probably is the best single diagnostic character, seed set comes next, followed by foliage and male sterility. A combination of stellate corolla and partial pollen sterility, especially on a fairly isogenic background, is almost decisive.

The diversity of characters that constitute cabbage certainly suggests several linked loci, as in the case of the virescent tangerine mutant t^v. Some plants in backcross and F_2 families lacked one or occasionally two of the four diagnostic characters, but as yet no progeny tests have been made.

The proportion of cb in F_2 and backcross families clearly indicates that it behaves like a recessive (Table). Previous data suggested that cb was in chromosome 1, about 28 units from y. The new data support this conclusion but indicate a distance nearer to 20-25% by product moment calculation (Immer, F. R. Genetics 15:81-98, 1930). In one small F_2 family, 63,057 cb and y were independent but the S.E. is high 0.32. No significant heterogeneity occurred between families either in the monogenic or digenic ratios (Table). In all families cb and y were coupled. Whether the cb locus is near br or fla is unknown.

As previously reported, cabbage is diploid. In the sporogenous tissue cell size is variable and few p.m.c. enlarge and develop normally. Occasional double-sized cells are formed. These may have one nucleus with 48 chromosomes or two diploid nuclei. It is evident that some physiological condition prevents normal meiosis in cabbage.

B.C. and F_2 families with cabbage (cb) and non-yellow skin coupled. C.O. estimated by product method.

Family		n	cb^+y^+	cb^+y	$cb\ y^+$	$cb\ y$	cb^+:cb y^+:y linkage X^2	X^2	X^2	C.O.	S.E.	Linkage heterogeneity
63.045	B.C.	62	26	9	7	20	0.8	0.5	14.5	0.26		
63.049	B.C	14	6	1	2	5	0.0	0.3	4.6	0.21		
All	B.C.						0.8	0.5	19.0	0.25	0.05	0.1
63.048	F_2	119	87	11	8	13	3.4	1.5	20.2	0.20		
63.050	F_2	117	76	16	9	16	0.8	0.4	20.0	0.24		
63.057	F_2	12	5	4	2	1	0.0	1.8	2.4	0.5		
All	F_2						3.6	0.9	37.2	0.24	0.032	5.4

Machold, O., and K. Gröber Effect of nutrition on growth and chlorophyll production of the tomato mutant $xantha_5$.

In a former report (TGC 13) we described the chlorophyll mutants xan_1 and xan_4. Besides these mutants another form exists in the material from H. Stubbe called xan_5. This mutant shows a segregation ratio of 3:1, has yellow cotyledons, and is lethal under normal growing conditions. Yet it is possible to cultivate this mutant without grafting if growing at optimal conditions, at which the chlorophyll content of the cotyledons is already increased at 25-30°C. If growing in fertile soils in connection with especial physical factors the mutant is able to produce leaves high in chlorophyll. To analyse the factors responsible for this phenomenon many trials were carried out with culture solutions of different composition. The experiments point out that none of the applied 10 standard culture solutions has an equal effect on chlorophyll production at the same physical conditions as do soils high in fertilizer. Good results were obtained in culture solutions with high buffer capacity against H ions (v.d.Crone, Zinzadze) and weak acid reaction (pH 5.5-6). Furthermore, it was evident that the kind of nitrogen has an important influence on chlorophyll synthesis. All culture solutions with NH_4 nitrogen were distinctly superior to NO_3 nitrogen.

Martin, F. W. Use of Cycocel in dwarfing greenhouse-grown tomato plants.

In an effort to satisfactorily dwarf tomato plants, particularly species materials, to reduce labor of pruning and tying and to save greenhouse space, the commercial product Cycocel[1] (2 chloroethyl trimethylammonium chloride) has been applied to tomato seeds and seedlings in a variety of formulations. This chemical acts in a manner analogous to cold nights and short days, for the chief effects are to shorten internodes and reduce dry weight (Wittwer and Tolbert. 1960. Amer. Jour. Bot. 47:560-565). However, flowering is not retarded and may even be slightly stimulated. Only a summary of the experimental methods and results can be given here, but details are available to correspondents.

Time and method of application	Amounts or concentrations	Effects
1. Preplanting soak of seeds for 24 hrs.	0.0006%[2] to 11.8%	Higher concentrations slightly retarded germination. No dwarfing.
2. Continuous treatment of seeds on filter paper.	0.006% to 11.8%	Drastic reduction of germination, poor viability, very little dwarfing of survivors.
3. As soil drench with first watering after planting of seeds.	1 ml. of each solution above	Slightly reduced germination, retardation of growth but little dwarfing.
4. As soil drench after transplanting of seedlings.	1 ml. of each solution above	Excessive killing and chlorosis. Survivors well-dwarfed. Only higher concentrations effective.
5. As soil drench when first true leaf expanded.	1 ml. of each solution above	Satisfactory dwarfing without killing and without delay in flowering.
6. As soil drench when first buds seen.	1 ml. of each solution above	New growth dwarfed but plants too large for full benefit of the treatment.

