**Purpose:**

* To reinforce understanding of gene action and differences that can exist between populations from crosses and their reciprocal crosses
* To emphasize understanding of use of Chi-squared test of hypothesis and interpretation of results
* To reinforce understanding of segregation patterns following self-fertilization from generation to generation up to the fourth

**Keywords**: mutant, mutagenesis, population, reciprocal cross, herbicide, gene action

**References:** CG Gene Segregation Module 4

**CG ALA-4\_Gene segregation Module 4**

A homozygous mutant plant resistant to the herbicide Imazamox was obtained by mutagenesis for barley, a self-pollinated diploid species (Lee et al., 2011). Single nucleotide mutation in the barley acetohydroxy acid synthase (AHAS) gene confers resistance to imidazolinone herbicides. Proceedings of the National Academy of Sciences 103:8909-8913)

Reciprocal crosses between the mutant plant and its progenitor cultivar, Bob were made and a total of six F2 populations were obtained. They were treated with the herbicide Imazamox. Table 1 shows the number of plants that either survived (healthy or injured) or died after herbicide treatment, and the Chi-square test results.

Table 1 Phenotypic evaluation of six F2 populations derived from the reciprocal crosses between the mutant and progenitor Bob

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Survived |  | χ2\* |
| Crosses | Plants tested | Healthy† | Injured‡ | Total | Dead | Value | Probability |
| Mutant x Bob |  |  |  |  |  |  |  |
|  Mutant x Bob 1 | 121 | 69 | 20 | 89 | 32 | 0.135 | 0.7133 |
|  Mutant x Bob 2 | 129 | 91 | 10 | 101 | 28 | 0.747 | 0.3875 |
|  Mutant x Bob 3 | 211 | 157 | 2 | 159 | 52 | 0.014 | 0.9501 |
|  Pooled total | 461 | 317 | 32 | 349 | 112 | 0.122 | 0.7266 |
| Bob x Mutant  |  |  |  |  |  |  |  |
|  Bob x Mutant 1 | 85 | 56 | 5 | 61 | 24 | 0.475 | 0.4909 |
|  Bob x Mutant 2 | 135 | 75 | 22 | 97 | 38 | 0.757 | 0.3843 |
|  Bob x Mutant 3 | 144 | 101 | 4 | 105 | 39 | 0.333 | 0.5637 |
|  Pooled Total | 364 | 232 | 31 | 263 | 101 | 1.465 | 0.2261 |

The χ2 test for a single dominant nuclear gene model was performed.

\*χ2 test at the 0.05 level against survived (healthy and injured F2 plants combined); dead = 3:1 ratio model with 1 degree of freedom.

χ2 probabilities greater than 0.05 indicate that observed values were not significantly different from expected values, and the proposed 3:1 ratio model was accepted.

†Plants showing no injury after Imazamox treatment.

‡Plants showing injury after Imazamox treatment.

a. Based on Table 1, is the trait of herbicide resistance controlled by a single gene or multiple genes? Justify your answer.

b. Is the gene action for the herbicide resistance gene dominant, incompletely (partially) dominant or overdominant? Justify your answer.

c. You advance the generations for one of the six populations by selfing, what fraction or percentage of plants at F4 would be killed if sprayed by the herbicide Imazamox? Justify your answer.