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CONTAINER GARDENING: FASCINATING WAY OF PLANTING

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Introduction

Container gardening is the practice of growing plants in containers instead of planting them in the ground. It has expanded the horizons of gardening in apartment and multi-complex buildings. The container can be anything that is enclosed, small, and usually portable, such as a box, tub, basket, tin, hanging basket, or barrel. Container gardening is a best option where land is limited and soils are not suitable for cultivation. Better control over growing conditions water, sunlight and nutrients supply. Containers place where, there 6-8 hrs sun light reaches to plant for warm season crops and 4-5 hrs sun light for cool season crops. Container can be place at-decks, balconies, along driveways, sidewalks, hanging baskets and window boxes. Containers are important features of many garden like-roof garden, vertical garden, window garden and kitchen garden. Different size containers are requiring for different crop according to their shoot and root size. These types of garden require nutrient rich growing media for boosting their growth and development. Timely watering and proper drainage facility boost the immunity of plants. This type of garden is suitable for growing of vegetable, fruits and flowers.

Type of containers

Plastic container

Plastic container is the most common and inexpensive type of container. These are available in a multitude of sizes, shapes, designer colors and range in price from downright cheap to the more expensive designer lines. These containers are too light in weight, easy to carry and hold

moisture for longer time. These containers are available with or without drainage trays. They become brittle in lower temperatures or they may deteriorate in UV of the sunlight.

Fiberglass container

Fiberglass containers are used widely in commercial planting. The surface is durable and easily formed into different custom shapes for any look. They are non porous type container. Ridges are often built into bottom surfaces to provide drainage isolation. They are considerably more expensive than plastic containers.

Ceramic container

Ceramic containers are comparatively more expensive than plastic containers. Surface of these containers are porous and it bleed easily. They are available with or without water drainage trays. Ceramic container available in different textured surfaces, painted and glossy finishes. They can create a quality custom look and they come in a wide range of prices.

Wood container

Wood containers are not commonly use like other container. Wood containers are susceptible to rot. Wood should be lined with a non-porous material to avoid staining and rot. Wood containers are easily used for outdoor areas where leaking is not a problem and where weathering of the container surface is either desirable. Wooden containers can be built to sizes and shapes suiting the location. Redwood and cedar are relatively rot resistant.

Metal container

Metal containers provide a nice accent for plants. Commonly used metals in container construction are brass, copper, stainless steel and aluminum. Reflective quality of metals is a pleasing contrast and adds dimension in planting area. Maintenance cost of metals is higher than other surface materials. Metal containers are commonly used as outer covers for plant containers because it does not provide drainage. Metal containers are available in different shapes and sizes. Metal containers heat up rapidly which can cause root damage.

Terra Cotta container

These are cost effective containers for interior display. These containers provide good drainage facility due to having lot of pours on that surface. It is necessary to place pots on a waterproof tray to catch excess water and prevent bleeding of moisture through the pot onto surface areas. They break easily and tend to dry out more rapidly. Terra cotta containers are heavy in weight.

Other containers

Different type of waste material can be use as a container. Different waste like plastic bottles, old tiers, feed sacks, waste shoes, plastic glass and trays also use as container. These containers can be renovate by coloring and decorate by other material.

Plastic container

Fiber glass container

Ceramic container

Wood container

Metal container

Terra cotta container

Characters of plant use in container gardening

- Easy growing
- Shallow rooted
- Low to medium heighted plants
- Hanging type plants are more suitable
- Requirement of low nutrient
- Hardy in nature
- Easily responded towards nutrients and watering
- Resistant to insect pest and diseases

Choice of plants for container gardening

Flowering plants:

Annual flowering plants: Marigold, Pansy, Petunia, Portulaca, Sweet pea, Verbena and Phlox.

Foliage plants: Asparagus, Ferns, Coleus, Crotons and Syngonium.

Bulbs/Tubers/Rhizomes: Amaryllis, Anemone, Begonia, Canna, Crocus, Daffodil, Hyacinth, lily, Narcissus, Tuberous and Tulip.

Perennials: Golden alyssum, Chrysanthemum, Foxglove, Sweet William, Carnation and Kale (ornamental).

Hanging basket: tradescantia, verbena, pansy, petunia, nasturtium, portulaca, chlorophtum.

Planting Information for Growing Flowers in Containers

Name of plant	Nature of plant	Colour of flowers	Flowering time	Amount of light	Size of container
Zinnia	Annual	White, red, orange, yellow	Summer	Sunny	Small
Pansy	Annual	White, purple	Winter	Shady	Small
Portulaca	Annual	Yellow, pink	Rainy	Sunny	Small
Marigold	Annual	yellow	Year around	Sunny	Medium
Sweet William	Annual	White	Winter	Semi shady	Medium
Butterfly pea creeper	Perennial	Blue	Winter	Sunny	Medium
Asparagus	Perennial	foliage	-	Shady	Large
Madhavi lata	Perennial	White	Winter	Semi shady	Large
Money plant	Perennial	foliage	-	Shady	Small to Large

Vegetables

Herbaceous: Lettuce, Palak, Coriander, Fenugreek, Amaranths and Spinach.

Fruit vegetables: Tomato, Brinjal, Chilli, Capsicum and Beans.

Bulb vegetable: Onion, Garlic.

Root and Tuber vegetable: Carrot, Radish, Turnip and Potato.

Other vegetable: Cauliflower, Cabbage and Broccoli.

Planting Information for Growing Vegetables in Containers

Crops	Days for germination	Weeks taken for transplanting	Size of container	Light requirement	Crop Duration
Beans	5-8	NA	Medium	Sun	45-65
Cucumbers	6-8	3-4	Large	Sun	50-70
Eggplant	8-12	6-8	Large	Sun	90-120
Lettuce leaf	6-8	3-4	Medium	Partial shade	45-60
Onions	6-8	6-8	Small	Partial shade	80-100
Parsley	10-12	NA	Small	Partial shade	70-90
Pepper	10-14	6-8	Large	Sun	90-120
Radish	4-6	NA	Small	Partial shade	20-60
Squash	5-7	3-4	Large	Sun	50-70
Tomato	7-10	5-6	Large	Sun	90-130

Fruits

(i) Low growing varieties (ii) Shallow rooted (iii) Small fruit size (iv) Canopy spread less

- E.g. – Citrus species, Gooseberry, Cherry, Apple, Pomegranate, Fig, Guava, Strawberry and Phalsa.

Growing Media

- A good growing media must drain well.
- Synthetic or soilless mixes are well suited for vegetable container gardening and may be composed of sawdust, wood chips, peat moss, perlite, or vermiculite.
- These are free from disease and weed seeds.
- Hold moisture and nutrients but drain well.
- Lightweight.
- Soilless mixes can also be prepared by mixing horticultural grade vermiculite, peat moss, limestone, superphosphate and garden fertilizer.

- Soil mixes are made up of equal parts of sphagnum peat moss or compost, pasteurized soil, and vermiculite or perlite. Composted cow manure is then added to improve the soil's physical properties and as a nutrient source.
- Soil mixes tend to hold water better than soilless mixes**.**
- Traditional growing media for container gardening preparing by mixing 1 part garden soil: 1 part peat moss: 1 part sand.
- Repotting is a compulsory practice in container gardening. Change the growing media at list once in a year.

