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Breeding for Biotic and Abiotic Stresses in Coconut (*Cocos Nucifera*l.)

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Introduction

Coconut scientific name is *Cocos nucifera*, having Chromosome No. 2n=32, is a member of the palm family Palmae/Arecaceae and the only species in the genus Cocos. Origin South-east Asia. Coconut is a perennial crop, an important multipurpose palm, provides nutritious food and refreshing drink, oil for edible and non-edible uses, pharmaceutical uses, fiber and timbers for commercial and industrial uses, also for environmental protection other than this, creates employment and income generation to the people. Hence Eulogized as "Kalpavriksha - The tree of heaven" considered as nature's valuable gift to the mankind providing multipurpose benefits derived from each and every part of the palm.

Stress and its classifications

Any changes in the environmental conditions that might reduce or adversely change a plant's growth or development is called stress.

There have been significant ups and downs in current coconut cultivation. Due to the high occurrence of disease and pests and the vulnerability to drought, which causes the farmers to experience low production and inconsistent productivity. Thing that causes the pricing effect in market value of coconut. All these because of the reason, cultivation of coconut undergone through stress.

Classification of stress and its factors: Depending on the crop, biotic and abiotic stress reduce average productivity of 65 – 87%.

1. **Biotic stress:** Biotic stress is stress that occurs as a result of damage done to an organism by other living organisms such as pests and pathogens.

Factors: Pest and pathogens

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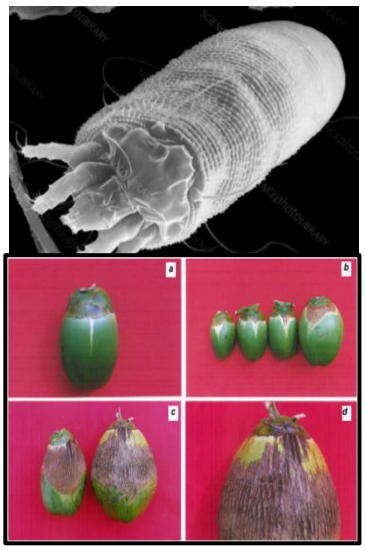
2. **Abiotic stress:** Abiotic stress is the negative impact of non-living factors on living organisms in a specific environment.

Factors: Drought, high and low temperature and salinity

I. Pests as biotic stress

1. Black headed caterpillar (*Opisinaarenosella*)
2. Rhinoceros beetle (*Oryctes rhinoceros*)
3. Red Palm Weevil (*Rhynchophorusferrugineus*)
4. Rugose spiraling whitefly (*Aleurodiscusrugioperculatus)*
5. **Eriophyid mite (*Aceriaguerreronis)***



Eriophyid mite is an invasive pest has become a major problem in most of the coconut growing regions and has drastically reduced the nut yield as well as quality. Most control measures were field tested under experimental conditions have either been unsuccessful or impractical to adopt. Because of microscopic in nature, mites live beneath the perianth of the nut causing damage to developing nuts.

Symptoms of damage:

a. The mites suck the sap inside the perianth, White triangular patches close to perianth of young nut is seen as the initial symptom of Attack

b. White triangular patch widens to cover more area and slowly turns brown

c. Nuts with severely infected resulting in brownish patches, warting and longitudinal splits on the nut surface,

Higher mite incidence results in a 60 % decrease in harvested fruits per bunch and 28 per cent decrease in tender water. Coconut which grown for tendernut purpose, if infested by this mite, market value gets decrease in mature nuts, found difficulty to dehusk result poor quality of nut.

Breeding approaches for eriophyid mite:

Except eriophyid mite, other pests respond to conventional plant protectionmeasures and therefore no specific breeding programmes for developing resistant genotypes. Preliminary screening of cultivars against black headed caterpillar and rhinoceros

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beetle indicated variations in susceptibility among cultivars, though no resistant variety was observed.

In eriophyid mite infestation, as it is very difficult to completely eradicate the pest through conventional plant protection measures, hence tolerant varieties are ultimate solution.

- **Survey or exploration:** Initially, exploration or surveying of particular stress prone or hots area. Identification of some accessions such as Kenthali, Chowghat Orange Dwarf (COD) and Kulasekharam Green Tall (KGT) with very less incidence of mite
- **Association of fruit characters with mite resistance:** Round and dark green fruits show better tolerance against the eriophyid mite than the elongated fruits and of other colors, The entry of mites depends on the tightness of perianth to the fruits at the early stages of fruit development. The smaller the gap between fruit and perianth, the less mite incidence. Greater tightness is achieved in round rather than elongated and angled fruits.
- **Selection:** Later, go for selection. In such a way, Kalpa Haritha, a high yielding tall palm, selection of KGT.

Disease as biotic stress:

1. Bud rot (*Phytophthora palmivora*)
2. Thanjore wilt/ Basal stem end rot/ Ganoderma wilt (*Ganoderma lucidem)*
3. Stem bleeding (*Thielaviopsis paradoxa*)
4. Root wilt (*Phytoplasma*)

Root wilt (*Phytoplasma*)

Root (wilt) is the most devastating disease in India, particularly in Kerala. Annual loss of 968 million nuts was estimated as the loss due to root (wilt) disease in Kerala. The persistent mode of transmission of phytoplasma through the vector lace wing bug (*Stephanitis typica*) and plant hopper (*Proutistamoesta*).

