Section B. Genetics, Breeding, Seed and Varieties - Chairman: A. W. Skuderna

LIST OF CHARACTERS AND GENE SYMBOLS REPORTED FOR THE SPECIES BETA VULGARIS L.

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Introduction

A list of characters and their gene symbols is presented for the species Beta vulgaris L., in so far as these have been reported in literature or have been communicated to the writer. Only those characters are included for which breeding data, meager in some instances, have led to a reasonable factorial interpretation.

The gene symbols recorded in table 1 follow the terminology suggested by the worker who originally described the character or the one who supplied the factorial analysis. The character description is limited to the obvious gene effects which were indicated in the original reference sources.

Several characters, such as those dealing with root size, foliage size, and sucrose formation have not been included in the present list. For information regarding the possible genetic basis of these quantitative characters the reader is referred to the review by Schneider (11). Attention is also called to the omission, from table 1, of several factors (L_1, L_2, A_1, A_2, O, B and F) which according to the earlier view of Kajanus (3) condition the shape of the root. In a later paper, Kajanus (4) points out that root shape is a difficult character to classify into basic root types because of the existence of intermediate forms.

So far one linkage group including nine genes has been established. These linked factors are collectively designated as the R group. Eight other factors appear to be inherited independently of the R linkage group. No linkage data are available for the four remaining factors, included in the present list. The available information regarding linkages is given in connection with the description of the main gene effects.

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1/ The writer is indebted to Dr. G. H. Coons, Mr. Dewey Stewart and Dr. F. V. Owen for helpful suggestions in preparing this character list.

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Table 1.--- List of characters and gene symbols reported for Beta vulgaris L. 1/

Character type	Description of gene effect	Present symbol	Authority
Foliage and root color	Red color series 2/		
	Red hypocotyl and crown-bud color. Basic authocyan factor.	R 3/	Kajanus, B.(5) Keller, W.(6)
	Red striped petioles. Termed "red-top".	R^t	Keller, W.(6)

Table 1 (continued)

Character type	Description of gene effect	Present symbol	Authority
	Absence of anthocyan pigment. With y gives green hypocotyl and crown-bud type. With intense sunlight exposure yellow pigment may develop.	r	
	Yellow color series		
	Yellow pigment produced in presence of r. Color extended to petioles, larger leaf veins and root epidermis. With R color is red. Linked with R group of factors.	Y 4/	Keller, W. (6)
	Yellow pigment produced but restricted to epidermis of root and sometimes part of the flesh. Linked with R group of factors.	Y^r	do.
	Absence of yellow pigment.	y	
	Colored leaf. Colored areas on leaf blades occur as irregular sector-like blotches. Pigment intensified by sunlight and fails to develop in darkness. Spots red with R and yellow with r. Linked with R group of factors.	Cl	Owen, F. V.
	Small veins of leaf red in presence of R and yellow with r. Large veins in leaf petioles are free from pigment with Cv but strongly colored with Y. Linked with R group of factors.	Cv	Deming, G. W. Owen, F.V.
	"Trout" leaf. Colored spots smaller than in case of colored leaf Cl. Spots red with R and yellow with r. Pigment not intensified by sunlight and develops in the dark. Linked with R group of factors.	Tr	Owen, F. V.
Chlorophyll variations	Albino seedlings. Absence of normal chlorophyll. Lethal. Probably independent of R linkage group.	w	Stewart, D.
	Variegated foliage. A mosaic of white and normal green sectors. Linked with R group of factors.	v_1	Owen, F. V.
	Variegated cotyledons. Light green to normal green sectors. Probably independent of R linkage group.	v_2	Stewart, D. Abegg, F. A.
	Variegated foliage and root flesh. Yellow to normal green sectors. No linkage data available.	v_3	Abegg, F. A.
	Virescent. Seedlings yellowish but turn green in later stages of development. No linkage data available.	vi	Stewart, D.