Watering

- The limited volume of growing medium available to container plant makes it critical to keep the root system moist at all times.
- Watering done with rose cane.
- Watering done daily in summer.
- Small and hanging containers need extra care.
- Drainage facility should be proper.

Nutrients

- Organic manure is mostly used in container gardening.
- Nutrition provide by compost or vermicompost.
- Leafy plants require more nitrogen.
- For root vegetables phosphorus require in adequate quantity.
- Flower crop require more amount of K for better colour development.
- Nutrition applies as per requirement of plants.

Management

- Container gardening can be successful if care properly.
- Plant growth and vigour will vary depending on the location and attention given to plants.
- Inspect the garden daily.
- Check the plants daily for insect pests and treat the diseases.

Benefit of container gardening

As container gardening can be practiced anywhere, benefits and advantages are extremely diverse:

- It helps in water conservation, these plant require less water compare to plant grown in field due to low water loss by evaporation.
- It avoids weeding practice, it save time and labor.

- Apartment blocks and high buildings can be decorated with the help of containers as making roof garden, window garden, vertical garden, kitchen garden and hanging baskets.
- It avoids competition with wildlife.
- It provides fresh produce to the gardener.
- It gives esthetics value to space.
- It gives pleasing felling to the owner.

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ISKISAN: INFORMATION FOR FARMERS GROWTH

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Ikisan is an agricultural portal, was launched on 5 April 2000. Ikisan is a one-stop information resource for the Indian farmer. Ikisan provides online, detailed content on crops, crop management techniques, fertilizers, pesticides and a host of other agriculture related material.Latest updates on related markets, products and weather forecasts are also available.Ikisan enables farmers to network with other farmers, suppliers and consumers across the world.Ikisan has been conceptualized and developed by the Nagarjuna Group - a large diversified South India based group with interests in infrastructural projects and areas such as agriculture (fertilizers, insecticides), energy, steel, finance, refineries etc.Ikisan is a partner in the consortium project on rural livelihoods by Central Research Institute for Dry land Agriculture (CRIDA) under National Agricultural Innovation Project (NAIP)

Overview

Ikisan limited is a company belonging to the Nagarjuna group that has significant presence in the Indian agri input sector encompassing crop nutrients, crop protection chemicals, specialty nutrition, micro-irrigation, agricultural research and development, bio-technology apart from presence in other core sectors of the economy. The parent company is based in Hyderabad, Andhra Pradesh. Ikisan is also based in Hyderabad with its own infrastructure/personnel. The company was initiated in 1999 and formally incorporated in 2000. Ikisan is one of the few companies to have persevered successfully in a nascent sub-sector that exhibits tremendous growth potential.

Ikisan's Business Model

Ikisan business model aims to enable farmer derive best value from his business by direct intervention in the agribusiness value chain. The model has both content provision and community creation and uses these as springboard to commerce. The concept aims at establishing a self sustaining network wherein participants derive comparative advantage over existing business processes and therefore pass on a portion of value thus generated towards perpetuating the system.

Ikisan's Expertise

Ikisan is a pioneer in the field of leveraging the internet and IT technologies in the field of agriculture. Ikisan's portal www.ikisan.com is the foremost among the agri portals to address the various needs of the Indian farmer, in the language he understands.

Vision

Rural prosperity through enhanced knowledge and technology.

Mission

To facilitate continual enhancement of agricultural productivity and rural prosperity,thereby making the Indian farmer globally competitive.

Values

Ikisan provide innovative and customized Agri services and solutions to farming community and other stakeholders of agri sector, which includes leveraging the advances in Information and Communication Technologies for agriculture.Educating farmers in advanced agricultural practices relevant to their region of operation. Providing them with price and quality information about agricultural inputs, farm equipment's and agri-produce and weather. Enabling them to access the world right from their villages. Providing opportunities to build farmer communities through an interactive forum, in vernacular. Enable innovative modules of trade and commerce. Ikisan strive for excellence by way of continually improving services and solutions, thereby enhancing customer satisfaction.

Founder

Shri K V K Raju - An Eternal Source of Inspiration

Nagarjuna Group is a dream willed into reality by its visionary Founder Shri KVK Raju. Shri KVK Raju a first generation technopreneur was born in a humble agricultural family in Andhra Pradesh on November 28, 1928.On graduating from Banaras Hindu University and the Madras Institute of Technology he went on to complete his Master's in Mechanical and Industrial Engineering from Michigan State University and the University of Minnesota, USA. After a short stint in the American Industry he returned to India and worked for short periods at Caltex Oil Refinery, Orient General Industries and Associated Electrical Industries. Finally, he joined Union Carbide of India and stayed there for 15 years. While working with Union Carbide, KVK's deep-rooted urge to serve society through industry impelled him to start a venture of his own. Thus was born Nagarjuna Group in 1973 with an investment of US$ 23 million. The Group has since then come a long way to become a diversified conglomerate with an asset base of US$ 2.5 billion.

Welcome to ikisan.com

Agricultural information hub

Ikisan is an agricultural portal, a one-stop information resource for farmers. Ikisan provides online, detailed content on crops, crop management techniques, fertilizers and pesticides and a host of other agriculture related material. Latest updates on related markets, products and weather forecasts are also available. In this section Agri Info is categorized into two major groups. I.e. Generic and Crop Specific information. Generic information enriches you with common topics on agriculture like Soils, Seeds, Nutrients, Rural Credit, Insurance, Sprayers, and Machineryetc. Crop Specific Information deals with localized crop wise details. To view text in vernacular, click the relevant regional language link.

Market Information

In the age of online marketing farmers need to know current market information for production planning for further marketing which makes easy for the farmer to access larger markets. It is also equally important for other market participants in arriving at optimal trading decisions. Realizing this, Ikisan provides Commodity Prices, Commodity Arrivals and Analysis Reports for major commodities, at local market level on a daily basis.

Field manager

Field manager provides an intelligent way of planning and recording of information to the farmer. This data along with history is also available to experts for suggesting improvements.For further details on Field Manager Please write us at: **helpdesk@ikisan.com**

Buy & Sell ikisan with an objective of providing a platform for the buyers and sellers developed a web based e-commerce model - Vyapar and Mandi to enhance their business transactions.Ikisan Vyapar is a virtual market place. Here the important players such as companies, channel members and farmers can have the convenience of interacting and transacting with each other. IKisan Mandi is an online marketplace for buyers and sellers of agricultural commodities. Through easy to use interactions, the marketplace aims to bring enormous value to all participants.

Procurement and Marketing: 2009 onwards

TNSAMB (Tamil Nadu State Agricultural Marketing Board): Regulated Market Modernization Project comprising of end to end automation of all activities across 20 markets including setting up the central server at the Head Office. PSAMB (Punjab State Agricultural Marketing Board): recording Project comprising of design and development of software for data capture pertaining to arrivals, weighment and auction of agri produce.

Processing

Centre for Development of Advanced Computing has developed technology for quality measurement of agri produce. The agreement between CDAC and Ikisan for Transfer of Technology pertaining to these electronic sensors driven evaluation of tea and rice quality is underway. This offers immense benefits to the farming and trading community by way of establishing empirical quality standards.

