RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

SEED DEVELOPMENT, MATURATION AND SEED STRUCTURE

A true seed is defined as a fertilized mature ovule consisting of embryo, stored food material and protective coats. The important events involved in seed development and maturation include pollination, fertilization and development of the fertilized ovule by cell division, accumulation of reserve food material and loss of moisture content.

Pollination and Fertilization

The mature anthers dehisce and release pollen -grains (haploid microspores). When pollen grains are transferred from an anther to the stigma of the same flower the process is called self-pollination or autogamy. If they are transferred to the stigma of another flower, cross-pollination or allogamy is said to have occurred.

Self-pollination occurs in those plants where bisexual flowers achieve anther dehiscence and stigma receptivity simultaneously. The majority of angiosperms bear chasmogamous flowers. In some plants, flowers do not open before pollination such flowers are called cleistogamous, and this is the most efficient floral adaptation for promoting self-pollination.

Cross-pollination is ensured in plants which bear unisexual flowers. In bisexual flowers also self-pollination may be prevented by self-sterility, dichogamy (maturation of male and female organs at different times), herkogamy (where the structure of male and female sex organs proves a barrier to self pollination) and heterostyly (where flowers are of different types depending on the length of the style and stigma and pollination occurs only between 2 dissimilar types).

The important self-pollinated crops are wheat, rice, barely, mungbean and cowpea and cross pollinated are maize, rye, forage legumes and vegetables like carrot, cauliflower and onion. There is yet another category of crops called often cross pollinated crops such as cotton and pigeon pea where there may be 10-40 % cross pollination.

Different agents bring about the dissemination of pollen grains. The agents may be abiotic including wind (anemophily) and water (hydrophily) or biotic including insects (entomophily) and bats (cheiropterophily).

After landing on the stigma, the pollen grain germinates and pollen tube grows through the style. The surface of the stigma secretes substances, which may provide optimum conditions for pollen germination.

The embryo is very small and lies in a groove at one end of the endosperm. It consist of a shield shaped cotyledon (Scutellum) and a short axis with plumule and radicle protected by root cap. The plumule as a whole is surrounded by coleptile, a protective sheath, and similarly the radicle including the root cap is surrounded and protected by coleorrhiza. Scutellum supplies growing embryo with food material absorbed from endosperm through epithelium. The initial synthesis of alpha-amylase and certain proteolases also occurs in scutellum.

Seed Growth and Maturation

Wheat and soybean representing monocots and dicots may illustrate the changes in the pattern of accumulation of reserve materials at different stages of seed maturation.In wheat, the dry weight of the seed increases rapidly in about 35 days after anthesis. The water content of the grain is maximum between 14 and 21 days after anthesis, and then it declines rapidly. The amounts of reducing sugar and sucrose are high between 7 and 14 days and decline rapidly thereafter due to conversion to starch.Since in wheat, starch is the major reserve material of the seed, the pattern of starch accumulation is similar to that of dry matter accumulation.

The speed of germination is faster in wheat varieties that begin to lose water early during seed development. The seed is said to have physiologically matured only when it attains maximum dry weight, germinability and vigour. Normally the seed is harvested at field maturity, a stage when the moisture content is reduced to about 6-10 % in wheat. Field maturity is a crop specific character.

A soybean seed attains maximum dry weight between 48 and 54 days after flowering. Oil accumulation is less during 12-18 days after fertilization; maximum oil accumulates between 24 and 42 days after flowering, after which the rate decreases. The protein content in the seed is maximum during 12-18 days after fertilization and decreases subsequently. The initial high percentage of protein may be due to the high content of non-protein nitrogen, which decreases with seed age. Oil accumulation picks up only after protein accumulation completes in the seed.

Friut Types

Psedocarpic fruit consists of one or more ripened ovaries attached or fused to modified bracts or other nonfloral structures. Examples : burdock, sandbur. Multiple fruit is composed of the ovaries of more than one flower. Each unit of these fruits may be berries, drupes, or nutlets. Examples: fig, mulberry, pineapple.

Aggregate fruit is composed of several ovaries of a single flower. Each unit of these fruits may be a berry, drupe, or nutlets. Examples: Straw berry, raspberry, blackberry.