A screening of 62 varieties and species using technique No. 5 (soil drench of 1 ml. of a 11.8% solution after expansion of first true leaf, 4-inch pot, previously watered soil) showed that all tolerated this dosage. Higher dosages often caused chlorosis and sometimes death. Varieties differed in the degree of dwarfing caused by Cycocel. Repeated treatments every 2 or 3 weeks kept the plants in a dwarf condition. In all treatments, time of flowering was not changed. Flowering was not induced during long days in short-day L. hirsutum. Fruit-set was normal in terms of seeds per fruit and fruits per pollination. As yet, no evidence of change in compatibility relationships has been found. Seeds from heavily treated plants germinated normally and plants were not dwarfed. Data on interaction of Cycocel treatment with environmental factors were not obtained.

[1]Manufactured by American Cyanamid Company, Princeton, New Jersey.
[2]A total of 15 different concentrations used.

The dosage recommended above is now used as a standard treatment for several kinds of experiments with tomatoes and is an effective worksaver.

The accompanying table summarizes the typical results of Cycocel treatment of the variety Red Cherry. It is interesting to note that a second application of 1 ml. of solution after 14 days was more effective in reducing size than a single application of 2 or 4 ml.

Amount of 11.8% solution	Applications	Height before treatment	Height after 14 days	Height after 28 days	Time to flower	Nodes at flowering	Fruit set
cc	number	cm	cm	cm	days	number	%
0	-	4.67	29.62	74.50	39.75	9.75	80
1	1	4.95	16.62	49.25	39.00	10.00	65
2	1	4.87	17.75	46.50	37.25	10.00	85
4	1	4.50	15.50	38.75	39.00	10.00	70
1	2	4.55	16.52	30.25	39.25	10.00	95
2	2	4.62	16.37	30.50	39.25	10.00	85
4	2	5.12	15.12	29.25	39.25	9.75	75

Moens, P. The diffuse stage in tomato meiosis. Observations on squashes of pollen mother cells in different stages of meiosis indicated that after pachytene the chromosomes go through a diffuse stage before contracting to diakinesis and diplotene. During diffuse the chromosomes lose their individuality and the cell is filled with a tangle of thin threads. This stage has been observed previously by Gottschalk, Menzel and Rick, although the latter suspected an artifact.

To determine the nature and occurrence of the diffuse stage, sections of young tomato buds were prepared. From longitudinal sections it was apparent that a gradient exists through the anther. The earlier stages are near the top (distal) end, and the later stages are at the lower end. For example, the upper cells could be in diplotene, the central ones in first metaphase and first anaphase, and the cells near the lower end would be in interphase.

Sections of buds with prophase cells showed that the diffuse stage follows pachytene and that it precedes diakinesis. From sections and squashes it was observed that at late pachytene the bivalent nature of the chromosomes becomes apparent. Subsequently, the heterochromatic areas separate, leaving the centromere and the euchromatic zones paired. It is suspected that published illustrations of zygotene in effect are pictures of early diffuse stage. The cell then passes into diffuse proper at which time the cell somewhat resembles the classic leptotene configuration in that it is filled with thin strands. Gradually the individual bivalents become clear and diakinesis and diplotene follow. (This research has been supported by the National Research Council.)

Moens, P. Endo mitosis in tapetum cells.

In the young tapetum cell of the anther, mitosis results in two daughter cells with 24 chromosomes each. These chromosomes are clearly double, and shortly after the division, the chromosomes start to elongate somewhat and simultaneously split apart lengthwise. A cell with 48 chromosomes results and each chromosome again is double. The same process is repeated to give a cell with 96 (8n) chromosomes. At this time the euchromatic and heterochromatic areas as well as the centromere can be distinguished on the individual chromosomes. It seems that the cells enter interphase at this stage, but some metaphase of high ploidy have also been observed.

Pecaut, P., and H. Laterrot Linkage between Tm_2 and n v.

The use of Tm_2 would be useful since a virulent strain of T.M.V. which presents a high rate of multiplication in Tm_1/Tm_1 plants has a very low rate of multiplication and does not affect growth of Tm_2/Tm_2 or $Tm_2/+$ plants. *Solanum pennellii* LA716 (seeds supplied by Rick) shows severe symptoms when young seedlings are inoculated with this virulent strain.