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EXPRESSION, IDENTIFICATION AND DETERMINATION OF SEX FORMS IN PAPAYA

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Papaya is native to Tropical America. In India, introduced in early part of the 16th century from Philippines through Malaysia by portuguese. Papaya belongs to family Caricaceae, a small group with 4 genera and 40 species. Papaya is diploid (2n=2x=18) with basic chromosome number (x=n=9). **Badillo (2000)** divided papaya into two genus, *Carica* and *Vasconcella*. Most of the papaya species have been transferred to the genus *Vasconcellea*. *Carica Papaya* is the only species which produce edible fruits.

Flower biology :-

The *carica papaya* is found to flower throughout the year because neither photoperiod nor temperature induces flowering. However, photoperiodic changes are responsible for sex reversal in certain phenotypically unstable forms of hermaphrodite and male trees.

- Inflorescence is axillary in position and flowers are fragrant. The male flower appears in the axil of the 24th leaf and female flower in 18th to 20th leaf.
- Days for development of male and female flower within 42 and 32 days respectively, after bud initiation.
- The peak anthesis was found between 5.00 to 6.00 AM. Anther dehiscence was completed in 18-36 hours before flower opened.
- Stigma become receptive a day before flower opened, remains receptive for 6 days and was found to be maximum on the day of anthesis.
- Pollination is carried out by wind or honey bees. 10% male plants are requires for pollinating the dioecious plants.

Types of Papaya Flower :-

Character	Male flower	Female flower	Hermaphrodite
Inflorescence	Pedunculate, 25-100 cm long	Solitary or few flowered cyme, stalk 3.5-5 cm long	Short peduncle cluster, stalks less than 25 cm
Corolla	Trumpet shaped, 2.5 cm long, 5 lobes, light yellow/cream	5 almost free petals (fused at base), petals fleshy, yellow/cream	5 partially united petals, fused from 1/4 - 3/5 of their total length

Stigmas	None	5, fan shaped on a short style	5, fan shaped
Ovary	Rudimentary non-functional ovary	Large ovoid oblong, 2-3 cm long, central cavity, numerous ovules	Elongate
Stamens	10 in 2 whorls alternating with petal lobes	None	10 borne at the throat of the corolla in 2 clusters (5 long, 5 short)
Shape of fruit	None	Spherical/ovoid	Cylindrical to pear shaped

Sex Form of Papaya :-

Except of *Carica papaya*, all members of caricaceae are dioecious. These species have sexually ambivalent form which go through 'sex reversals' in response to climate or photoperiodic changes during the year. **Storey (1958)** identified 31 different phenotypes among them 15 are variations in male types, 15 in hermaphrodite or andromonoecious and remaining one is the female plant based on peduncle length, ramification and of seasonal sexual responses. He classified these types into 8 major groups:

i. Staminate	**ii.** Elongata	**iii.** Carpelloid petandria
iv. Tetatological staminate	**v.** Carpelloid elongata	vi. Pistillat
vii. Reduced elongata	**iii.** Petandria	

Sex expression in papaya :-

Papaya is a polygamous plant with various sex form. He further stated that *Carica papaya* exists three basic sex form i.e. staminate, hermaphrodite and pistillate. Sex expression in papaya is very complicated phenomenon. Hermaphrodite and staminate form show sex reversal in different environment conditions. Female plant never undergo any change in sex expression and thus never found to possess any hermaphrodite or male plant. Thus femaleness is the most stable character, least affected by seasonal variations. Staminate flower is produce by male plant. Teratological staminate flower is produced by sex reversing male plants. Reduced elongata, elongate, carpelloid elongate, pentandria and carpelloid pentandria are produced by hermaphrodite plants. Pistillate flower is produced by female plant.

The effect of different factor on sex change in papaya are as follow :

1. **Influence of environment -** The Changes in sex expression is accelerated by environmental factors such as low temperature to produce perfect flower on male plant. Fertile hermaphrodite types also have some pistillate flowers which may show male tendency in summer and female tendency in winter. A large difference between day and night temperature can produce more female flowers than normal. Long day and high temperature has been reported to promote the formation of female flower in Coorg Honey Dew.

2. **Effect of chemicals –** The application of growth regulators has been found to change sex in papaya. GA_3 spray @ 50 ppm in Co-1 increased femaleness. Ethephon at 240-960 ppm and chlorflurenol at 20-80 ppm induced intersexual and female flowers as well as male flowers on genetically male plants of Honey Dew cultivar. GA_3 @ 25 ppm and ethrel @ 100 ppm on 100-125 days old seedlings tended to produce more females. Defoliation has been reported to induce maleness and defloration induces femaleness.

Sex identification in papaya :-

It is difficult to identify the correct sex in papaya varieties until their floral emergence. However, the karyological analysis indicate that there is a satellite chromosome in male plant.

- It is reported that leaves of male plant are rich in carbohydrate, phosphorus, chlorophyll a and b, than female plants which are rich in nitrogen and potassium.
- The use of peroxidase enzyme system for the identification of sex in papaya was tried at Cuba, Munoz *et al.* (1982). Peroxidase zymogram patterns established by polyacrylamide gel electrophoresis of leaf, petiole and root tissues from adult plant of 4 clones differed with sex of the plant and a similar differentiation could be recognized in juvenile plants. More bands were present in the zymogram of male plants than the female plants.
- In another study in Bangladesh revealed that the level of most amino acids has been similar in both male and female plant except proline which is present in female plants only and cesteine which is absent. The level of tryptophan in female plant has been twice as high as male plants, Khan *et al.* (1982).

Sex determination in Papaya :-

Sex in papaya is controlled by single gene with three alleles. **Storey (1958)** reported that sex in papaya is determined by the complex gene which is closely linked in differential segments occupying identical region on sex chromosomes. Maleness is controlled by satellite chromosomes. Sex reversal is governed by single gene (R). Gene complexes are generally designated as:

- **M_1** dominant factor for malness.
- **M_2** dominant factor for hermaphrodite.
- **m** recessive factor for femaleness.

The genetic constitution of all the three sexes are as follows:

- M_1 m male plants having staminate flowers.
- M_2 m hermaphrodite plants having bisexual flowers.
- mm female plants having pistillate flowers.
- M_1M_1, M_2M_2 and M_2M_1 homozygous dominant are lethal and thus fail to produce viable seeds.
- The crossing of two plants differing in sex form produces either two (male/female) or three (male/female/hermaphrodite) in set ratio. A cross between dioecious and gynodioecious produce the ratio of 1 male; 2 female; 1 hermaphrodite progenies were produced in the ratio of 1:1 and 3:1.

Ram *et al.* (1983) suggested that multiple allelic genes are at play in determining sex of papaya plant. Symbols for

- Pure male (M_1^{rr} m) (do not go under sex change) and
- Sex reversing male (M_1^{RR} m or M_1^{Rr} m) recognizing dominant gene for homozygous sex.
- In this hypothesis, Mp or mp is the main distinguishing factor between male and hermaphrodite plants, respectively.
- X chromosome carries a vitality gene (V) which is recessive (v) in Y chromosome. The homozygous recessive (vv) state is lethal. Thus presence of lethal gene in recessive state in both male and hermaphrodite plants adds heterozygosity to the sex forms.
- A dominant gene for suppressing femaleness is present only in pure male and this plant never produce any fruit.
- These observation confirms that the inheritance of sex in papaya is under polygenic control.

