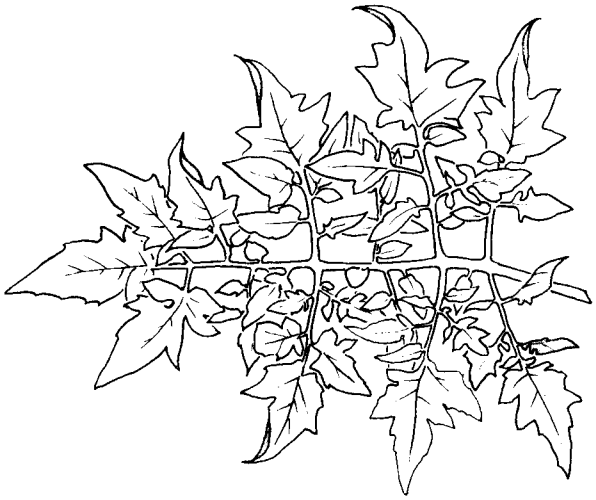
REPORT
of the
TOMATO GENETICS
COOPERATIVE



NUMBER 16 FEBRUARY 1966

DEPARTMENT OF VEGETABLE CROPS
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

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.

The year 1965 witnessed further growth of the TGC. Membership increased from 285 to an even 300 at January 1, 1966, including 132 (44%) in 38 foreign countries. At that time our financial balance stood at $279.77.

The regular annual meeting was held under the auspices of AIBS at Purdue University on August 16, 1965. Minutes appear on the next page. Arrangements are being made currently for the 1966 meeting at the AIBS sessions in College Park, Maryland.

We report with deep regret that the TGC lost two of its stalwart charter members in 1965. Dr. J. A. Jenkins, who pioneered research on the origin of the cultivated tomato and on the developmental genetics of leaf form, passed away September 15, 1965. The status of Jim's research on the leaf-shape mutants is summarized, and a list of his stocks presented in this Report. Dr. P. A. Young, who was prominent in early linkage investigations and bred new varieties adapted to lower U.S. latitudes, resigned from membership because he has recently removed from tomato research. Both served on various committees and were otherwise prominent in TGC affairs. Both will long be remembered for these contributions and for their resolute, independent thinking.

Another unpleasant duty is to report action taken to increase the annual assessment from $.75 to $1.00 and the price of backnumbers from $1.00 to $1.50 each. As outlined in the minutes of the Purdue meeting, this series of changes--the second since the TGC was organized in 1949--was dictated by the declining trend of our yearly balances.

Special features of this Report are the Report on the New Mutant Program and Summaries of the Committee on Varietal Pedigrees. The former summarizes progress during the first two years of operation. The latter, a sequel to a Report issued in TGC 11, presents the pedigrees of many additional, important tomato introductions.

We take special pleasure in acknowledging the faithful help of the following workers in preparing TGC 16. Dora Hunt, veritably our Editor and Executive Secretary, assembled the bibliography, took charge of the membership list, prepared the financial statement, and edited all copy for TGC 16. She additionally took charge of membership arrangements throughout the year. Credit for the excellent job of typing the stencils goes again to Betty Bell. Many others, including graduate students and colleagues, assisted with assembling the Report and with other details.

Five hundred copies of this Report have been issued.

Minutes of the Urbana Meeting

August 16, 1965

The regular annual meeting of the TGC was held at 4:30 p.m., Monday, August 16, in Room E, Law Building, University of Illinois, in conjunction with the AIBS meetings. Sixteen members of TGC were in attendance.

The financial condition of TGC was reported in some detail from information supplied by C. M. Rick. The balance on August 1, 1965 was $197.21 with a membership of 281. This compares with a balance of approximately $300 on August 1, 1964. Increased size of the report, increased mailing costs, and the probable income for TGC were discussed with the conclusion that an increase in dues was necessary to maintain solvency.