We did not succeed apparently to break the linkage between Tm_2 and n v. Using Tm_2 (from Clayberg 60.L.195.10 supplied by Pelham) we tested the selfed progenies of 288 resistant plants issued themselves by selfing 4 plants Tm_2.n v/++. We obtained the following results:

Number of progenies - 288
Number of seeds sown - 7,117 -- either 24 or 25 by progeny --
Number of seedlings - 5,988 (germination 84.1%) among which only 17 n v/n v seedlings (in 17 different progenies).
Number of T.M.V. inoculated seedlings - 5,716
Number of resistant seedlings - 3,973 = 69.6%
Number of susceptible seedlings - 1,743 = 30.4%
Number of progenies segregating for T.M.V. resistance - all = 288.

We observed: the very rare occurrence of n v/n v (never more than 1 for 25 seeds and very often 0 even with a 100% rate of germination.

The ratio of resistant seedlings is slightly higher than the expected one (2/3 - 1/3).

Pelham, J. More news of Tm_2. (Submitted by L. A. Darby)

P. G. Smith (TGC 12:44, 1962) has suggested that certain lines which appear to have the linkage between the Tm_2 and nv genes broken really carry a lethal factor which prevents the recovery of Tm_2 nv homozygotes. In the course of a backcross breeding programme to transfer Tm_2 from such a line into several British varieties the following observations were made.

(a) D. Lapushner's observation (TGC 13:37, 1963) of necrotic lesions on inoculated resistant plants has been confirmed, but sometimes a more severe necrosis is also found. Occasionally older plants, initially screened as resistant, develop a veinal necrosis in the younger leaves

which spreads to and kills the growing point. Such plants contain virus in their tissues which is detectable by the normal N. glutinosa test. Very severe TMV symptoms are seen in any later growth and green fruit on the plant at the first symptoms of necrosis show severe bronzing and pitting.

(b) Even after five backcrosses with a recurrent parent followed by several selfing generations, there is still a 2:1 segregation for resistance: susceptibility. Not more than 1% of the plants are nv/nv.

(c) One plant in a programme involving an anthocyaninless recurrent parent has given rise on selfing to a family segregating for a lethal character. The cotyledons of seedlings with this character gradually became yellow and the seedlings died before the first leaves were formed. The segregation was 138 green:50 lethal. 116 green plants were inoculated with virus; 81 were resistant and 35 susceptible.

The anthocyaninless character is one of a syndrome of characters which are inherited together in simple genetic fashion. Tests for allelism with other anthocyaninless genes have so far been inconclusive but crosses with plants carrying ah which is located, as is Tm_2, on chromosome 9 are being made. Further crosses are being carried out to determine if this new lethal is merely the late expression of Smith's original lethal when in a different genetic background or a new character resulting from mutation or from the interaction of the genotypes involved.

(d) So far no cross has been reported between a line carrying Smith's postulated lethal factor and the original Tm_2 nv/Tm_2 nv line. The F_1 of such a cross consisted of 16 normal:19 nv plants. This gives conclusive evidence of the continued presence of nv in the lethal carrying line of Tm_2.

Phatak, S. C., M. E. Austin, and S. Honma "Top" forming tomato mutant - morphological and developmental observations.

During the summer of 1963 in a field of Campbell 1327 variety, a plant was noticed which lacked the usual normal yellow flowers. Close observation showed the flowers were light green due to the leafy enlarged tube-like calyx. Of special interest was the observation that the other floral parts failed to develop and were minute in size.

Four cuttings rooted in July have been maintained in the greenhouse. When these plants were observed in mid-October, it appeared that the rudimentary appendages developed into leafy structures resembling a compressed shoot with short nodes (rosette).

Since the male and female parts were non-functional, no attempt was made to study inheritance. Present efforts are devoted to obtaining functional organs.

Ramirez, D. A., and M. L. Tomes
The inheritance and gene action in the dirty red (green flesh) mutant.

A mutant, tentatively called dirty red, was found in the F_5 generation of a cross between two pigment strains, alpha-delta and apricot. This mutant is characterized by the presence of chlorophyll in ripe fruits, resulting in a dirty red flesh color. The inheritance study revealed that dirty red is either allelic or synonymous to the green flesh (gf) mutant. Like gf, the dirty red mutant is controlled by a single recessive gene.

Analyses of chlorophyll a and chlorophyll b contents showed that plants homozygous for the dirty red factor did not differ significantly from those of the normal red type when the fruits were at the immature green stage. Upon ripening, however, those homozygous for the dirty red factor contained considerable chlorophyll, while none was detected in the normal red type.