Sex inheritance in different cross combination is as follows :

Sex ratio					
S.No.	**Crosses or Self**	**Female (mm)**	**Male (M_1 m)**	**Hermaphrodite (M_2 m)**	**Non –viable**
i.	Male (M_1m) selfed	1	2	-	1 M_1M_1
ii.	mm **X** M_2m	1	-	1	-
iii.	mm **X** M_1m	1	1	-	-
iv.	M_2m **X** M_2m	1	-	2	1 M_2M_2
v.	M_1m **X** M_1m	1	2	-	1 M_1M_1
vi.	M_2m **X** M_1m	1	1	1	1 M_2M_1

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VERMICOMPOST

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Vermicomposting is the process of converting organic debris into worm castings. Vermicompost is the excreta of earthworms, which is rich in humus and nutrients. Red Wiggler worm (*Eiseniafoetida*) is recommendedto prepare vermicompost. We can rear earthworms artificially in a brick tank or near the stem / trunk of trees (specially horticultural trees). The content of the earthworm castings improves the permeability of water in the soil,its structure, texture, aeration, and water holding capacity and prevents soil erosion. The nutrients content in vermicompost vary depending on the waste materials that is being used for compost preparation. It contains nitrogen, phosphorus and potassium and many micronutrients as well as valuable vitamins, enzymes and hormones like auxins, gibberellins etc. The harvested vermicompost should be stored in dark, cool place. It should be maintained at 40% moisture level. A recommended rate of vermicompost application is 15-20 percent.

Introduction

Vermicompost is an organic compost which is prepared by earthworm by utilizing the carbonic or organic wastes. By proper utilization of agriculture residue, plant produce, dung and wastage from home which is decomposed by earthworm and output a kind of compost, known as vermicompost and the process is known as vermicomposting. This compost is rich in hormone, vitamins, essentials nutrients and microbes. It improves physical, biological and chemical properties of soil.

Relevance of Problem

Due to continuous use chemical fertilizer there is loss of soil health and fertility. They also reduce water holding capacity of soil. Use of chemicals is also responsible for environmental pollution like water pollution.

Why Use Vermicompost

(i).To maintain the soil health and fertility. (ii) To maintain soil structure and water holding capacity. (iii) To provide essential nutrients to the plant (iv) To reduce environment pollution

Pre-requisite Condition We should select shady place to make pits for vermicompost. The location should be near to farm. Pits should be made at places which are free from waterlogging condition and preferably upland. The location should be near to water source and levelled.

Materials Required

First requirement is nearly 200-250 bricks to make a pit for vermicomposting. Next materials required are 100-150kg fertile soil, 80-100 kg partially decomposed cow dung, 45 kg sand and 12-15 kg crop residue. Last and most important material is earthworm. Out of two thousand five hundred species of earthworms identified in the world, more than five hundred species of earthworms have been identified in India.Earthworm diversity varies with soils and choosing a native species for vermicomposting is necessary and there is no need to import them.Local species used in India are Perionyxexcavatus and Lampitomauritii. But Red Wiggler worms (*Eiseniafoetida*) are amongst the most popular worm species in worm composting and organic gardening. Thus *Eiseniafoetida* is recommended for vermicomposting. These earthworms can be cultured or used in composting applying simple procedures either in pits, crates, tanks, concrete rings or any containers. For our purpose we need 0.5kg earthworm/pit. For preparation of shade, we need bamboo, straw and woods.

Preparation of Pit

Compost pit of any convenient dimension can be constructed in the backyard or garden or in a field.It may be single pit, two pits or tank of any sizes with brick and mortar with proper water outlets. Although 1m*1m*0.5m size pits are recommended with 2-3 water outlets. The 'four chamber' pit will facilitate easy and continuous movement of earthworms from one chamber with fully composted matter to the one with the pre-processed waste in the chambers.

Filling of Pit orPreparation of Vermibed

First layer should be of sand of 5-6 cm. This layer helps to drain excess water from the pit. Spread 8-10cm thick layer of fertile soil and sprinkle little amount of water.Again spread 8-10cm thick layer of partially decomposed crop residue.Last layer is of 8-10cm partially decomposed cow dung. After filling of tank carefully release earthworm@500gm/pit. Top 8-10 cm height of space should be left unfilled. Cover the vermibed with gunny bag.Plastic sheets on the bed are to be avoided as they trap heat.To maintain 40-50% moisture water should be sprinkle once or twiceevery day.The bed should neither be dry or soggy.

After the first 30 days, wet organic waste of animal and/or plant origin from the kitchen or hotel or hostel or farm that has been pre-digested is spread over it to a thickness of about 5 cm. Repeat this twice a week.All these organic wastes can be turned over or mixed periodically with a spade.

(a)

(b)

Figure 1: 1(a) shows design of pits with filled organic materials and **1(b)** shows earthworms used for vermicomposting

Collection and Sieving

Vermicompost is prepared in 50-60 days.It appears like tea and free from any kind of smell.The compost becomes moderately loose, crumbly with dark brown colour. It will be black, granular, lightweight and humus-rich. Watering should be stopped 5-7 days before collection.It will facilitate separation of earthworms from compost.Any bad odour if formed in compost while collection, is a sign that fermentation has not reached its final goal and that the bacterial processes are still going on. A musty smell indicates the presence of mold or overheating which leads to loss of nitrogen. If this happens, aerate the heap better or start again, adding more fibrous material and keeping the heap drier.After collection, heap the compost in shady place while maintaining 20-25% moisture.Sieve it by 2 mm sieve to separate earthworm.Undecomposed material should be separated and kept back in pit for further decomposition.

Nutrient composition

Organic carbon	9.5 -17.98%
Nitrogen	0.5 -1.50%
Phosphorus	0.1 - 0.30%
Potassium	0.15 - 0.56%

Precaution
➢ Fresh cow dung should not be used.
➢ Optimum moisture level (40-50%) should be maintained
➢ Suitable earthworm species should be selected.
➢ Protect the bed from direct sunlight.

Advantage

• Reduces the dependence on chemical fertilizers,	• Increase the soil aeration
• Increase the population of beneficial microorganism,	• Increase the production of crop,
• Improve soil health,	• Environment friendly,
• Increase the quality of crops,	• Provide essential nutrients to plant
• Increases water holding capacity of soil.	

Limitation

- ➢ Takes about 2 months or more in compost preparation depending upon climatic conditions,
- ➢ Special type of earthworm needed like - *Eiceniafoetida*.

Economic Analysis

Installation cost will be more than income during first cycle as it involves preparation of pits and shade. This is one time investment and in subsequent cycles the profit will be more. Production of vermicompost from 1 pit is around 105 kg. Thus from 50 pits total production will be 5250 kg in one cycle. Production cost of vermicompost is Rs. 4/kg excluding installation cost. Average selling price of vermicompost is Rs. 8/kg. Thus net profit will be Rs. 4/kg from second cycle.

