

Bean Improvement in Germany

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Selection of new varieties of beans is done in the Federal Republic of Germany by private breeders. Crossing of varieties in order to combine favorable characteristics is the normal method of breeding. Resistance to *Colletotrichum lindemuthianum* is of great importance. Snap beans are mostly cultivated for processing. Dry beans are of less importance. Varieties for both purposes must have white color of testa. It is of curious interest that in eastern Frisia on the North Sea varieties are cultivated with special characteristics of the pods which permits them to be harvested just before ripening, giving a fine palatable legume after soaking and cooking.

In our own work wild species and primitive forms are used as bearers for genes of different resistances. *Phaseolus vulgaris* f. *aboriginus* BURK. has proved to be resistant to four groups of races of *Colletotrichum lindemuthianum*.

Inheritance of reaction to photoperiods has been shown as follows: *P. vulgaris* f. *aboriginus* = $fin^+ fin^+ neu^+ neu^+$; the *P. vulgaris* parent = $fin fin neu neu$ (fin^+ = indeterminate climbing, fin = determinate bush, neu^+ = short day reaction, neu = day neutral). Fin is epistatic to neu^+ , therefore in F_2 segregation is $9 fin^+ neu^+ : 3 fin^+ neu : 3 fin neu^+ : 1 fin neu$. See Bibliography. 4 day neutral bush types.

Resistance to *Colletotrichum lindemuthianum* is conditioned by recessive alleles of 2 genes to the alpha, gamma and delta group, and by the recessive allele of 1 gene to the beta group. It has not been verified, if all these genes act on independent loci or whether some of these genes are in the same loci. Other characteristics have been observed, but not genetically analyzed. For breeding purposes the known genetics of pod and seed colour, pod form and size and other morphological characteristics are used.

An experiment with S^{35} as sulfate was initiated in 1956 by imbibing seeds with 3 different concentrations of S^{35} . In M_2 morphological and physiological aberrants and a number of hereditary mutations (aurea, different forms of sterility, growth habit, pod size and form, seed form and size, and flower and testa color) have been found. The percentage of mutations, which have taken place in M_1 and M_2 was 4.8% with reference to M_1 plants. Remarkable is the fact that several mutated genes up to 6 occur in the same M_1 plant resp. in its F_2 descendancy. New combinations of mutated genes will have occurred in M_3 . In M_4 , 2 or 3 promising mutations could be isolated within 64,000 plants.

Breeding Beans for Disease Resistance in Germany

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1. *Colletotrichum lindemuthianum*. The frequent appearance of new races has made the selection of resistant varieties very difficult. Varieties with partial resistance to single races are known (HUBBELING and others). In search for general resistance to all groups of races a strain of *Phaseolus vulgaris* f. *aboriginus* from northwestern Argentina proved to be of great importance (see previous note). Crossing of this wild species and backcrossing combined with artificial infections of young seedlings have been done with the single groups

of races and with mixtures of the different groups. A variety "Regula", selected from a cross of *P. vulgaris* x *P. coccineus*, backcrossed by *P. vulgaris* with partial resistance to some races has been used for backcrossing. After 3 backcrosses in F_8 generation strains with resistance to all groups of races and the characteristics of "Regula" have been produced and are in the state of releasing.

2. *Phytophthora medicaginis phaseolicola*. *Phytophthora* is also of much importance, as there is no protection from fungicides (the same as with *Colletotrichum*). A semiwild strain Bo 19 from a Russian collection has proved to be the only resistant variety from among many tested varieties. Bo 2 of the same origin has shown to be relatively resistant. As Bo 19 contains at the same time recessive factors for extreme resistance to all our known strains of mosaic virus 1, this form was used in breeding for resistance to *Phytophthora*. From crosses of Bo 19 to Topcrop strains immune to *Phytophthora* and mosaic virus 1 have been selected. They have the pod form of Topcrop, but pods are too short. Besides, the testa is colored. Resistance to *Phytophthora* in this cross is apparently dominant.

3. Mosaic Virus 1 and 2. Several strains of this virus from Germany, Spain and Argentina have been analyzed. They display a different aggressivity to different host varieties and show different symptoms. It has been proved that the extreme resistance of Bo 19, conditioned by the factors a and s (the latter found in the variety Saxa) is valid for all strains. The hypersensitivity type of Topcrop holds also true for all strains. Stipple streak has not been observed in our work earlier at Voldagsen and now at Köln-Vogelsang.

Resistance to the yellow bean mosaic 2 has been observed in varieties of *Phaseolus coccineus*. Genetic analyses of this characteristic and its transmission in *P. vulgaris* types is extremely difficult on account of sterility of the hybrids.

No resistance to yellow bean mosaic virus 2 has been found in *vulgaris* varieties. Dembi Schautam, a strain selected from material from Ethiopia shows a very vivid mosaic after infection but does not suffer in growth, pod, and seed production. Kentucky Wonder demonstrates total necrosis within a fortnight to three weeks after infection of primary leaves. In F_2 of Dembi Schautam x Kentucky Wonder reaction types of Kentucky Wonder (recessive) and Dembi Schautam segregated into types which have not been infected by repeated inoculations. Testing of F_3 descendencies of these apparently resistant plants will be done during the spring. Should resistance be continued in F_3 , the hypothesis could be forwarded that the recessive factor effect of Kentucky Wonder for total necrosis has been changed in the desired manner by interaction with genes from Dembi Schautam.

4. Combination of resistances to *Colletotrichum lindemuthianum*, *Phytophthora* and virus mosaic 1 is now in progress. In this work *Colletotrichum* resistant strains have been crossed with Topcrop and very promising strains have been selected. On the other side *P. vulgaris* f. *aborigineus*, resistant to *Colletotrichum*, crossed by Bo 19 (extreme resistance to *Phytophthora* and Mosaic virus 1), backcrossed by *P. vulgaris* f. *aborigineus* and then three times by the variety Regula, have allowed the selection of promising strains. Testing for the combined resistances in numerous strains will be done this spring.

For the purpose of combining the 3 resistances, also strains of Bo 19 x Topcrop, resistant to virus 1 and *Phytophthora*, have been crossed and backcrossed with Regula. Testing of numerous F_4 families will also be done during this spring.