To determine whether the chlorophyll present in the ripe fruits is due to the impairment of the degradative mechanism, the chlorophyllase activities of both the red and dirty red F_2 progenies were determined. There were no significant differences in chlorophyllase activities between the two types when the fruits were at the immature green stage. Upon ripening, slight chlorophyllase activity was detected in the dirty red progeny, while the normal progeny did not exhibit activity. Chlorophylls from the red and dirty red progenies were equally efficient as substrate for chlorophyllase from either source. The fact that the degradative mechanism appears normal suggests that the dirty red gene does not influence the degradative process, and impaired degradation does not account for the presence of chlorophyll in the ripe dirty red fruits.

The dirty red factor not only influences the presence of chlorophyll in the ripe fruits, but also the carotenoid contents of the ripe fruits. The carotene pigments and polyene fractions considered were lycopene, gamma-carotene, beta-carotene, phytofluene, and phytoene. The carotenoid content of the plants homozygous for the dirty red factor was lower than that of the normal red type, and the differences between the fractions were highly significant. A biosynthetic relationship between the two pigment systems is evident; where the dirty red factor was homozygous, chlorophyll was present in the ripe fruits and the carotenoid content was lower than that in the normal red genotype.

Retig, N., and N. Kedar Possible interaction between "self-pruning" and "short internodes".

The genetic basis of short internodes in line No. 145 (Acc. 334, Urbana) has not yet been fully explained. Crosses between No. 145, and eight different long internode lines of genotypes sp sp and + +, respectively, showed that internode length of the F_1 generation depends on the sp allele present.

Variety or cross	Genotype	Number of plants tested	Mean internode length in mm
No. 145	sp sp	30	23
Moneymaker	+ +	34	46
F_1 (Mon. x No. 145)	sp +	30	26
Tamar	+ +	34	42
F_1 (Tamar x No. 145)	sp +	43	21
Kc 146	+ +	34	49
F_1 (Kc 146 x No. 145)	sp +	37	32
Ejlon	sp sp	29	46
F_1 (Ejlon x No. 145)	sp sp	39	42
Roma	sp sp	20	31
F_1 (Roma x No. 145)	sp sp	35	42
Urbana	sp sp	33	48
F_1 (Urbana x No. 145)	sp sp	11	41
No. 135 (high pigment)	sp sp	37	52
F_1 (No. 135 x No. 145)	sp sp	38	44
No. 305 (Rehovot hp-line)	sp sp	17	39
F_1 (No. 305 x No. 145)	sp sp	15	43

In summarizing, we find the following internode lengths:

No. 145 (sp sp) common short internode ♂ parent	23.0 mm
Long internode parents (+ +)	45.7 mm
F_1 (sp +) between long parents and short parent	26.3 mm
Long internode parents (sp sp)	43.2 mm
F_1 (sp sp) between long parents and short parent	42.4 mm

Thus, mean internode length is similar in the two groups of long internode parents (sp sp and + +). F_1 generations (long x short) of genotype sp + show short internodes (26.3 mm) similar in length to the short parent (23 mm). F_1 generations (long x short) of genotype sp sp exhibit internodes approximately as long (42.4 mm) as those of the long parents (43.2 mm).

It can be concluded that in the present material expression of dominance in F_1 crosses between long and short internodes depends on the allele for self pruning.

Rick, C. M. Inheritance and linkage relations of Lapageria (Lpg).

Originally found as an unfruitful plant (2-561) in var. VF 36, Lapageria presents a unique appearance. The plant, aside from the consequences of unfruitfulness, is of normal habit, but reduced size. Leaves, however, have a dark green color, reduced size, obtuse extremities, and a glossy, concave, slightly bullate surface (see cover illustration). Trichomes are reduced in size and number, but glandular hairs seem to be present in normal numbers. The corolla at anthesis can

expand only at the tips; the flower consequently has a narrow companulate form, reminiscent of the flower of the elegant Lapageria rosea, national flower of Chile. The stamens, presumably as a result of hair reduction, are dialytic. Fruit set is 10% or less of normal. We have encountered the Lpg phenotype as a bud sport of unfruitful plants on repeated occasions, but this has been our first opportunity to subject it to any genetic tests.

The heterozygous condition of the original plant was revealed by segregation in its immediate progeny into 2 normal, 5 like the original and 1 extreme type. The latter, a smaller plant, had darker green, more highly modified leaves and few or no hairs, and never flowered. Fourteen separate crosses to other tomato stocks have yielded 86 normal and 94 Lpg of the same phenotype as the original. This information plus the following F_2 data prove that it is a dominant mutant with homozygotes viable at least under certain conditions.