Generally we get about 3 cycles per year, so from 50 pits:

Amount of vermicompost per year = 5250*3 =15750 kg
Expenditure cost per year = 15750*4 = Rs. 63000
Gross income per year = 15750*8 = Rs. 126000
Net profit per year = 126000 – 63000 = Rs. 63000

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VIRAL DISEASES IN CHICKPEA

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Introduction

Viruses differ from most fungal diseases in that they infect plants systematically and no curative treatment is available. Virus infections are spasmodic and levels depend heavily on seasonal conditions and differ greatly between years and locations. Early infection can lead to stunting, reduced tillering and plant death and losses can be high. Late infections have less impact, but can still affect seed quality. There are more than 14 species of virus that naturally infect chickpeas. These viruses are spread by airborne insects, with aphids being the predominant vector. The occurrence of virus in chickpeas is episodic and changes dramatically from season to season and location. Clovers, medics, canola/mustard, weeds and other pulses can host viruses that infect chickpea. The best control strategies to reduce risk of viruses are agronomic. These include retaining cereal stubble, sowing on time, establishing a uniform closed canopy and controlling weeds. Seed and foliar insecticides are not recommended for chickpea viruses, Govind *et al*., 2008.

Symptoms

Viruses exhibit a varied range of symptoms and severity from relatively unapparent to plant death. The intensity and symptoms depend on virus and pulse species and to a lesser extent on virus strain, pulse variety, climatic conditions and plant stage at infection. Plants infected at an early stage or through seed will usually show more uniform discolouration and stunting, but when infected at the later stage will usually occur at the leaf tip before the whole plant starts to deteriorate, Anonymous, 2015.

Foliage symptoms are often more visible on young leaves and can include yellowing (sometimes reddening), vein clearing, leaf mottle, leaf distortion, curling of leaves, reduced size, chlorotic or necrotic spotting, or more widespread necrosis. Shoot symptoms may be seen as bunching of young leaves, growth of auxiliary shoots, bending over of the growing point, tip or apical necrosis, streaking of stems, stunting and wilting or plant death.

Symptoms such as leaf yellowing, veining, mottling, and wilting can often be confused with nutrient deficiencies, herbicide damage or water stress unless sufficiently distinct. It is also difficult to tell which virus is present without resorting to laboratory tests on plant samples. It is best to collect living tissue samples and collection and packaging of fresh samples is simple. Instructions from local agronomists or Pulse Australia need to be heeded. Immediately place the

sample with paper towelling into a plastic bag, seal it and refrigerate it until dispatched. Send the sample by priority post and do not leave it sitting around.

Conditions favouring development

High levels of virus infections have occurred in recent years resulting from infected plants in the previous spring as a virus source and a 'green bridge' of summer plant material to carry over these viruses and as a refuge for aphids. Warm dry conditions during autumn have favoured increased aphid activity and virus transmission. Some aphid species prefer to land on plants surrounded by bare ground and favour thin crop stands or areas within the crop which have low plant densities. Stressed plants are also more attractive to aphids, possibly due to a higher level of plant sugars, and are vulnerable to colonisation and can become a source of virus spread. Environmental factors that impacted on chickpeas in 2009 were extremely dry conditions early in the season that favoured aphid build and this was particularly evident in vetch crops. Then followed cold and wet conditions that included some transient waterlogging that stressed plants making them more venerable to root diseases and aphid attack. Chickpea that border lentil, canola or lucerne crops can be subjected to larger numbers of aphids, as they can readily colonise these crops and multiply quickly.

Controlling aphids in these nearby host crops can potentially decrease aphid numbers moving through chickpea crops.

Reducing risk of viral diseases

Controlling virus disease in chickpeas is difficult. Chickpea plants that become infected with a virus invariably die. GRDC-funded field trials have shown no benefit of seed-applied insecticides or regular foliar-applied insecticides or a combination of both against chickpea viruses. The best and at this stage only, control strategies to reduce risk of viruses in chickpeas are agronomic. These include; retaining cereal stubble, sowing on time, establishing a uniform closed canopy, providing adequate nutrition and controlling weeds. Reduce risk of viruses in chickpea crops by planting between rows of standing cereal stubble, sowing on time and targeting at least 25 plants/m^2.

Management of viruses

A virus management strategy to reduce the risk of infection may require a number of control measures relevant to the various virus and pulse types.

Conclusion

Chickpea is distinct from other pulses in respect to virus diseases and how viruses spread in crops. Aphicide sprays and some other control strategies that are effective in other pulses are less effective. At present, the best control options for chickpea are the current best agronomic practices: retaining standing stubble, using optimal sowing rates and times, and controlling in-crop and fallow weeds. Virus management aims at prevention through integrated management practice that involves controlling the virus source, aphid populations and virus transmission into pulse crops. Rotate legume crops with cereals to reduce virus and vector sources and where possible avoid close proximity to perennial pastures (e.g. lucerne) or other crops that host viruses

and aphid vectors. Eliminate summer weeds and self-sown pulses 'green bridge' that are a host for viruses and a refuge for aphids. Aphid activity is influenced by seasonal conditions and will require early monitoring in nearby crops and pastures and possible use of an aphicide or cultural controls to reduce numbers. Sow directly into cereal stubbles (preferably standing), and encourage rapid canopy cover through early planting, high planting density as bare soil is more attractive to some aphid species. Purchase virus-tested seed or have farmer seed virus tested as PSbMV, CMV, BYMV and AMV depend largely on seed transmissions for survival. Gaucho® 350SD is now registered and when applied as seed treatment will help protect faba bean, field pea and lentil seedlings from early season aphid attack and reduce virus spread.

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BEWARE OF SAP FEEDERS OF CITRUS PLANTS

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Attack by non sucking insects immediately attracts attention in the form holes, mines, cuts or scratches etc. on different plant parts. Most of the sap suckers are hidden enemies and slow killers. Some of these are difficult to control. They have piercing and sucking type of month parts, insert them in the plant tissues and suck the cell sap. Many of these sucking insects remain congregated on different plant parts and suck out huge quantity of plant sap. Some of the major sucking insects are discussed here.

Citrus phyla:-

Identification:-

The adult sits in a typical manner mostly on the lower surface of leaves. Its head touches the leaf surface while rest of the body is raised up. It is about 2-3 mm long and brownish in colour. Eggs are orange coloured and almond shaped laid on tender shoots. Nymphs are yellowish-orange, circular in shape which are generally found crowded on new shoots.

Seasonal activity:-

It does not flourish in too cold or too hot and dry conditions. Although it is active from February to November, its activity declines during rainy season and its resumed after the rain are over i.e. August. Severe winter is passed in adult stage and activity is regained spring season.

Nature of damage and symptoms:-

Nymphs and adult suck cell sap. However, major feeding is done by nymphs on buds and terminal shoots. After 2-3 days they move out to tender leaves. A waxing material is exudates by nymphs which sometimes appear on whitish filamentous structure hanging on the shoots. Large amount of honey dew is excreted on which sooty mould develops. During feeding a toxin is injected in the plant tissues which causes toxemia. It also act as vector of a virus which causes citrus decline.

Infested trees can be recognized by presence of yellowing, curling and dropping of leaves and drying of terminal shoots. Toxemia leads to drying up of not only the infested branches but the adjacent branches too, dry up. Reduced fruit size, lesser juice and insipid taste are the effects on fruits.

Management:-

Removal and destruction of severely infested shoots is effective if a few shoot are infested. Spraying with Malathion 50 EC @ 1 ml per litre of water provides effective control.