It was moved and seconded that the annual dues be raised to $1.00 per year, with $1.50 per year for backnumbers. The motion passed without dissent. There was voiced an expression of appreciation to Dr. Rick, and to the Department of Vegetable Crops, University of California, for obvious time and effort expended without monetary compensation.

It was reported that the tomato gene list is in the process of being assembled for publication in the Journal of Heredity by Carl Clayberg and that the latest linkage map will be included by consent of all concerned.

It was noted that TGC 16 probably will include a report by the committee on varietal pedigrees headed by T. O. Graham.

The fact that the demand for backnumbers of TGC had diminished somewhat was reported with the comment that enough copies are on hand to meet most of the requests anticipated in the next year or two. A large number of extra copies of the last five TGC reports are available.

There was a brief discussion of the isogenic stock program suggested by L. A. Darby in TGC 15. A committee had been appointed to examine the proposal and to make recommendations to TGC. The deliberations of the committee were reported briefly, but no formal committee report was given. It was reported that Kerr and Darby had conferred in England this summer but that the results of these discussions were not yet available. R. W. Robinson expressed the feeling that the selection of one or two specific recurrent parents might not be desirable.

The fact that additional mutants in the new mutant program would be received for distribution from Dr. Verkerk and that Dr. Verkerk would take over the mutant categories relinquished by Dr. Bell of Penn State was reported.

The meeting adjourned at 5:15 p.m.

M. L. Tomes, Secretary, pro tem.

NEW MUTANT PROGRAM

Since the New Mutant Program has been in effect for two years, it is appropriate to make the following brief report on the activities of volunteer cooperators. Seeds of 110 mutants induced by radiation and EI were received from Dr. Kay Verkerk and Ir. G. J. Hildering of the University of Agriculture, Wageningen, The Netherlands. These were classified in 19 arbitrary phenotypic groups and distributed to eight cooperators. The purposes of the program are to compare the mutants and make allele tests with other genes of similar phenotype; to name, symbolize, and describe the distinguishable mutants; and to carry out linkage tests or other research of interest to the cooperator. As with any such volunteer program, the progress that is realized will depend on such factors as incentive, interest, and free time of the volunteer. Considering these and other factors, we can be pleased with the results of this initial effort and anticipate that in the next biennium the program will expand and its objectives become better crystallized. Opportunity still exists in the program for participation of more cooperators. Inquiries concerning this and any other aspects of the program are welcomed by its acting coordinator, C. M. Rick.

In the following report summaries are classified according to mutant categories.

Group No.	Type	Cooperator	Report
1	Anthocyanin modifiers	Penny Knowles	The three anthocyanin deficiencies referred to me proved to be allelic with previously described genes. Research Note in this Report.
2	Chloro. defic.: whitish	Unassigned	
3	Chloro. defic.: yellowish	R. G. Creech	Progress was made on the following aspects: a. Seed increase was made in the greenhouse in 1964 for all stocks. b. The phenotypes for all mutants were observed and recorded in the field in 1965. c. Allele test crosses are being made in the greenhouse this spring.
4	Chloro. defic.: light green		
5	Chloro. defic.: yellow-green		
10	Leaf form		

Group No.	Type	Cooperator	Report
6	Chloro. defic.: virescent	K. Verkerk	This group was originally assigned to Dr. W. D. Bell, but a change in the direction of his research required him to relinquish it. The groups were recently reassigned to Dr. K. Verkerk.
7	Chloro. defic.: variegated		
8	Necrotic		
9	Hair modifications	Unassigned	
11	Plant habit	R. W. Robinson	Two of Verkerk's genes, 377-20aa and 242, are closely linked with ah, hence are almost certainly distinct from any previously named gene. I've crossed the Verkerk mutants in my groups with mutants of similar phenotypes; results should be available next summer. Fifteen additional mutants, very distinct in phenotype from any named gene, deserve symbols.
13	Modifications of inflorescence		
12	Flower form and color	F. Angell	Assignment made in Nov., 1966.
17	Disease resistance		
14	Sterility	A. Andrasfalvy	No mutants yet received.
15	Fruit form	B. Bergh	Two mutants received in spring, 1965.
16	Fruit color	M. L. Tomes	Three mutants received in 1964; pigment analyses reported in TGC 15:61-62. Analyses of two additional mutants received in 1965 reported in a separate Research Note in this Report.
18	Physiological characters	Unassigned	
19	Miscellaneous	Unassigned	

PART I

RESEARCH NOTES

Bohn, G. W., and G. A. Sanderson
Grafting improved pau seed yields.

