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INHERITANCE OF LOW TEMPERATURE TOLERANCE IN BEANS AT SEVERAL GROWTH STAGES

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Beans are generally susceptible to injury caused by low temperatures at all stages of growth. Initially most studies on cold tolerance in beans involved germination studies. We developed selections NY 5-161 and its isogenic white seeded version NY 590 from crosses with Lamprecht's line 445 that germinate at 9.5-10C, and have good plant vigor at low temperatures.

NY590, a white seeded isogenic version of NY5-161, plus NY23 and BBL92, were used for the study. Both NY590 and NY23 exhibit good germination (emergence) for white seeded lines. Line 590 has better seedling vigor, and both reach bloom in 61 days at 16C and set quite well under cool nights. Like most cultivars under extreme conditions, BL92 germinates poorly, exhibits poor seedling vigor, takes 73 days to bloom at 16°C, and sets poorly under low night temperatures.

NY590 and NY23 were crossed with BBL92 and F_2 and backcross seed were developed. The F_2 seed and BC seed were planted in the field and seed harvested on an individual plant basis.

Seeds were planted in late November in Cornell mix prewetted and cooled to 5°C in growth chambers. After 5 days the pots were moved to a greenhouse at 16°C. From December to March in Geneva, NY, it is possible to keep the temperature of the greenhouse at 16°C with very little fluctuation. Good air turbulation resulted in uniform temperatures throughout the greenhouse.

Two pots with seed from individual F_2 or BC plants, each containing 5 seeds, were planted in 1983 and one pot in 1984. After 3-4 weeks seeding emergence and vigor were recorded and each pot was thinned to the two most vigorous seedlings. Vigor was also recorded at 60 days when early plants were starting to bloom. Vigor was rated on a 1-5 scale with 5 vigorous and 1 low vigor. In 1985 the height of the plants at 60 days was measured and plants under 15 cm were rated 1, 16-20 cm rated 2, 21-25 rated 3, 26-30 rated 4, and plants 31 cm or more rated 5. The day for first bloom for each plant was recorded, and about 20 days later pod set was recorded. One or more full pods were recorded as 'set'. A single pod with only one or two seeds was recorded as 'poor', and no pods as 'no set'.

Tables 1 and 2 give the means and variances for four of the plant performances recorded. For the cross NY590 x BBL92 the results indicate very workable narrow sense heritability, although the environmental effects were larger than desirable as interpreted from the broad sense heritability data. The statistical results for the NY23 x BL92 cross were disappointing as the BSH were mostly very low and the NSH of no value. For all four characters studied, the F_2 means approximated the mean of the parents, and the backcross to the cold tolerant parent approached the mean of the F_2 and the cold tolerant parent. All results indicate additive effects, but the generally high NSH values indicate few genes were involved.

In general there were low levels or no correlation between days to bloom and plant vigor, seedling vigor, or germination and between seedling vigor and immature plant vigor and with germination.

The last character studied was the ability to set under cool conditions (Table 3). The results suggest a single gene controlled the ability to set at 16°C. The agreement from one year to the next was 66%, but since the F_3 lines are heterozygous in most cases this is expected. Also, in neither population did 100% of the cold tolerant parents set pods. This may reflect variation in the parental line and may indicate benefit from further progeny testing. The ability to set at low temperatures reduces the chance of double setting due to low temperatures during the bloom period. This was very apparent in the cool 1985 season when varieties and breeding lines unrelated to the cold tolerance studies in many cases exhibited considerable double set. Progeny of plants which set at 16°C in the greenhouse set well in the same cool season.

This project is part of a breeding program to select for cold tolerance. Remnant seed of lines which performed well in these tests were planted in the field and most were considerably more vigorous than the checks producing plants flowering earlier and having better germination. However, since weather conditions can fluctuate widely in New York State, screening and selection for cold tolerance is more efficient and reliable under controlled cool greenhouse conditions.

Table 1. Mean cold tolerance performance and variances for cross 590 x BBL92

Pedigree	Germination		Seedling vigor		Plant vigor		Days to Bloom		n
	Out of 15	s^2	1-5	s^2	1-5	s^2	Days	s^2	
F_2	12.09	4.56	2.22	.863	2.67	.551	65.63	20.2	58
BC-S	13.79	1.51	2.28	.561	3.01	.288	64.14	11.41	71
BC-R	12.50	6.35	2.87	.679	3.51	.309	61.12	14.14	24
$S-P_1$	9.85	1.39	1.50	.112	1.43	.111	72.69	1.64	18
$R-P_2$	14.40	2.76	3.53	.481	3.60	.230	59.92	5.93	15
NSH%	28		56		45		74		
BSH%	54		66		69		85		

Table 2. Mean cold tolerance performance and variances for cross NY23 x BBL92

Pedigree	Germination		Seedling vigor		Plant vigor		Days to Bloom		n
	Out of 5	s^2	1-5	s^2	1-5	s^2	Days	s^2	
F_2	4.39	.87	2.42	.84	2.92	.39	67.6	23.9	48
BC-S	4.41	.75	2.27	1.90	2.91	.31	67.5	14.6	61
BC-R	4.40	.80	3.06	1.00	3.76	.53	63.5	10.2	55
$S-P_1$	.5	.79	1.00	.01	1.43	.11	72.7	1.66	18
$R-P_2$	3.14	.75	3.50	1.35	3.48	.48	61.0	6.50	14
NSH%	22								
BSH%	11		19		22		83		

Table 3. No. of lines in pod set classes at 16°C of cross NY590 x BBL92.

Pedigree	Set	Poor set[1]	No set	Expected set/no set	x^2	P
NY590 x BL92 F_2	10	7	38	1:3	.006	.90
NY590 x BC BBL92	16	15	37	0:1	-	-
NY590 x BC NY590	8	1	11	1:1	.2	.80
NY590	17	1	0	1:0	-	-
BBL92	0	0	15	0:1	-	-

1. Poor set group were divided equally to set and no set for x^2 analysis.