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FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

(Crop Improvement I (Kharif))

For

B.Sc. Ag (Third Year)

Course Instructor

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Genotype – Environment – Interaction and Adaptation

It is established that

$$P = G + E,$$

Phenotype (p) is the function of the genotype (G) and environment (E). this is relevant to an individual subjected to a particular environmental condition. When the same individual is subjected to more than one kind of environment, its phenotypic expression for any trait may often change. Then, the differences is phenotypic expression for any trait cannot be accounted for by G and E alone, since $P > G + E$.

This lack of correspondence between heritable and non-heritable effects, or the remainder of 'P' that cannot be accounted for by 'G and 'E', is attributed to the interaction of G with E (i.e. G X E).

Then

$P = G + E + (G X E)$

This holds true for all the individuals or populations which tend to behave differentially in diverse environmental conditions due to genotype x environment interaction.

Genotypes, Environments and their Interaction

1. Genotypes (G) : Comprises all the crop varieties (cultivars), improved or unimproved, homogeneous or heterogeneous, under domestication, and genetic stocks in the breeder's nursery.

2. Environments (E) : Plants surrounded and influenced by physical, chemical and biological conditions of their habitat. All these conditions constitute an environment.

These conditions might vary over time (years or seasons) and space (locations or altitudes).

According to Comstock and Moll, 1963 there are two types environments

Micro Environment & Macro Environment.

Micro -environment : The environment of a single plant or organism as opposed to that of another growing at the same time in almost the same place is known as micro environment. Each member of a population is subjected to a specific environment of its own. The individual itself contributes to its environment by way of maintaining a certain level of temperature and humidity around it. This micro environ differ from one individual to another in a pop. And includes solar radiation, disease and pest incidence and soil factors and weather fluctuations.

Macro -environment : The environment associated with variables having large and easily recognizable effect is termed as macro-environment and may include differences over years, locations (latitude / altitude) fertilizer levers, planting dates, irrigation schedules etc.

A macro environment can be riewed as a collection of micro environments whose individuals effects on organism are quite small.

Allard and Bradshaw (1964) : classified the environmental variation into two types:

1. Predictable and 2. Unpredictable variations.

Predictable component variations : include all the permanent attributes features of the environment, such as climate, edapthic factors (soil types), day length (photo period), agronomic practices such as planting dates, plant density, water management, fertilization etc.

Unpredictable variations / component : All the uncontrollable actors i.e. it include fluctuations, mild or violent, in weather / season / year with respect to annual precipitation (rainfall), te mperature, relative humidity, etc. coupled with variant agronomic practices.

Genotypes x Environment Interaction It is the differential behaviour of the genotype under varietal environmental conditions. This concept was put forth by Allard.

The performance of a crop variety in there resultant effect of its genotype and the environment in which it grows. The variety may perform differently in different environments.

The interplay of genetic and non-genetic effects causing differential relative performances of different genotypes (varieties) in different environments is called genotype environment (GE) interaction.

Table: Yield of varieties in two locations (e.x)

Variety Location	**Yield quintal per acre**	**Maruteru**	**Yield quintal per acre** **Nizamabad**
Surekha	18.00		23.00
Pothanna	16.00		27.00
Mean	17.00		25.00

Each genotype attends its maximum biological performance in a particular environment. Due to negative G E interaction – environmental element fall short to produce, of the required biological optimum. Depending on the optimally considerations of different genotypes it is possible to develop genotype suited to 'or' tailored for a range of environments

ADAPTATION : It is the capacity of genotypes to adjust themselves in a specific or particular environmental condition, so as to reach a certain level of phenotypic expression.

TYPES OF ADAPTATION

There are four types of adaptation, *viz.,* (1) specific genotypic adaptation, (2) general genotypic adaptation, (3) specific population adaptation and (4) general population adaptation.

These are briefly described below.

1. Specific Genotypic Adaptation: It is the close adaptation of a genotype to a limited environment. For the production of rice in a deep water area; a variety's capacity for rapid inter-node elongation is an essential feature of its specific adaptation.

2. General Genotypic Adaptation: It refers to the capacity of a genotype to produce a

wide range of phenotypes compatible with a range of environments. Semi-dwarf varieties of wheat and rice which can be grown over a wide range of environmental conditions are examples of this type of adaptation (i.e., adaptability).

3. Specific Population Adaptation: It refers to the capacity of a heterogeneous population to adapt to specific environment. A composite or a varietal mixture giving stable production is an example of this category. Here the competition is between the components of variety or mixture rather than adaptation of components themselves.

4. General Population Adaptation: It is the capacity of heterogeneous populations to adapt to a variety of environments. Synthetic varieties of forage crops are example of this type of adaptation. This property of adaptation is specific to an individual genotype or a group of genotypes and is termed as **homeostasis.**

1. Morphological adaptation : Growth habit, stalk strength, radial symmetry of rhizome etc.

2. Physiological adaptation : Resistance to parasites, greater ability to compete for nutrients or to stand desiccation.

TYPES OF ADAPTATION

Adaptation

Genotypic adaptation Population Adaptation

It is associated with the individual It is related with the genotype whether homozygous (inbred) heterozygous population in a or heterozygous (hybrid) in an specific specified environment

Specific genotypic General genotypic Specific Population General Population Adaptation Adaptation Adaptation Adaptation

Adaptation of a Wide range of Heterogeneous popl Heterogeneous popl Genotype to a Phenotypes compatible to adapt to specific to adapt to a variety Limited envrnt. With the range of environment of environments like *e.g.,* Rice in deep environment *e.g.,* composites *e.g.,* synthetic varities water area *e.g.,* Semi-dwarf wheat popl in soil salinity varieties

ADAPTABILITY : is the ability of a genotype to produce a relatively narrow range of phenotypes in different environments. It is the result of genetic homeostatis, refers to the buffering capacity of a genotype to environmental fluctuations.

STABILITY: It refers to its performance with respective changing environmental factors overtime within a given location. This means that a stable variety is less sensitive to the temporal environmental changes that may take place.

MODELS FOR STABILITY ANALYSIS :

1. Finlay and Wilkinson Model (1963)
2. Eberhart and Russell Model (1966)
3. Perkins and Jinks Model (1968)
4. Freeman and Perkins Model (1971)

Eberhart and Russel (1966) Model

This is the widely used model and it is relatively simple yet quite informative. They defined a stable variety as one with regression co-efficient of unity (b=1) and a minimum

deviation from the regression line (S2d = 0, i.e. not significantly different from zero) with high mean.