Simple fruit is derived from a single pistil

A. Fleshy fruits have a fleshy or leathery pericarp.

1. Berry has a fleshy pericarp. Examples : grape, tomato, gooseberry, huckleberry.
2. Pepo has a hard but without internal separations, or septa, Examples. watermelon, cantoloupe, squash, cucumber.
3. Pome has floral cup that forms a thick outer fleshy layer, and a papery inner pericarp (endocarp) forming a multiseeded core. Examples: apple, pear quince.
4. Drupe is also called stone fruit, and has stony endocarp, a thick, leathery, or fleshy mesocarp, and a thin exocarp. The pit is usually one-seeded, but occasionally several one-seeded pits represent. Examples; cherry, coconut, walnut, peach plum, olive.
5. Hesperidia are berry like fruits with papery internal separations, or septa, and a leathery separable rind. Examples : lemon, lime grape fruit.

B. Dry fruit has a thin pericarp that is dry at maturity.

1. Dehiscent fruit splits open at maturity and releases mature seed.

a. Legume has a simple (single) pistil that splits open at maturity along two sutures. Examples: Bean, Pea, Soybean, Locust.

b. Follicle has a single (singles) pistil that splits open at maturity along one suture. Examples: Milkweed, Larkspur, pirea.

c. Capsule has a compound pistil that splits open at maturity in one of four ways.

Loculicidal - splitting open through the midrib of the carpel into the locules. Examples : Iris, Tulip.

Circumscissle - splitting open at the middle so that the top comes off like a lid (also called pyxis). Examples: Plantain, Portulaca.

Septicidal - splitting along the septa. Examples: Yucca, Azalea.

Poricidal - splitting open at pores near the top, releasing mature seeds. Example: Poppy.

d. Silique and silicle are characteristic of the mustard family, with two valves which maturity split away from a persistent central partition. A fruit that is several times longer than wide is termed silique, while a silicle is broad and short.

2. Indehiscent fruits do not open at maturity to release the seeds.

a. Achene is a small one seeded fruit in which the seed is attached to the pericarp at only one point and may be rather loose iniside the pericarp. Examples: Dandelion, Buttercup, Sunflower, Dock.

b. Utricle is similar to an achene except that is has an inflated papery pericarp. Example: Russian thistle.

c. Caryopsis is similar to an achene except that the entire seed coat is tightly fused with the pericarb. Example: Grasses.

d. Samara is similar to an achene except that the pericarp develops a thin, flat, wing like appendage. This is characteristic of some woody species. Examples: Ash, Elm, and tree of heaven. Double samaras occur in the fruit of Maple.

e. Nut is a dry one seeded fruit from a compound pistil that has a very hard and tough pericarp and that is usually wholly or partially enclosed in an involucure. Examples: Acorn, Hazel, Filbert, Chestnut.

f. Nutlet is a small, dry fruit composed of one-half a carpel, enclosing a single seed. Folding and splitting of the carpels into a compound pistil develops it. Examples: members of Lamiaceae (Mint family) and Boraginaceae (Forget-me-not-family).

g. Schizocarp has two fused carpels separating at maturity to form one-seeded mericarps. Exmaple: members of Apiaceae (Carrot Family).

COMPONENTS OF SEED

Seed coat

It is the outer covering of seed and gives protection. It develops from the 2 integuments of ovule. Outer layer of the seed coat which is smooth and rough is known as the testa and is formed from the outer integument. The inner layer of the seed coat is called the tegmen and is formed from inner integument.

Embryo

It is the mature ovule consisting of an embryonic plant together with a store of food, all surrounded by a protective coat, which gives rise to a plant similar to that of its mother. It is a miniature plant consists of plumule, radicle and cotyledon. The plumule and radical without the cotyledon is known as primary axis.

Radicle

Rudimentary root of a plant compressed in the embryo is the radicle, which forms the primary root of the young seedling. It is enclosed in a protective cover known as coleorhiza.

Plumule

It is the first terminal bud of the plant compressed in the embryo and it gives rise to the first vegetative shoot of the plant. It is enclosed in a protective cover known as coleoptile.

Cotyledon

Cotyledons are the compressed seed leaves. A single cotyledon (Scutellum) is present in monocots while two cotyledons are present in dicots, hence they are named as monocots and dicots, respectively. In dicots they serve as storage tissue and are well developed, while scutellum is a very tiny structure in monocots.

Endosperm

Endosperm develops from the endosperm nuclei which is formed by the two polar nuclei and one sperm nuclei. It stores food for the developing embryo.

Appendages of seeds

Some seeds will have appentages that are attached to the seed coat. They vary with kind of seed. The appendages sometimes help in dispersal of seeds or in identification of genotypes. Some of the appendages are Awn, Hilum, Caruncle, Aril, Hair and Wings.

Awn

The thorn like projection at tip of the seeds. (eg) Paddy - The bract tip was elongated into the awn.

Hilum

It is the scar mostly white in colour present on the lateral side of the seed. It represents attachment of the seed stalk to placenta of the fruit to mother plant (eg) Pulses.