Table 1 (continued)

Character type	Description of gene effect	Present symbol	Authority
Dwarf types	Crinkled foliage. Plant size reduced. Linked with R group of factors.	cr	Stewart, D.
	Flaccid leaf. Vigor of plant markedly reduced. Probably independent of R linkage group.	f	do.
	Nana plants. Leaves thick and leathery. No linkage data available.	n	do.
	Miniature. Greatly reduced plant size. Lethal. Probably independent of R linkage group.	m	Abegg, F. A.
Fertility	Self-fertility. Dominant factor. Probably independent of R linkage group.	S^f	Owen, F. V.
Growth habit	Annual habit or rapidly blooming types. Dominant. A possible variation of the B locus which conditions a bolting tendency but not a strictly annual habit is described by Owen, F. V., Carsner, E., and Stout, Myron (10). Linked with R group of factors.	B	Munerati, O.(9) Abegg, F.A.(1)
	Biennial or vegetative habit.	b	
Foliage venation	Semiparallel venation as contrasted with normal pinnate type. Probably independent of R linkage group.	pl	Abegg, F.A.(1)
Foliage shape and area	Newly formed leaves at end of vegetative period markedly reduced in leaf area, narrow lanceolate in shape. No linkage data available.	re	Zavitsky, V.E. (13)
Root epidermis	Black root skin. Probably independent of R linkage group.	bl	Munerati, O. & T. Costa (8) Vilmorin, J.L. (12)
	Russett root skin. Probably independent of R. linkage group.	ru	Owen, F.V. Owen, F.V.
Disease resistance	Partially dominant major factor which conditions high curly-top resistance. Linked with R group of factors.	C	Abegg, F. A.
	Susceptible	c	

1/ In form, table 1 is similar to that used by Hutchinson and Silow (2) in presenting the subject of gene symbols for use in cotton genetics.
2/ The term "series" implies multiple allelomorphs.
3/ Symbols of dominant genes are capitalized and those of the recessives are in small letters.

4/ The symbol G (gelb) was used by Kajanus (5) to describe a yellow root character which may have been a similar genetic type for which Keller (6) used the symbol Y. Lindhard and Iverson (7) adopted Kajanus' symbols of R and G for red and yellow color types. Vilmorin (12) substituted the symbol J (jaune) for that of G. Owen in correspondence expresses the viewpoint that Y is a factor for extension of pigment rather than one which produces yellow pigment. Y causes much more pigment to be developed but does not determine whether the color is red or yellow.

THE THREE DIMENSIONAL QUASI-FACTORIAL EXPERIMENT WITH THREE GROUPS OF SETS FOR TESTING SUGAR BEET BREEDING STRAINS

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The recent trend toward breeding and production of "Home Grown" sugar beet seed has emphasized the problem as to how the breeding strains may be adequately tested in order to insure the maintenance or improvement in performance of the commercial varieties which evolve from these strains.

The ordinary commercial variety of sugar beets is extremely heterozygous, not unlike the commonly known varieties of corn (excluding present-day hybrids), or the human race. When a plant breeder is attempting improvement in resistance to disease, yielding ability, sugar content, shape of root and crown, and perhaps other characters, he is certain to be dealing with large numbers of strains regardless of whether the family or inbreeding mode of attack is followed.

The fact that our soils are very heterogeneous is generally recognized. When the number of strains being tested becomes quite large, the soil variations are necessarily increased due to the larger area covered by the test. It is obviously desirable to remove the effects of soil variations upon yield and other characters as nearly as possible.

Fisher 2/[b] introduced the randomized scheme of plot technique, basing his theory on the complete block setup i.e., where each replication includes all varieties. Yates 6/7/8/ has more recently evolved the scheme whereby incomplete blocks are used as the basis. These incomplete blocks are made up by arranging the strains in a series of blocks, each of which contains only a small number of the strains being tested. The arrangement is such that a variety variance can be calculated which is free from block effects and an error variance obtained for testing the significance of variety means.

There have been several types of designs evolved covering all phases of agronomic tests. Goulden 3/4/ has discussed the various types of designs and worked out examples to demonstrate the calculations involved for each type. He recommends the use of the Three Dimensional Quasi-Factorial method, designed by Yates, where the number of strains to be considered is 216 or more.

Day and Austin 1/ have applied this three dimensional scheme in testing the germination of 729 varieties of pines. Their experiment was planned so that the varieties were subjected to as many different block effects as possible, even to the point of introducing watering differences between blocks. The corrected average number of days from watering time to germination for each

a) Statistician, Great Western Sugar Company
b) Figures in brackets refer to Literature Cited, Page 116