Seeds were difficult to obtain from plants with the pau marker because the genetically depauperate plants grew poorly in the greenhouse and died in the field. We improved growth and obtained a few good seeds by grafting pau cions (whip and tongue) onto normal stocks. Depauperate cions grew better on stocks with considerable normal foliage than on severely pruned stocks. Normal cions remained alive but failed to grow on depauperate stocks. [Photos are available].

Boynton, John E. A search for biochemical mutants in the tomato.

The present study was initiated in 1961 with the hypothesis that among the many mutants described in the tomato (see gene lists, TGC 4, 9, 12, 15) some might represent simple metabolic blocks that could be corrected by supplying an exogenous source of the blocked compound. During the last 20 years many such biochemical mutants have been found in mutagenic experiments with Neurospora, bacteria and a number of other lower organisms. It was felt that if biochemical mutants should be found among the many chlorophyll-deficient and other morphologically distinct tomato mutant types, these would be unusually favorable material for learning more about the way in which genes control the complex processes of differentiation.

For the initial screening, a collection of 25 spontaneous and induced mutants were selected, all of which had distinct phenotypes strongly manifested in the first 3 weeks following germination. Nineteen could be classified as semi-vital chlorophyll-deficient types with varying patterns of white to yellow-green pigmentation and growth rates of 10 to 50% of normal (mutants dv, rv, wv, yv, t^v, au_1, gh, ten_1, ven_1, ph, afl, deb_1, inv_1, Xa/+, exl_1, plus 4 unnamed albino accessions). Three mutants, Cri_1, neg_1, and m_1, produced variously shaped patches of necrotic tissue on an otherwise normally pigmented background and grew at sub-normal rates. Two mutants, Fw and pr, with strongly modified patterns of epicotyl differentiation that resulted in greatly thickened and laterally unexpanded laminae, produced plants of weak and distorted stature but with normal pigmentation. An unnamed diminutive mutant, which grows at about 10% of normal rate, produced an otherwise normal phenotype.

Three replicates of 5 plants per mutant and 5 plants of normal genotype (Marglobe--homozygous for the normal alleles of all the mutants tested) were grown on washed quartz sand in 4-inch plastic pots watered as needed with standard Hoagland's solution. Each replicate was treated 3 times weekly with one of the following which was applied to the sand along with the Hoagland's solution: total amino acid solution, total vitamin solution, or distilled water. All plants were grown under natural daylight in a heated and air-conditioned greenhouse with a 65° F night and 75° F day temperature. The total amino acid solution was composed of a 0.002 Molar solution in distilled water of either the DL or L form of each of the 21 naturally

occurring amino acids. The total vitamin solution contained the following 17 vitamins each at a concentration of 20 ppm: vitamin A acetate, vitamin B_{12}, vitamin D, d-alpha tocopheryl acetate and folic acid--fat soluble compounds that were dissolved in a small quantity of ethyl acetate prior to mixing in the aqueous solution; thiamine (B_1), riboflavin (B_2), panthothenic acid (B_3), niacin (B_5), pyridoxine HCl (B_6), inositol, p-amino benzoic acid, menadione sodium bisulfite (K), choline chloride, biotin and ascorbic acid (C)--water soluble compounds that were dissolved directly in distilled water. All chemicals were obtained from Nutritional Biochemicals, Cleveland, Ohio. Solutions were stored in the dark at 4° C for the duration of the experiment. Treatments were continued for six weeks during which weekly visual comparisons were made between plants of each mutant treated with total amino acids, total vitamins, or distilled water; and the treated mutants were compared with the normal genotype grown on the three regimes.