Stephanitis typica

Proutistamoesta

Symptoms:

- Abnormal bending or ribbing of leaf lets termed as flaccidity, is the earliest symptom
- Reduction of leaf size, wilting drooping, yellowing and marginal necrosis of leaflets and deterioration and decay of root system are other salient features of the disease

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- Flowering is delayed, Abnormal shedding of buttons and immature nuts and also Progressive decline in yield

Flower malformation

Flaccidity of leaflets

Diseased palm

Milestones in development of root wilt resistance cultivars:

1908	Butler	started search for resistance to coconut root (wilt) disease & suggested that resistance could be in the local cultivars
1934	Varghese	initiated studies on identifying coconut resistant/tolerant genotypes
1961	CPCRI, RRS, Kayangulam	has made considerable efforts to screen the available cultivars for tolerance to disease, all the cultivar were found susceptible to the disease
1972	Anon et al.	Surveyed & identified CGD has found to have field tolerance over 90%
1979	Iyer et al.	A survey of the disease affected areas identified disease free WCT & CGD palms. Subsequently, disease-free COD palms were also identified
1983	Solomon et al.	Investigation carried out at CPCRI, on the etiology of disease & suggested the association of phytoplasma
1988	CPCRI, Kayangulam	Comprehensive breeding programme by utilizing tolerant WCT, CGD and COD palms
1996	Nair et al.	found higher level of resistance in CGD from the natural survey

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		& screening trials of eight exotic and two indigenous coconut accessions
2005	CPCRI	A selection from MGD was identified as a promising RWD resistant variety, among five dwarf cv., MGD, MYD, MOD, CGD & COD
2007	CPCRI	Kalparaksha, a semi tall selection of MGD with higher level of resistance
2008	CPCRI	Kalpa Sankara developed by considering the performance of CGD x WCT hybrid in the diseased tract
2009	CPCRI	A selection from CGD was released under the name Kalpasree

Breeding approaches for root (wilt) disease: Coconut is affected by a number of diseases. Among them, root (wilt) disease is the most serious and in the absence of effective control measures, developing resistant cultivars is the practical solution.

- **Survey:** A survey of disease *hot spots area*, somedisease-free palms were identified as the base material for the breeding programme
- **Selection:** After survey, go for selection by Screening of the available coconut cultivars for their performance under different ecological conditions is a promising method of obtaining ecotypes
- **Hybridization:** Artificial pollination of mother palms were carried out in farmer's plots with a view to produce artificially pollinated progenies which can be used either for developing aroot (wilt) resistant / tolerant variety and cross combination are carried out in hybridization

II. Abiotic stress:

Abiotic stresses such as drought, high and cold temperature and salinity which can significantly constrain the palm growth and metabolism that ultimately disturbs plant mechanism and reduces crop yield.

1. **Drought:** Plants are subjected to the drought conditions when either the water supply to the root is limited or the loss of water through transpiration is very high.

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Effects of drought:

Drought slows down the activity of the growing point of stem. Leaf production is reduced and causes early aging and collapse. Palms without a minimum of about twenty leaves, lack the vitality to produce nuts. Drought arrest spikelet formation in theinflorescence bud, resulting in loss of female flowers. Heavy button shedding and immature nut fall is observed. Weight of fruit, husk and endosperm is reduced. When soils dry up for prolonged periods, outer cells in the absorbing region of roots develop thickened walls through which water cannot enter.

Symptoms of drought:

Bending and breaking of dry leaves. Poor spathe development and bunches with one or two nuts. Activity of roots and transpirational rates show marked variations.

Breeding approaches for drought:

Survey for identification of coconut germplasm and its evaluation from drought-prone areas. The identification of drought tolerant palms based on the phenotype and the physiological parameters has been demonstrated. Physiological traits such as, low transpiration rate, low osmotic potential, accumulation of epicuticular wax, high turgor pressure are reliable parameters. Utilizing these parameters for developing drought tolerant palms. More roots and a fine root density is less affected by drought.*In vitro* cultureused as a preliminary screening procedure, growth medium containing selective agents offers a rapid and a reliable alternative to screen a large number of individual genotypes in a short period of time

Achievements:

1. **Drought tolerant varieties**
   - Chandra Kalpa
   - Chandra Laksha
   - Kera Chandra
   - Kera Sankara
   - Kalpa Pratibha
   - Kalpatharu
   - Kalpa Dhenu
   - Kalpa Mitra
   - Kalpa Shatabdi

2. **Tolerant to Eriophyid mite**

   3. Root (wilt) disease resistance variety
   - Kalpa Haritha
   - Kalparaksha
   - Kalpasree
   - Kalpa Sankara

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Conclusion:

Some biotic stresses are managed by conventional plant protection measures, but management of devastating biotic stresses (root wilt and eriophyid mite) and abiotic drought as stress, through these measures are practically not possible. Hence, development of resistant or tolerant varieties are considered to be the only practical solution. Considering the achievements made and opportunities available, these strategies suggested for future breeding programs includes development of high yielding varieties coupled with biotic and abiotic stress tolerance or resistances to expand the coconut cultivation in stress prone areas.

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