Physiological Genetic Studies of Seed Coat Cracking, Seed Coat Whiteness and Seed Hardness in Great Northern Type and Pinto Dry Beans (Phaseolus Vulgaris)

Safi S. Korban, Dermot P. Coyne, John L. Weihing and M. Hanna
University of Nebraska
Lincoln, Nebraska

Seed injury and seed hardness are two features contributing to economical losses for the grower and the processor of beans (Phaseolus vulgaris). Dull white color of bean seeds depreciates the product in the competitive market.

This research was undertaken in part to determine the range of seed coat cracking resistance available in Great Northern dry bean varieties under controlled test conditions. Genetic studies were conducted for seed coat cracking and brighter white seed coat traits. Anatomical investigations of seed coats were conducted to study the structure of the seed coat in relation to mechanical abuse. Finally, seed hardness was studied in several dry bean varieties.

Overall, the results obtained from the rotating impact-disk machine were more consistent over the two years of testing than the other two cracking methods (Vogel thresher and 'Dropping' method). The rotating impact-disk machine provided a good separation for seed injury between susceptible and resistant varieties over the two years; moreover, there was no variety x year interaction. Whereas, dropping seed samples on a steel plate resulted in no separation among the varieties over the two years. There was no year x variety interaction. Results obtained from the Vogel thresher indicated a highly significant variety x year interaction. GN Star had the highest amount of injured seed; whereas, GN Emerson and the near-isogenic determinate GN Neb. =1 had the least amount of injured seed.

Determination of the relationships of growth habit (determinate versus indeterminate) and maturity (early versus late) with seed injury using near-isogenic lines of GN Nebraska #1 revealed greater resistance to cracking in determinate lines; moreover, early maturity tended to enhance this resistance.

Seven different genetic experiments were conducted in the field in 1978 using parents and F2 generations. Bulgarian White and PI 165078 have bright white seed coats and the former is also resistant to seed coat cracking. A continuous distribution for number of plants in different seed injury classes was observed in the F2's indicating a quantitative inheritance pattern. Some transgressive segregation for both increased resistance and susceptibility to seed coat cracking were observed in some crosses. Similarly, the brighter white seed coat character appeared to be quantitatively inherited; however, it is thought that few genes control this trait. Broad Sense Heritability (BSH) estimates ranged from 35 to 65 percent for seed coat cracking, and 45 to 57 percent for seed coat whiteness.

A diallel cross study was conducted in the field in 1979 with 6 GN type lines and Pinto UI 111 to determine the genetic control for seed coat cracking. The Gardner and Eberhart (1966) model, Analysis II, was used to generate estimates of the genetic effects for the trait.
Crosses involving Bulgarian White, Pinto UI 111, and GN D-88 demonstrated high combining ability for resistance to seed coat cracking. The estimates of the genetic effects for seed coat cracking indicated that additive effects were mainly involved in the control of the trait; moreover, heterosis effects were also important. Among heterosis effects, line and reciprocal effects were significant.

The same diallel study was used to study the genetic control of white seed coat character. Again, Bulgarian White had a good combining ability to transmit brighter whiteness in crosses. The estimates of the genetic effects for brighter seed coat whiteness indicated that additive effects were mainly involved in the genetic control of the trait.

Anatomical investigations of the seed coat of the six GN type lines and Pinto UI 111 revealed differences in thickness in macrosclerid, osteosclerid and parenchyma cell layers among all the genotypes. However, no distinct relation to seed coat cracking and cell structure and cell arrangement of the seed coat was observed.

Soaking seeds of 6 GN type lines and Pinto UI 111 of dry beans in water revealed varying rates of water imbition. By sealing the seed coat, hilum and raphe with silicone, the micropyle was observed to be the major site of water entry in all the white-seeded GN type lines. When the micropyle, hilum and raphe were sealed with silicone, there was no water uptake by the seeds of all the varieties until after 24 hours of imbibition, where even then, only a small amount of water was absorbed. In the Pinto UI 111 variety neither the micropyle nor the seed coat seemed to be responsible for the water uptake.

The present address of the senior author is Department of Horticulture, University of Illinois, Urbana, Illinois

****

Inheritance and Genotype x Environment Interaction of Flowering In Phaseolus vulgaris L.

H. Kimaryo G. Leyna
D. P. Coyne and S. Korban
University of Nebraska, Lincoln, Nebraska 68583

An understanding of the inheritance pattern of time of flowering and maturity in beans (Phaseolus vulgaris L.) will aid plant breeders in developing genotypes that are adapted to particular regions. We have found along with other researchers that cultivars of dry beans exhibit different responses for days to first flower depending on photoperiod and temperature. The objectives of this research were to study the genetic variation in a collection of dry bean lines/varieties and the inheritance of days to first flower in dry bean crosses under different environmental conditions in the field. Plant growth chambers were also used to study the effects of different photoperiod and temperature regimes on the flowering date of the parents used in this genetic study.