One radiation-induced mutant, ten_1, from Stubbe's Group I, showed a significant growth response to the total vitamin solution from the second week of treatment. By the termination of the experiments 6 weeks later, plants of ten_1 in the vitamin treated replicate were about 4 times larger and of darker green color than the untreated and amino acid treated cultures. No other responses were detected among the 24 mutants tested. Replicated cultures of the mutant ten_1, prepared in the manner previously described, were then treated in a similar fashion with individual 20 ppm solutions of the 17 vitamins that comprised the total vitamin solution. Plants of the mutant ten_1 treated with vitamin B_1 (thiamine) gave the same significant growth response that was observed when this mutant was treated with total vitamin solution. None of the other 16 individual vitamin treatments gave any detectable growth or pigment response.

Since subsidary experiments have shown that the elaborate sand culture techniques of our first experiment were unnecessary, all subsequent plantings have been made on a standardized soil mixture in either 4-inch plastic pots or in shallow wooden flats. Thiamine, or other related compounds, is then applied to the leaves of mutant plants as a foliar spray to the point of run-off by means of small atomizers (DeVilbiss #15).

While our initial study was in its infancy, Langridge and Brock reported a thiamine-requiring tomato mutant, of spontaneous origin, with a striking chlorophyll phenotype that could be entirely corrected by treatment with foliar sprays of thiamine or of appropriate thiamine precursors (Australian J. Biol. Sci. 14:66, 1961). They have kindly provided seeds of their seedling-lethal mutant, tl, for further study.

In 1964, a second group of 57 chlorophyll-deficient tomato mutants was screened specifically for thiamine deficiencies. Twenty of the mutants have been described in the gene lists of TGC 15 and earlier: cla_1, ful_1^1, ful_1^2, var_1, cn_1, dis_1, ru_1, tab_1, mu_1, si_1, spa_1, sy, nv, spl_1, res_1, ga_1, era_1, vga_1, pl_1, and a new accession, citrine. Thirty-seven were chlorophyll-deficient selections from the new mutant program started with accessions from Hildering and Verkerk (TGC 14). One mutant, spa_1, (Stubbe III) proved to be a thiamine-requiring mutant.

Genetic tests have shown that the thiamine mutants ten_1, tl, and spa_1 are not allelic and are located on chromosomes 10, 6, and 8, respectively. Studies

of the physiology of these mutants, the location of the gene blocks in the biosynthesis of thiamine in them, and the effect of thiamine on the development of normal chloroplast ultrastructure will be published elsewhere.

Clayberg, C. D. Further data on the aw-ms_{15} linkage.

As described in TGC 15, no aw-ms_{15} recombinants were recovered in a repulsion F_2 of 413 plants in 1964. Consequently, in 1965 small F_3 families were grown from each of the 119 F_2 aw segregants. One of these families segregated for aw and thus was discarded. Among the rest only two families were segregating for ms_{15}. The following data were used to estimate the crossover value, using the method of Rick (TGC 10:33).

Family size	Segregating families	Non-segregating families	P for ms detection	Effective number non-segregating families
9		3	0.925	2.8
10	1	5	0.944	4.7
11	1	27	0.958	25.9
12		81	0.968	78.4
Total	2	116		111.8

The crossover value (p) can be calculated from the following formulas: $q^2 = 0.9833$ and $2pq = 0.01759$. The values obtained, 0.84 and 0.89, agree well with each other and with the F_2 value of 1.3% previously calculated. They further suggest that even though the F_2 value obtained for the aw-d_1 interval was low (TGC 15:29), the aw-ms_{15} interval is probably more accurately represented as 1 crossover unit, rather than 3 units. Thus aw should be highly effective in identifying ms_{15} segregants in the transfer of the latter into parental stocks of F_1 hybrids. This male sterile is quite satisfactory for hand pollination, as the stigma is well exserted. Limited amounts of ++/aw-ms_{15} seed are available.