Citrus whitefly:-

Identification-

Adult fly is 2 mm long and pale yellow in colour. Egg, nymphs and pupae are also pale yellow. Eggs are attached to leaf surface with a stalk. Leaves with heavy egg laying appear as if covered with a pale –yellowish powder.

Seasonal activity:-

Early autumn or spring is the season when adults are active and March through April all the stages i.e. eggs, nymphs, pupae and adult are found. Pupae are found from October to February.

Management:-

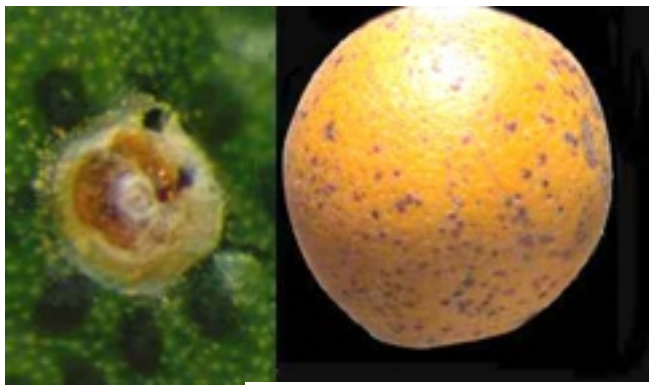
Collection and destruction of the damaged plant parts along with nymphs, pupa and adults is effective if a few plants are infested. Spraying with Acephate or Phosphamidon @ 1 ml per litre of water provides effective control.

Citrus psylla

Citrus whitefly

Citrus mealy bug

Citrus black wing whitefly



Citrus red scale

Citrus black wing whitefly:-

Identification:-

Body of adult fly is covered with a coating and appears salty bluish. Eggs are creamy white which turn brownish and blackish. Eggs are laid on the lower surface of leaves in three whorls in a spiral fashion. Each whorl contains 15 to 22 eggs. Newly hatched nymphs are dark brown to shiny pupae are also black in colour.

Patel, (2019). Beware of Sap Feeders of Citrus Plants

Nature of damage and symptoms:-

Damage and symptoms are similar in both the species. Newly hatched nymphs move around and select a suitable feeding site at the lower surface of leaves. They then insert their needle like mouth parts in the leaf tissue and remain stationary at that point and keep on sucking the cell sap. Adults are fliers and they also suck cell sap. The impact of desaping is expressed in the form of pale-green leaves which slowly turn pale brown, severely curled up followed by flower shedding pre maturely. Overall impact of heavy infestation could be reduced vitality of trees delayed ripening and insipid taste of fruits. Sooty mould grows on the honey dew excreted by nymphs and adults which interferes with photosynthesis.

Management:-

In new plantings, close spacing should be avoided. In case of localized infestation, severely infested leaves should be plucked. Spraying Chloropyriphos 20EC @ 2ml per litre of water provides effective control. Subsequent need based spray should be given at an interval of 12-15 days.

Citrus mealy bug:-

Identification:-

Adult female is light brown, 3-4 mm long and its body is covered with white waxy secretion. Spine like structures project from periphery of body including the posterior end of abdomen. Newly hatched nymphs do not have waxy coating on their body and are pale-yellowish in colour.

Nature of damage and symptoms:-

First instar nymphs crawl and select a suitable feeding point and keep on sucking the cell sap. Almost all plant parts are attacked including the base of fruit stalks, roots, tender branches as well as leaves. Feeding on fruit stalk causes pre-mature fruit drop. They also excrete honey dew on which a black fungus grows. Growth of affected trees is retarded and fruit yield is reduced.

Management:-

Chemical control is rather difficult as the dose required to kill the bugs is higher which may have adverse effect on trees. Use of biological control a predatory beetle, *Cryptolaemus montrouzieri*. This feeds an eggs, nymphs and adults of the mealy bug.

Spraying with quinalphos 25EC @2 ml per litre of water will be effective against crawlers.

Citrus red scale:-

Female lays young ones which secrete waxy coating on their body. Female has more or less flattened and circular scale covering its body. Females are reddish and turn yellowish - orange and kidney -shaped when gravid.

Nature of damage and symptoms:-

These scales suck cell sap from tender branches and leaves. Fruits and even fruits may also be attacked. Besides direct feeding a toxin is also injected into the cell sap. This may lead

to the death of young trees. A gummy exudates may also be seen from the infested parts.

Seasonal activity:-

Their growth is retarded during December-February. Although this insect may be found throughout the year at different levels in different seasons, it is most active from August to October.

Management:-

Chemical insecticides hardly control it because these scale do not suck sap from deeper region i.e. phloem and their body is covered with thick scale. In case of localized infestation, pruning of severely infested parts should be done.

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CUSTARD APPLE – POTENTIAL UNDERUTILIZED FRUIT OF 21st CENTURY

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Introduction: Custard apple (*Annona squamosa* L.) belongs to family annonaceae. It is native to tropical America. It is known by several vernacular names such as sugar apple, sweet sop, Sitaphal and Sharifa in different parts of the country. Custard apple performs well in tropical and warmer sub-tropical parts of India and is predominant in Aravalli hills and regions of South Eastern Rajasthan. It is cultivated mainly in Maharashtra, Andhra Pradesh, Madhya Pradesh, Bihar, Assam, Orissa and sub mountainous tracts of South Eastern districts of Rajasthan. In Rajasthan, custard apple is in abundance in natural gene sanctuary of Aravalli hills. It is commercial cultivation is gaining momentum in Chittorgarh and Jhalawar districts. In Maharashtra, it is cultivated in Pune, Ahemdanagar, Sholapur, Aurangabad, Osmanabad, Beed, Dhule and Bhandara districts. Custard apple thrives well under climate with mild winter and is considered as a sustainable crop for a wasteland and being successfully grown in rocky, gravel and heavy and even in sandy loam soils.

Importance: Custard apple is very hardy, medium in growth and deciduous in nature under sub-tropical condition.Every part of the plant including leaves and seeds have lots of uses. The leaves havegote utility in Ayurveda and Herbal Treatment. Custard apple fruit itself has a delicious taste and peculiar aroma as milk shakes, rabdi prepration in tempting delicious as in marriage compares. The main use of Custard apple fruits generally used for ice creams and custard apple powder preparation. The custard apple fruit provides high nutritional value and it possesses low glycemic index levels.Unripe fruits, seeds, leave and roots are considered for use in medicinal

preparations. Most of the Custard apple fruits are consumed as fresh fruit as well as freeze dried pulp bricks are stored at -20º C along with KMS to be used round the year for various processed products

Climate: All annonas are tropical in origin and grow well in hot and dry climate with varying degrees of difference of soil topography and medium to heavy precipitation. Custard apple requires mid dry climate during flowering and high humidity during period of fruit setting. Flowering initiates during hot dry climate of May but fruit setting takes place on onset of monsoon. Low humidity is harmful for pollination and fertilization. The Custard apple withstands drought conditions, aberrant weather condition and also thrives well when the temperatures go down below 10 degrees. Annual rainfall of 50-80 cm is optimum, though it can withstand higher rainfall. For establishment of orchard, weekly irrigation during summer and protection from cold winds during severe winter is much needed for plant survival.