The following data have been collected for tests of Lpg against various mutants. The segregation of Lpg by itself varies in the different progenies, suggesting that in some combinations its homozygotes might be completely viable, in others less viable or completely inviable. Positive evidence of linkage is found for au and yv. The data for yv are not consistent and the indication of linkage is not nearly so convincing as that for the single family of au. Further tests will be made in an attempt to clear up this situation, but on the basis of present evidence, it appears more likely that Lpg lies on chromosome 1, some 16 units from au.

Combination	+ +	+ t	Lpg +	Lpg t	Adj. cont. χ^2
Lpg-ag	43	11	107	30	
	52	16	112	43	
Lpg-au	40	74	278	24	146.0
Lpg-c	41	13	110	27	
	53	13	115	40	
	125	30	238	86	
	73	16	134	39	
Lpg-yv	45	9	115	22	
	52	16	137	18	4.3
	96	59	273	51	28.3
	56	33	148	25	16.2
Lpg-d	91	23	198	104	
Lpg-tf	92	22	219	83	
Lpg-lg_5	55	21	103	64	

Rick, C. M., and J. E. Boynton
Further linkage tests with mutants of Stubbe's group III.

Linkage tests have been continued with the same procedures previously reported. Four new linkages are reported, for which results of all completed tests are given in the following tables. Linkages are indicated by L, suggested, but non-significant deviations by S, and no marked departures from random recombination by X. Data for the last two categories are not presented, but records are maintained for anyone who might need them.

The relationships indicated for adp are very clearly established. The linkage between it and deb has not been broken and the distance from La must be a short one. These new findings coincide well with our previous discovery of a distance of about 4 units between La and deb.

The tight linkage between div and sf is also very clearly indicated. Both genes are well expressed in the seedling stage and their compound should be readily identified. Only one possible double recessive has been found so far.

The identification of pen with chromosome 2 is unmistakable, although the linkage intensities in the different tests are not consistent. The bulk of evidence suggests that pen is closer to d_1 than to Wo^m. That it probably does not lie between them is betrayed by the fact that most pen-d_1 recombinants were also aw and Wo^m.

The data for prc seem to affiliate it with chromosome 6, but clearly much more must be done before a locus can be approximated. Significant deviations from random recombination were found for all three tested markers of 6. The interaction between prc and yv is difficult to distinguish even under field conditions, so that the data for this end of the group are least reliable.

Summary of linkage tests

Chromosome	Tester	adp	div	pen	prc
1	au	X	X	X	X
	pr		X		X
	Jau	X	X		X
	y	X	X		
2	d_1	X	X	L	X
	aw			L	X
	Wo^m	X	X	L	X
3	sy		X		X
	wf		X		
4	e		X	X	
	ht		S		
	clau		X		X
5	tf	X	X	X	X
	mc		X		
6	c	X	X		S
	md				L
	yv	X	X	X	L
7	lg_5		X		X
8	al		X		
	dl	X	X	X	X
	l_1	X	X	X	X
9	ah	X	X	X	X
10	H	X	X	X	X
	u		X		
	t		X		
11	a_1	X	X	X	X
	hl		X		
?	rv				
	sf		L		S
?	La	L	X		X
	deb	L			

Linkage data for genes of Dr. Stubbe's group III

Combination	+ +	+ t	m +	m t	Adj. cont. chi-square	Co.
adp-La	5	54	20	3	44.5	6
	21	216	80	19	170.0	5
adp-deb	111	44	40	0	13.0	0
	Disc.	117	Disc.	0	37.3	0
div-sf	140	88	67	0	35.0	0
	147	74	79	1?	30.9	0-11
pen-Wo^m	26	137	24	40	11.2	34.5
	98	885	88	120	133.8	25.5
pen-aw	109	54	57	7	10.4	31.0
	548	435	199	9	115.3	-
pen-d_1	196	99	76	4	24.3	21.5
	115	48	57	7	7.6	34.0
	681	302	204	4	73.0	14.5
prc-c	182	62	85	12	6.2	-
	49	14	16	2	3.5	-
prc-md	184	60	87	10	7.8	-
	41	22	17	1	5.1	-
prc-yv	202	42	87	10	2.1	-
	41	22	18	0	4.9	-

Rick, C. M., and W. H. Dempsey

Chromosome 12 continues to hold out.