Micropyle

The point where the integuments meet at the nucellar apex has been referred as micropyle.

Chalaza

At region of integumentary origin and attachment opposite to micropyle is called chalaza.

Rapha

The area between the micropyle and chalaza is the rapha.The rapha may be visible on the seed coat of some species.

Caruncle

It is the white spongy outgrowth of the micropyle seen in some species (eg) Castor, Tapioca.

Aril

It is the coloured flesh mass present on the outside of the seed (eg) Nutmeg.

Hairs

They are the minute thread like appendages present on the surface of the seed (eg) Cotton.

Wings

It is the papery structure attached to the side of the seed coat either to a specific side of the seed coat or to all sides (eg) Moringa.

IMPORTANCE OF SEED STRUCTURE

1. For identification of cultivars, it can be done based on the morphological, inheritable physiological and biochemical characters

2. To decide the shelf life potential of seeds -by determining how much storage organ the seed has

3. To decide about the various post harvest operations namely drying ,threshing , processing ,cleaning, grading to prevent or minimize the mechanical damage

4. To design post harvest handling equipments.

5. To decide about mechanized sowing.

SEED STRUCTURE

CEREALS

Paddy (*Oryza sativa*)

The fruit is caryopsis. The seed is having lemma and palea, which may be hairy or slightly hairy. Below the lemma and palea, the lower and upper glume are present. The colour of the lemma and palea may be orange, yellow,golden yellow, brownish black and grey. In case of the hulled grain at the top of the grain the silk integuments are present , which may be orange, black, yellow, brown, reddish brown and red violet. The colour of the grain also varies as that of the silk integument colour. The endosperm may be translucent or opague and has pearl spot which may be in the centre or side.

Maize(*Zea mays*)

Maize seed consist of seed coat, storage organ (Endosperm) and embryonic axis. Outer layer of the seed is called pericarp. Fruit coat and seed coat combine together and form the outer layer of pericarp. Aleurone layer is the thin layer present below the pericarp. Inside portion consist of endosperm and embryonic axis and scutellum . The maturity of maize seed is indicated by dunken layer. Which is found below the seed. The embryonic axis consist of shoot and root region. The shoot region consist of first leaf and tip of plumule which is covered by coleoptile and root region consist of root tip of radical and coleorhiza.

Sorghum (*Sorghum bicolor*) and Cumbu (*Pennisetum glaucum*)

The outer layer is called pericarp. Below which a thin layer, endosperm is present. Embryo is placed inside the seed. There are two types of endosperms namely corneous and vitreous. The variation in endosperm is due to genetic factors and place of production.

Ragi (*Eluesine coracana*)

It is a naked seed, botanically the seed is called utricle. The seed has thin papery pericarp. Some times it may or may not be attached with the seed. The shape is round at the top and flattened at the end. The embryo has scutellum (root and shoot tip) . Root tip is covered by coleorhiza and shoot tip is covered by coleoptile.

Thenai (*Setaria italica*), Panivaragu (*Panicum miliaceum*) and VARAGU (*Paspalum scrobiculatum*)

Seed is botanically called caryopsis. Seeds are having smooth shiny appearance. Seed consist of endosperm, scutellum. Seeds are rich in carbohydrate content

PULSES

Structures between pulse seeds are one and the same. But they may differ in colour, shape and texture of seed coat and size. Raphe, hilum and micropyle are present. The embryo consists of two cotyledons, radicle and plumule. The other differences are as follows:

Cowpea *(Vigna unguiculata)*

The shape varies from globular to kidney shaped. The colour varies from white, green, puff, red, brown, black and various mottled and blotched. The surface of seed coat may be smooth wrinkled. A dark black ring surrounds the hilum.

Soybean *(Glycine max*)

It is a dicot seed, it has concave hilum, below the hilum a small hole micropyle is present. The outer layer is called seed coat. The two cotyledons are attached by a part called hypocotyl. One end of hypocotyl is called plumule and the other end is known as radicle. Formation of hilum is the indication of physiological maturity of the seed.

Blackgram(*Vigna mungo*)

The shape is oblong with square ends. The colour of the seed is black. The surface of seed coat is smooth. The hilum is white and concave.

Green gram(*Vigna radiata*)

The shape varies from kidney, oblong, globular shaped. The colour varies from green, white, yellow and purple brown. The surface of seed coat is rough (or) wrinkled. The hilum is coloured and round.

Redgram (*Cajanus cajan*)

The shape is round or oval. The colour is white, greenish red, brownish purplish. The surface of the seed coat is smooth and the hilum is white.