Soil: The Custard Apple is not very particular about soil conditions and flourishes in all types of soils like shallow, loamy to clay loam soils but growth is restricted if the subsoil is ill drained. It can grow well in deep black soils provided they are well drained along with gradient of slope. A little salinity or acidity does not affect it but alkalinity, chlorine, poor drainage or marshy-wet lands hamper the survival and growth potential.

Varieties: The following are some of the varieties being grown and well acclimatized in different agro-climatic regions of the country.

Balanagar: It is a local seedling variety collected from Balanagar area of Mahaboobnagar district of Andhra Pradesh. Fruit are very large and heart shaped, having good pulp percentage, smooth consistency and heavy bearer. The fruit quality is good. Fruit size big with large tuberless and plenty of very sweet pulp with high TSS content. It is recommended for Maharashtra, Rajasthan, Chhattisgarh, Gujarat, Madhya Pradesh and Uttar Pradesh. It is the most popular variety still today being a good pollinizer for custard apple cv. Arka Sahan.

Red Sitaphal: The fruits are purple colored and the leaves of the plant are purplish at the midrib. Sweet in taste but possesses numerous seeds. This variety has got the disadvantage of developing stone fruits. Its seedlings come into bearing early but for getting true to type plants propagation through T- budding and soft wood grafting recommended. This cultivar is a shy bearer.

British Guinea: Fruit large, greenish white in color, pulpy, few seeded quality good, bearing sparse. Fruits keep for about week after ripening without spoilage. Not common in cultivation but is utilized for germplasm conservation.

Island Gem: This is an Australian variety. The fruit is very large in size, smooth surface, very large segments, verypulpy very delicious, few seeded, greenish white in color, pulp very sweet, excellent flavor, bearing is sparse, fruits are irregular in shape and keeping quality is good under ambient condition for about a week.

Pink's Mammoth: This is a variety of Atemoya, introduced from Australia. The fruits are very large, ovoid, pulpy, and delicious, very few seeded and greenish pink in color, smooth surface, has very broad and round segments, excellent in quality, bearing is poor. Fruits are irregular in

shape. Fruits can be kept in good condition for about a week after ripening and should be handled carefully due to soft texture.

Raydurg: The fruit quality is good. Fruit size is medium with less numbers of areoles and plenty of very sweet pulp, while fruit shape is pyri form with smooth pulp consistency, high TSS content. It is recommended for Maharashtra, Rajasthan, Chhattisgarh, Gujarat, Madhya Pradesh and Uttar Pradesh.

Washington: The fruit is medium in size, smooth surface, with dominant areoles and core portion is prominent with high pulp content, tempting delicious, few seeded, greenish white in color, pulp very sweet, excellent flavor, bearing is sparse fruits are irregular in shape and shelf life is about a weak.

Purandhar (Pune): This local cultivar is very popular in and around Pune district. The fruit is very large in size, areoles are smooth with large number, very pulpy delicious, few seeded greenish white in color, pulp very sweet, excellent flavor and bearing is sparse, fruits are irregular in shape, keeps for about a week.

Hybrids varieties:-

Atemoya: This is a hybrid between Sitaphal and Cherimoya. Atemoya grows to a height of about 5-6m and has luxuriant growth. Hence, planting distance must be 7m x 7m. Ripe fruits are whitish green in color, juicy, delicious and pulpy with an excellent acidic flavor. Very few seeded. Keeping the quality good can be kept even up to 10 days. Bearing is erratic and is a shy bearer. For every 8-10 plants of Atemoya, one custard apple plant should be planted in the middle to act as pollinizer plant, otherwise the bearing of Atemoya will be poor and erratic. Atemoya fruits will generally harvests from October to December.

Arka Sahan: It is a hybrid variety of custard apple which has been developed from a cross between Island Gem and Mammoth cultivars. Fruit is large, greenish white in color, pulpy, few seeded quality well. It produced good quality fruit with better aroma and flavour. The properties of ripe fruits especially the taste, flavour, smoothness makes this cultivar unparalled to any other hybrid variety. Unlike the common custard apple, the pulp in this hybrid has to be scooped out with a spoon. There are fewer and smaller seeds which do not stick to the pulp. The TSS content is around 35º brix. It has a mild pleasant aroma which makes Arka Sahan cultivar a distinct one. Because the skin is tough, the ripening process is slow and storage is easier. The easy way to eat the fruit is to cut it open into two halves using a knife. This cultivar was developed by Dr. Jalikop, a renowned Horticulturist at IIHR Bangalore.

Propagation: The annonas species are commonly propagated by seeds. The researchers have developed some techniques in vegetative methods and T- budding as well as soft wood grafting can be adopted for multiplication and for producing true to type plants. The seedlings of local custard apple cultivar have proved a good root stock for many improved varieties and hybrids. Seeds treated with 100 ppm Bavistin for 24 hours germinate within a period of 1to 2 months.

Planting and Season: Planting is done during rainy season and may be done during spring if arranged irrigation is available during summer months to provide monthly. The pits of 60x60x60

cm at spacing 5x5 or depending on soil type and pits are dug prior to monsoon and filled with a good quality FYM, single super phosphate and neem or Karanj cake, vermicompost before onset of monsoon and with drip irrigation system planting at 5 x 5 meters has given good result in the establishment of orchard.

Interculturing: For good plant growth, the weeding should be done to keep away the weeds. Intercropping with some legumes, peas, beans and marigold flowers are commonly taken by the growers in order to utilize the inter space during gestations phase of plants. Normally, no crop is taken during winter as the plants go under rest.

Care of young orchard: The gap filling is to be done as early as possible. Stagnation of water during monsoon should be taken care of and drainage should be provided for avoiding water logging condition. Fungicides should be applied as soil drenching to avoid fungus infection in rhizosphere of the plants.

Special horticultural practices: For uniform flowering and for early flowering and also to check the flower and fruit drop and for improving fruit size, following growth regulators are used.

- Apply vermicompost according to age of the plants just at the outset of monsoon.
- Apply fungicides (metalaxyl+mancozeb)@0.1% during July and August month will help in better nutrition of fruits and control of fruit drop.
- For better and early flowering zinc sulphate @0.2% prior to flowering helps in improvement of fruit set.
- During fruit development 50 ppm GA foliar spray improves the fruit size and luster of the fruits.

Irrigation: In general, Custard apple is grown as a rainfed crop and no irrigation given. However, for early and bumper harvest of the crop. Irrigation on flowering i.e. from May should be given till regular monsoon starts. For better flowering and fruit setting, mist sprinkling is better over flood or drip system of irrigation as it keeps to lower down the temperatures and to increase in the relative humidity.

Nutrition: Generally, no manures or fertilizers are applied to rainfed crop. However, for early and bumper harvest with a good keeping quality, the following dose is recommended to a fully grown tree. FYM 20 kg before flowering and further spray of N: P: K 19: 19: 19 mixture after fruit setting. Occasionally, zinc or iron or both deficiencies are noticed and can be taken care of by spraying zinc or ferrous sulphate solution @0.2%.

Plant protection: Though the crop is hardy, it suffers from the following pests-

- **Mealy bug:** the infestation is more during continuous saw fall spelt and becomes more sever under damp conditions.
- **Leaf spot:** for control leaf spot and anthracnose, spray of carbendazim @ 0.1% and (mencozeb @ 0.1%can be employed in high rainfall zone.