With linkage groups identified for each of the tomato chromosomes except No. 12, we are concentrating our efforts on an attempt to find at least one marker for this chromosome. To date 60 genes have been systematically tested against triplo-12 with negative results. These include the described genes: a_1, ah, al, bl, br, c, ch, cl_2, clau, cm, cpt, d_1, dl, e, f, gq, gs, H, hp, ht, j_1, j_2, Jau, l_1, ls, lut, Lx, marm, mc, Nr, Od, og, pr, ps, r, Sd, sf, sp, t, tf, u, ug, var, vg, w_4, wd, sf, st, y, and yv, and the following undescribed genes provisionally symbolled bkd, brd, cdm, Di, lk, lyr, ph, Px, ruf, and sn.

Considering the number of genes that have been tested, we have become curious about the probability of such repeated failure. Probabilities have been estimated on the basis of several assumptions. For the first estimate: an estimate based on equal likelihood for a gene to be located on any of the tomato chromosomes is $(11/12)^{60} = 0.0038$. A more realistic estimate takes account of the relative euchromatic lengths of the pachytene chromosomes. Since chromosome 12 carries 4.1% of the total euchromatic length of the tomato complement, the probability can be calculated as $0.959^{60} = 0.081$.

In the preceding estimates account is not taken of the fact that the 60 genes were not taken at random, but at least part of them were selected particularly because they had not yet been located. To each of the genes not yet located a probability can be assigned for failure that it lies on chromosome 12. If relative euchromatic lengths are taken into account, the product of such probabilities is 0.0274. The probability of failure for the remaining group of located genes is calculated as above at 0.165. The product of the two, 0.0045, is the best estimate of probability of failure to locate a gene on chromosome 12 by our tests.

Since it does not appear likely that random variation could explain this failure, it either represents a real genetic inertness of chromosome 12 or some flaw in our methods. We are convinced that our stocks of triplo-12 are correctly identified. This trisomic has a very distinct phenotype, and every preparation of its pachytene chromosomes revealed 12 to be the extra. If the 60 genes were validly tested against triplo-12, it is difficult to escape the conclusion that chromosome 12 is peculiarly deficient for marker genes. Such a conclusion would be in keeping with the one which we previously drew that chromosomes 2 and 11 seemed to be disproportionately overpopulated with marker genes. Nothing in the proportion of heterochromatin or other cytological properties seems to account for these differences. We shall continue to test unlocated genes against triplo-12 with the hope that we can find a marker in the near future.

Rick, C. M., and G. S. Khush
Location of chromosome 8 markers by X-ray induced deficiencies.

Last year (TGC 13:24-25) we gave a preliminary report on the delimitation of dl and l_1 to the short arm and long arm, respectively, of chromosome 8. The family from which these deficient plants were recovered was small and only one dl and l_1 plant appeared. Both of these plants carried compound deficiencies and poor preparations were obtained. Since we were somewhat uncertain of our previous identifications we grew large progenies this year. Fortunately, 10 l_1 plants appeared among more than 9,000 plants grown from the cross ms a_1 c d_1 l_1 x +++++, X-rayed pollen. Three plants out of these 10 were examined cytologically. Two were deficient for the entire short arm of chromosome 8, and one had an interstitial deficiency of the euchromatic region of 8S. This means that l_1 must be in the euchromatin of 8S, and our previous analysis of the l_1 plant recovered in 1962 from ms_2 l_1-bu-dl x ++++, X-rayed pollen, must be in error. Unfortunately, the plant had already died and was not available for reexamination. The sister dl plant from which earlier determination was made was still living, and its reexamination revealed that it had a terminal deficiency of 7S which was misidentified with 8. A small heterochromatic segment of this missing 7S replaced the small interstitial euchromatic segment of the 8L at an interstitial location near the junction of heterochromatin and euchromatin. This means that the revised location of dl in this segment of 8L and that of l_1 in the euchromatin of 8S is established with certainty; bu may be either in the short arm or in the long arm, probably in the heterochromatin. We are now trying to obtain plants which are deficient for bu region so that its location may also be ascertained.

Schroeder, W. T., R. Provvidenti, and R. W. Robinson Necrodeformis (ned), a new tomato mutant markedly responsive to temperature.

A virosis-like disorder, discovered in the field in 1961 at Geneva, New York, among Eastern States 24 tomato plants (grown from seed supplied by C. A. John of the H. J. Heinz Company) has been characterized as a mutant markedly responsive to temperature. Symptoms are suppressed at temperatures below 70°F or thereabout and intensified proportionately at higher temperatures. Primary symptoms usually appear at the time of the first flowers as a

chlorosis that extends distally and irregularly from the basal area of the leaflets along the midrib. Sometimes purplish-brown areas develop, become necrotic, and fall out to give some leaflets a shot-hole appearance. Superficial purplish areas that later turn brown may develop on the petioles and stems. In severe cases the plant is stunted and unproductive, the flowers and leaves twisted and distorted, and the few fruits that develop are often patched with a superficial necrosis or browning. A severely affected plant will develop normal growth if the temperature drops to 70°F or below and will resume symptom expression on subsequent growth when returned to the higher temperature.

