Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Botany

Course Code: BOC 108

Course Title: Cytogenetics and Plant Breeding

Unit: 11 Inbreeding Depression and Heterosis

Module Name: Inbreeding Depression and its Applications

Name of the Presenter: Ms. Emma Fernandes

Notes

Introduction

The cross-pollinated species are highly heterozygous and these plants lose their increased vigour and other superior qualities if selfing or inbreeding is allowed in them.

Inbreeding is mating between genetically related individuals, i.e., brother – sister mating or sib-mating.

The mating between the individuals of different genetic constitution is known as out breeding.

The reduction in growth, vigour and fertility due to inbreeding is referred to as inbreeding depression.

Inbreeding reduces heterozygosity and leads to homozygosity in the progeny. Thus, there is a direct correlation between the homozygosity and degree of inbreeding. Selfing reduces the heterozygosity by a factor of ½ in each generation and the degrees of inbreeding increases in the same proportion.

Work done by various scientists on inbreeding depression

Koelreuter (1761-1766) conducted his hybridization experiments on *Nicotiana*. He suggested that the vigour of hybrid is related to the degree of genetic

dissimilarity of parents and hybrid vigour is of particular significance in evolution.

Darwin (1876) published the account of his experiment on self and cross pollination in maize and concluded that the progeny obtained from self-fertilization is weaker than those derived from out crossing or cross fertilization.

E.M. East (1906) and G.H. Shull (1909) studied the effects of inbreeding in maize for 30 generations of inbreeding independently. They found that the yielding ability in these lines finally reduced to about one-third of the open-pollinated variety from which these samples were derived.

They drew following conclusions:

1. A number of lethal and sub-vital types appear in early generations of selfing.
2. The material rapidly separates into distinct lines, which become increasingly uniform for differences in various morphological and functional characteristics.
3. Many of the lines decrease in vigour and fecundity until they cannot be maintained even under the most favourable culture conditions.
4. The lines that survive show a general decline in size and vigour.

Degree of inbreeding depression

The degree of inbreeding response differs in different species and my range from very high to very low or zero. They may be grouped into the following four categories:

A. High inbreeding depression
B. Moderate I breeding depression
C. Very low inbreeding depression
D. No inbreeding depression

High inbreeding depression

In some plants the loss in vigour and fertility due to inbreeding is so great that a very few lines survive after 3 or 4 generations of inbreeding. They show greatly reduced yield, generally less than 25% of the open pollinated varieties. Example: Alfalfa (*Medicago sativa*) and Carrot (*Daucus carota*)

Moderate I breeding depression

Some plant speices show moderate inbreeding depression. Selfing of progeny results in many weak, lethal or sub-lethal types in population which are eliminated but a good proportion of population can be maintained under self-pollination. Example: Jowar (*Sorghum bicolor*) and Bajra (*Pennisetum americanum*)

Very low inbreeding depression

Some plants show very little loss in vigour and fertility due to inbreeding and some of the inbred lines yield as much as their open pollinated parent varieties. Example: Rye (*Secale cereal*) and Sunflower (*Helianthus annuus*)

No inbreeding depression

The self-pollinated species do not show inbreeding depression, although they show some degree of hybrid vigour or heterosis.

Practical applications of inbreeding

In a heterozygous individual, the harmful recessive alleles remain masked by their normal dominant alleles. If a heterozygous individual undergoes inbreeding for various generations, there will be equal chances for dominant as well as recessive alleles.

In homozygous condition, recessive alleles will be able to express their deleterious phenotypic effects on an individual. On the other hand the homozygosity for dominant alleles has equal opportunity to express their beneficial phenotypic effects on inbred races.

1. Inbreeding cause homozygosity of deleterious recessive genes which may result in defective phenotype, therefore in human society the religious ethics unknowingly and modern social norms consciously have condemned and banned the marriage of brothers and sisters. Further, the plant breeders and animal breeders too avoid inbreeding in the individuals due to this reason.
2. The inbreeding results in homozygosity of dominant allele therefore; it is a best means of mating among hermaphrodites and self-pollinating plant

species of several families. The animal breeder employed the inbreeding to produce best races of horses, dogs, bulls, cattle etc.

The modern race horses are all descendants of three Arabian stallions imported into England and mated with several local mares of the slow, heavy type that had carried the medieval knights in heavy armour.

Similarly merino sheep are widely known as fine wool producers. They are the result of about 200 years of inbreeding. This strain was being developed in Spain in the 17^{th} century by stock raisers. They observed that the ancestors of the present day merino sheep had two coats of wool, one composed of long, coarse fibres arising from primary follicles, and a second coat composed of short fine wool arising from clusters of secondary follicles. Intensive artificial selection was maintained for animals with more uniform production of fine wool and a lesser amount of coarse wool.