Genetic investigation of corn

According to Mendel’s Law of Segregation, phenotypic ratios may be influenced by dominance of one allele compared to another. The alleles separate when an organism produces gametes via meiosis. This experiment investigated

INTRODUCTION

In order to conduct this experimental, Mendel’s laws of inheritance were to be studied in order to understand genetics. Mendel’s first law (the principle of segregation), is where two alleles of a homologous pair segregate during the formation of gametes, via meiosis, and each gamete only receives one allele and the phenotype ratios are influenced by the dominance of one allele compared to another. Mendel’s second law is the principle of independent assortment where alleles of a pair of genes arrange themselves independently of the other gene pairs on heterozygous chromosomes.

Corn cobs were provided for the experiment and each cob had more than one phenotype. Corn plants pollinate via wind, therefore, each kernel may be the product of a different cross. All kernels within a cob share the same female parent but could have many different male parents. By looking at Figure 1 below you can see the aleurone layer. This layer can be all sorts of different colours due to the anthocyanin pigments that are contained within it.

Genes are the fundamental biophysical unit of hereditary information. It occupies the locus of a chromosome, and when it is copied it affects the phenotype. Genes are able mutate and various allelic forms can be produced. Genes are contained within the DNA (deoxyribonucleic acid) of an organism, for bacteria and viruses it is kept within RNA. Alleles are an alternative version of a gene that produces distinguishable phenotypic effects. If the alleles that are produced are identical to each other, the individual has the homozygous trait. However, if it is made of two different alleles the individual is heterozygous.

In order to determine the type of cross and genes responsible for what a corn can look like, the colouration and texture of the kernels were looked at. The four phenotypes identified were red and smooth (RS), red and wrinkled (Rs), yellow and smooth (rS), and yellow and wrinkled (rs).

The aim of this experimental was to examine the behaviour of two different genes for colouration and texture within corn kernels. The experiment investigated the F2 generation results from two monohybrid crosses, RS Rs rS rs x RS Rs rS rs. A null hypothesis was proposed, H0, there is no difference between the phenotype of the observed class results and the expected class results. There will be a phenotypic ratio of 3: 1, red to yellow phenotypes with the crosses RS Rs x rS rs. As an alternative hypothesis, H1, the phenotypical ratio between the observed and expected class results are different to that predicted ratio of 3: 1.

SECTION I – MONOHYBRID CROSS WITH SWEET CORN

P generation

F1 generation

F2 generationThe trait investigated in the first section is the kernel colour. A monohybrid cross is the product of a single pair of alleles. The red colour (R) is the dominant gene, whereas the recessive is the yellow colour (r). The P generation represents the parental, F1 and F2 generations represent the first filial and second filial generations.

RR (homozygous) x rr (homozygous)

Rr (heterozygous) x Rr (heterozygous)

RR Rr rr

SECTION II – MONOHYBRID TEST CROSS

In a test cross, the individual with the unknown genotype is crossed with a homozygous individual that expresses the recessive trait, and punnett squares are used to predict the possible outcomes (refer to results and discussion) (Campbell et al., 2008). This monohybrid test cross involved several plants from a pure line of plants that produced all yellow kernels, and one individual plant that only produced red seeds. The red genotype could be RR but since the R (red) allele is dominant to the r (yellow) allele, it could produce the phenotype Rr.

SECTION III – DIHYBRID CROSS

The dihybrid cross had for grain phenotypes in the ear of genetic corn and they were red and smooth (RS), red and wrinkled (Rs), yellow and smooth (rS), and yellow and wrinkled (rs). In addition to our previous dominant and recessive genes of red (R) and (r), S represents a smooth texture dominant to s which is a wrinkled texture.

The difference texture characteristics is because of the gene controlling storage within the endosperm (protective layer that surrounds the embryo in seed plants) (Figure 1). The endosperm can contain either sugar or starch. If it encases starch it will appear full, smooth and rounded (S), however, if it is sugar it will look wrinkly (s).

PROCEDURES:

SECTION I – MONOHYBRID CROSS

Determine the expected frequencies of the genotypes and phenotypes in the F2 generation of the monohybrid cross, by filling in the genotypes, transferring them, and calculating genotype and phenotype frequencies.

Count the kernels on one ear of corn, classifying them as either red or yellow. Keep track of your results, and when you are done, add them to the class results. Use the table to keep track of your results. To prevent counting kernels twice, use pins to mark your position: one for the row you started on and one for the row you are currently counting.

Compare the numbers of each phenotype on your kernels and on the class kernels with the numbers you would expect based on the outcome of a monohybrid cross. Expected numbers may be calculated for each phenotypic class by multiplying the total number of kernels counted (by you and by the class) times the expected fraction for that phenotypic class.

Carry out a test on the class results.

SECTION II – MONOHYBRID TEST CROSS

Count the kernels on one ear of corn from the monohybrid test cross set, using the same techniques as previously. Keep track of your results.

Construct punnet squares in order to determine whether the parent that grew from a red seed had the genotype RR or the genotype Rr.

Determine which expected frequency best fits the data you observed. This does not require a statistical test.

SECTION III – DIHYBRID CROSS

First use a punnet square to examine the theoretical outcome of the heterozygous x heterozygous dihybrid cross. Remember that each box represents a genotype possibility for an offspring. Determine the outcome as phenotypic ratios.

Obtain an ear of corn that is the result of a cross that was heterozygous x heterozygous for both traits. Count the kernels using the same techniques as previously.

Now calculate the ratio for the cross. The phenotype with the least number of individuals you will call 1. Place the 1 in the space below the appropriate phenotype. Now divide the other count numbers by the number of individuals from the phenotype you called 1, and round your answers to the nearest whole number. Compare your results with the theoretical answers you obtained for the cross.

DISCUSSION

SECTION I – MONOHYBRID CROSS

Data from the monohybrid test cross did support the predicted ratio of 3: 1. The monohybrid phenotypic ratio of 3 red seeds versus 1 yellow seed is derived from a punnett square (see tables 1 and 2). The observed values were 263 red kernels and 133 yellow kernels, while the class observations were 363 red and 143 yellow. The chi-squared value was used to interpret the data and came to 3. 09. Also, the chi-squared value for p0. 05 was calculated and came to 3. 03. Therefore, the null hypothesis was accepted and there was no difference between the phenotypes of the observed and expected class results.

SECTION II – MONOHYBRID TEST CROSS

Punnett squares were constructed in order to determine whether the parent that grew from a red seed had the genotype RR or the genotype Rr. The expected frequency had to be determined by using punnett squares (tables 5 and 6). My results of counting the kernels on this corn cob were 325 red seeds and 146 yellow seeds.

SECTION III -DIHYBRID CROSS

For the dihybrid cross examination, a punnett square was used, first to calculate the theoretical outcome of heterozygous x heterozygous dihybrid cross (table 8). Then, a phenotypic ratio was produced which was 9: 3: 3: 1. A corn cob was then counted using the same techniques that were used for the other corn cobs. There were 111 RS, 52 Rs, 341 rS, and 87 rs kernels. The ratio for the cross was calculated and supported the original phenotypic ratio of 9: 3: 3: 1. Therefore, it is easy to say that the dihybrid cross followed Mendel’s law of independent assortment.