Initial attempts failed to prove a virus as the incitant. Homozygous mutant and normal E.S. 24 lines were established by single plant selections. Backcross and F_2 populations derived from reciprocal crosses between homozygous mutant E.S. 24 and normal Fireball plants established the conditioning agent as a single recessive gene (Table 1). Crosses with aeg, Cri, lae, ne_1, and Nec indicated nonallelism with the new gene, designated necrodeformis (ned).

Table 1. Segregation for ned in self, F_1, F_2, and backcross generations.

Cross	No. of families	Segregation Normal	Segregation Mutant	Deviation X^2	Deviation P	Heterogeneity X^2	Heterogeneity P
Mutant ES 24 x self	4	0	633				
Normal ES 24 x self	9	642	0				
Normal ES 24 x self	4	216	69	0.09	0.70-0.80	0.65	0.80-0.90
(Mutant ES 24 x Fireball) F_1	4	310	0				
(Fireball x Mutant ES 24) F_1	3	197	0				
(Mutant ES 24 x Fireball) F_1 x Fireball	3	304	0				
(Mutant ES 24 x Fireball) F_1 x Mutant ES 24	3	107	92	1.13	0.20-0.30	0.10	0.95-0.98
(Mutant ES 24 x Fireball) F_2	3	244	75	0.37	0.50-0.70	0.18	0.90-0.95

Soost, R. K. Another source of j_2.

In TGC 7:13, 1957, I reported a mutant which was called ramified inflorescence and tentatively assigned the symbol ri. This symbol was retracted (TGC 8:35) because of prior usage. Assignment of a new symbol was withheld until additional segregation data was available. This mutant was subsequently crossed with a source of j_2 from Dr. George Reynard. The F_1 shows all the characteristics of Reynard's j_2. At the time the original mutant was isolated, neither Dr. Reynard's j_2 nor the j_2 gene from Dr. Rick's Galapagos Island accession were growing in the collections at this station. Previous crossing with j_1 and s clearly demonstrated that the

mutant was not either of these genes. The mutant originally appeared in a population involving the variety Earliana and a line with a complex background involving resistance to fusarium but having only L. esculentum parentage.

Williams, W. Report on rv-sf linkage. Experience with these two markers over several years has led to the conclusion that they are unsatisfactory for two- and three-point linkage studies. The presence of rv gives severely distorted ratios due to pre-germination lethality, and many of the standard markers are impossible to classify accurately in association with rv. sf alone is highly sterile as female due to its effect in conditioning dialytic styles; it also produces very little pollen. I doubt whether further work involving trisomic tests would be rewarding because of the distorted ratios that accompany the use of these mutants. I propose therefore to abandon the programme of linkage studies involving these two markers.

Whalen, R. H. The linkage relations of yg_6. The radiation-induced chlorophyll mutant yellow-green-6 (yg_6) (TGC 12:14, 1962) is actually a syndrome of three characteristics: yellow-green first true leaves, greatly elongated hypocotyl, and little or no development of anthocyanin.

A series of linkage tests showed yg_6 to be independent of c, md, cm, and yg_3. A significant indication of linkage was found between yg_6 and the gene hl of chromosome 11. The pertinent F_2 repulsion data are as follows:

+ +	yg_6 +	+ hl	yg_6 hl	Total	Contingency chi-square
1081	526	418	7	2032	167.8**

These data indicate 13% recombination, as calculated by the product method.

The three-point backcross, $\frac{yg_6 \quad + \quad +}{+ \quad hl \quad a_1} \times \frac{yg_6 \; hl \; a_1}{yg_6 \; hl \; a_1}$, was then made and gave the following results:

+	a_1	hl	yg_6	hl a_1	yg_6 hl	Total
55	13	34	412	361	52	927

Since yg_6/yg_6 plants cannot be scored for a_1 vs. a_1^+, only six phenotypic classes are obtained instead of the usual eight. Hence, recombination between hl-yg_6 only can be calculated; that between hl-a_1 and yg_6-a_1 cannot. The backcross data indicate 13% recombination between hl and yg_6, confirming the F_2 data.