Contant, R. B. Bench performance of short internode lines.

Our radiobiological studies require the growing to maturity of 2000-3000 irradiated tomato plants per experiment and the testing of their progeny for segregating mutants in the seedling stage. The normal spacing of about 50 sq cm per plant is extremely costly in greenhouses and prohibitive in growth chamber culture which is often required. As a substitute for Money Maker we have therefore searched for early, vigorous dwarf types with good fruiting and seed set under local greenhouse conditions and also in early and late season culture.

Ten lines, obtained from Dr. N. Kedar, contain the gene(s) br, cv, fru^{hem}, glo, d_1, bu, bu d_1, sd?, another unidentified gene for short internodes (his No. 522), and bc conferring different types of compact growth. These lines were tested in 12 cm peat-embedded pots at 15 x 20 cm spacing in a greenhouse at 23° C during the 16-hour day and 17° C at night with RH of 75%, and under natural light with an extra 200 watts/m^2 of mixed light during the last month of the test. The growth period was from 1st August till 14th December, 1964, when final evaluation took place. Some of the data are summarized below.

Line	Height (cm)	Avg. internode length (cm)	ø stem base (cm)	Seed harvest	Wt 100 seeds (mg)	Spread of foliage
br	55	2.5	0.9	++	332	large
sd	115	5	0.7	nil	-	little
cv	80	3.5	1.3	++	327	little
fru^{hem}	84	2.5	1.3	+	269	little
glo	100	2	?	++	266	little
d_1	100	6.5	1.3	±	368	very little
bu	50	3	1.5	nil	-	very little
bu d_1	45	3	1.3	nil	-	very little
No. 522	65	6	0.8	++	241	medium
bc	100	3.5	0.7	++	247	little

Only br, bu, bu d_1 and No. 522 maintained a short phenotype after 4 1/2 months. The internodes of these lines were relatively short, except for No. 522 which had very long internodes; the sd line was also characterized by long internodes (in strong contrast to out-of-doors performance in California, Israel and Holland), which may support Kedar's hypothesis that one of the genes of No. 522 is in fact sd. A possible anomaly arises from the long internodes of the d_1 line: bu d_1 has short internodes, which would imply that bu is epistatic over d_1 were it not that other d_1 lines, obtained from Dr. E. A. Kerr, remained short in the same period on the same bench (but in 1965); it may therefore be that the long internodes observed in Dr. Kedar's d_1 line are due to other factors.

In both lines with bu, the flowers and young fruits aborted. In line sd also, all fruits aborted by shrivelling of the pedicels. Consequently, for the present purpose only line br and No. 522 warrant further testing. It should be noted that in this experiment both lines had thin stems after 4 1/2 months; in this respect they seem to have reacted more to close spacing than some of the other lines. The long internodes of No. 522 probably signify that a more balanced plant would be obtained under higher light intensity, again at very close spacing. A growth chamber test on br and No. 522 will be made in 1966. This may yield more data on the possible causes of long internodes of sd types under greenhouse conditions, notably on the effect of certain parts of the visible and UV spectrums.

Of 10 lines from Dr. Kerr, each containing 6-9 recessives, amongst which were either br, d_1, sp or inc_2 for dwarfness, line 587-21-1958 (br (wf?) c sp n u f-j_1) performed excellently in the greenhouse at 15 x 20 cm spacing in 12 cm pots. This behavior confirms the superiority of br-containing lines under our greenhouse conditions. This line is very compact and strong, with large, heavy, medium-green, drooping foliage and persistent lower leaves; it flowers early and after 114 days under low-light autumn conditions gives a good harvest of fruits 2 1/2-3 cm in diam containing many medium sized seeds (276 mg/100 seeds). It is probably a good parent for crossing with other multi-recessive lines (aim: making hybrids, heterozygous on many known loci for mutability experiments, as done by Scarascia Mugnozza et al.). It may also be useful as breeding stock for obtaining types suitable for early-season greenhouse culture in beds at very close spacing.