Determination of the gene order from the above three-point backcross data requires special consideration because of the epistatic effect of yg_6/yg_6 on a_1 and a_1^+. The theoretical phenotypes expected (without epistasis) and those actually obtained (with epistasis) for each of the three possible orders are as follows:

Order		Parentals	Single Crossovers	Double Crossovers
yg_6-hl-a_1	Expected:	yg, hl a	+, hl, yg a, yg hl a	a, yg hl
	Actual:	yg, hl a	+, hl, yg, yg hl	$\boxed{a}$, yg hl
hl-yg_6-a_1	Expected:	yg, hl a	hl, a, hl yg, yg a	+, hl yg a
	Actual:	yg, hl a	hl, a, hl yg, yg	$\boxed{+}$, hl yg
hl-a_1-yg_6	Expected:	yg, hl a	+, a, hl yg, hl yg a	hl, yg a
	Actual:	yg, hl a	+, a, hl yg	$\boxed{hl}$, yg

The three classes enclosed by $\boxed{}$ are the critical ones for determining the gene order since they occur as double crossovers only and not also as parentals or single crossovers in that same gene order. Whenever these types also occur in some other gene order, they occur only as single crossovers and hence will be more frequent. The correct order is thus that order which gives the fewest of any one of these three types. The three-point backcross data show the a_1 class to be the least frequent, indicating the order to be yg_6-hl-a_1. Reconciling the above results with the known positions of hl and a_1 (TGC 13:6, 1963) gives a map of:

$$\ldots \underset{24}{yg_6} \underset{37}{hl} \underset{57}{a_1} \ldots$$

This puts yg_6 between j_1 and gh. Confirmatory three-point backcross tests with j_1 are now in progress.

Thus far some 10,000 plants from yg_6/+ heterozygotes have been scored in these and other experiments. No separation of the three characters of the yg_6 syndrome has yet been found. Until such a recombinant occurs, yg_6 must be considered to be a case of pleiotropy rather than a complex locus.

Young, P. A. Flesh color of tomatoes ripening in hot weather. Tomato flesh color usually is brightest red when the fruits ripen at temperatures near 60° to 85°F. The plants for the annual summer tomato field were set in the field about June 3rd. Rutgers set few fruits; the other kinds set big crops. Temperatures near 90° to 95°F were common in July and August when the fruits ripened.

Alpha 88FR bore the best crop of large early fruits, but the flesh was pale pink and white in contrast to the fine red flesh on the fruits that ripened in the spring crop. In contrast, Red Bobs fruits had beautiful bright red flesh color in the summer crop. Pinkdeal, Hotset and Early Alberta varieties had good flesh color. BV132-2111 and 2113 from Stevan Molnar from Brooks, Alberta also had fruits with good flesh color but had large percentages of fruits with catface or exserted carpels.

To the extent attainable, the core and locule walls of red-ripe tomato fruits should be red or pink instead of the common white color, although sliced tomatoes with both red and white colors are pretty and standard. Red flesh color is determined by the r+, t+ and mostly unidentified modifying genes. High Crimson tomatoes with cr_1+, cr_2 have extra beautiful flesh in spring weather.

PART II

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PART III

ADDITIONS TO STOCK LIST

STOCKS AVAILABLE

Source	Name	Description
Lesley, J. W.	blue green be virescent tangerine t^v	Identifiable as young seedling. Chromosome 10.
	aurea au_1	Chromosome 1
	cabbage cb	Not easily identified in some combinations. Probably in chromosome 1.
	anthocyaninless (totally)	Not an allele of a_1, but not tested against five or more others without anthocyanin listed in TGC 12, 1962.
Pecaut, P.	*Meloidogyne incognita* resistant Mi Mi strains (Resistance from the variety Anahu supplied by Frazier). Ronita (= Roma Mi/Mi, I/I) Piernita (= St-Pierre Mi/Mi, i/i) and other lines.	
	Some homogeneous sib lines of *L. peruvianum* (from populations supplied by P. I. Ames) resistant to severe strains of T.M.V.	
	Tobacco-mosaic virus resistant Tm_1/Tm_1 strains (Resistance from the variety H.E.S. 5639-15).	

PART IV

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PART V

FINANCIAL STATEMENT

(to December 31, 1963)

		Total
Balance from 1962		$282.24
Receipts		
Assessments	$211.55	
Sale of back numbers	83.00	
Interest on savings	10.41	304.96
Assets		587.20
Expenditures		
TGC Report No. 13, 1963		
Multilithing and covers	214.33	
Stencils, envelopes, and clasps	14.70	
Postage	33.16	
Miscellaneous		
Postage for newsletter	19.06	
Postage for notices and back issues	15.96	
Mimeographing newsletter	2.83	
Statement pads	1.19	301.23
Balance		$285.97

MEMBERSHIP STATUS

Assessments paid for	1963	112
	1964	55
	1965	47
	1966	50
	1967	10
	1968	3
	1969	1
	1970	1
	1971	1
	1978	1
Total members		281