Harvesting and yield: The Custard apple is a climacteric fruit and harvested at the maturity state when the fruit starts to change colour from green to yellow colour shade. Harvesting should be done at the proper stage of physiological maturity. Fruits are harvested when the color is

lightgreen, areoles become flat and the interspaces between areoles become yellowish white and initiated cracking of the skin between the carpel. Fully mature fruits ripen in 2-3 days after harvest. The temperature between 15-30º C and low relative humidity accelerates the process of ripening. Immature fruits do not ripe. Swelling of areoles with flattening is maturity indices, well managed nutritionally enriched trees yield above 80 to 90 fruits per plant. The harvesting duration of custard apple in North India condition is October- November.

Post-harvest handling: The fruits do not withstand cold storage as well as handling after ripening due to its rapid perishable nature. Firm but mature fruits can be kept for about a weak under normal condition. High temperature (>30º C) caucusesfruits to loose its texture and leads to rapid ripening.

Food Uses: In India, the fruit is eaten only by the lower classes, out-of-hand. In Rajasthan as well as in other states, the fruit is appreciated by all. When fully ripe it is soft to the touch and the stem and attached core can be easily pulled out. The flesh may be scooped from the skin and eaten as is or served with light cream and a sprinkling of sugar. Often it is pressed through a sieve and added to milk shakes, custards or ice cream.

Toxicity: The seeds are so hard that they may be swallowed whole with no ill effects but the kernels are very toxic. The seeds, leaves and young fruits are insecticidal. The leaf juice kills lice. The bark contains 0.12% anonaine. Injection of an extract from the bark caused paralysis in a rear limb of an experimental toad. Sap from cut branches is acrid and irritant and can severely injure the eyes. The root bark has yielded 3 alkaloids: anonaine, liriodenine and reticuline (muricinine).which are basically insect repellant in nature.

Other Uses: the fibre from leaves is used in preparation of quilt in Chittorgarh district is be combining popular these days. The leaves have been employed in tanning and they yield a blue or black dye. A fiber derived from the youngtwigs is superior to the bark fiber from *Annona squamosa*. Custard apple wood is yellow, rather soft, fibrous but durable, moderately close-grained, with a specific gravity of 0.650. It has been used to make yokes for oxen.

Medicinal Uses: The leaf decoction is given as a vermifuge. Crushed leaves or a paste of the flesh may be

Poulticed on boils, abscesses and ulcers. The unripe fruit is rich in tannin; is dried, pulverized and employedagainst diarrhea and dysentery. The bark is very astringent and the decoction is taken as a tonic and also as aremedy for diarrhea and dysentery. In severe cases, the leaves bark and green fruits are all boiled together for 5 minutes in a liter of water to make an exceedingly potent decoction. Fragments of the root bark are packed around the gums to relieve toothache. The root decoction is taken as a febrifuge.

Disorders-

Stone Fruits: Some fruits instead of attaining full size remain very small and become brown and dry up. These are known as stone fruits which are retained on tree for a long period. Improper pollination due to lack of insect activity and high temperature at the time of fruit setting leads to

the formation of stone fruits. Competition among the developing fruits and high temperature are supposed to cause stone fruit formation.

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NICKEL AFFECTING BIOCHEMICAL ACTIVITIES IN PLANTS

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Introduction

Nickel was suspected of possessing a metabolic role in plants when discovered as a constituent of plant ash in the early 20th Century. Various nickel salts; including the sulfate, chloride, and bromide were used in human medicine during the mid-to late-1800's to treat headache, diarrhea, and epilepsy and as an antiseptic. Later, some nickel salts have been incorporated into fungicides to combat plant pathogens. The discovery that Ni is a component of the plant urease in 1975 (Dixon *et al.*, 1975) prompted a renewed interest in the role of Ni in plant life. Now, nickel is considered as an essential element for plant growth (Brown *et al.*, 1987). There are numerous reports of growth stimulation in higher plants by lower concentrations of Ni (Mishra and Kar, 1974).

Nickel even though recognized as a trace element, its role in metabolism for certain enzyme activities, various other biochemical, physiological and growth responses is very decisive. The metabolic process particularly under increased nitrogen metabolism on application of Ni has emphasized the need to study the dual behavior of Ni in plants.

Ni uptake, transport and distribution in plants

The uptake of Ni in plants is carried out mainly by root systems via passive diffusion and active transport (Seregin and Kozhevnikova, 2006). The ratio of uptake between active and passive transport varies with species, Ni form and concentration in the soil or nutrient solution. The uptake of Ni by plants depends on Ni^{2+} concentrations, plant metabolism, the acidity of soil or solution, the presence of other metals and organic matter composition.

Ni is transported from roots to shoots and leaves through the transpiration stream via the xylem. This transport is tightly regulated by metalligand complexes and proteins that specifically bind Ni (Colpas and Hausinger, 2000). Metal ligands, such as nicotianamine (NA), histidine (His) and organic acids (citric acid and malate ions), can act as intracellular chelators, which bind Ni in the cytosol or in subcellular compartments for transport, translocation and accumulation within plants. Over 50% of the Ni absorbed by plants is retained in the roots. Furthermore, a high percentage (over 80%) of Ni in the roots is present in the vascular cylinder, while less than 20% is present in the cortex.

Enzyme activities as affected by Ni

Application of Ni increases the activity of catalase, peroxidase and urease enzymes in tomato plants at higher doses, while optimum activities were noticed on application of Ni at 30 ppm on tomato plants (Gad *et al.*, 2007) which resulted in higher plant biomass.

Gajewska *et al.* (2006) showed that application of Ni caused an increase in H_2O_2 content in wheat roots. They reported that Ni stress at 200µM application led to the inhibition of SOD activity in the roots significantly. The lack of induction of APX and CAT activities in response to Ni stress favored accumulation of H_2O_2 in the root tissue. Enhancement of H_2O_2 concentration did not lead to the induction of lipid peroxidation in the root. The results indicate that inhibition of root growth in wheat under Ni stress may be related to the increase in H_2O_2 content, but not to lipid peroxidation.

Nickel deficiency also reduced urease enzyme activity (Gerendas and Sattelmacher, 1997) which induced metabolic nitrogen deficiency and also affected amino acids content in several non-woody species (rye, wheat, soybean, rape, zucchini, and sunflower).

Effect of Ni on antioxidants

In response to Ni application, activities of enzyme like CAT, SOD, APX, POD and GST were found significantly altered in response to production of hydrogen peroxide and showed differential pattern in shoots and roots of wheat (Gajewska and Skłodowska, 2008).

Nitrogen metabolism as influenced by Ni

There are at least three key enzymes involved in urea metabolism in plants: arginase, urease and glutamine synthetase. The primary role of urease is to allow the organism to use external or internally generated urea as a nitrogen source. Significant amounts of plant nitrogen flows through urea. This compound derives from arginine and possibly from degradation of purines and ureides. The nitrogen present in urea is unavailable to the plant unless hydrolyzed by urease. The product of urease activity is ammonia which is incorporated into organic compounds mainly by glutamine synthetase (Marschner, 1995).

Gheibi *et al.* (2009) reported increase in urease enzyme activity of maize plants supplied with Ni in combination with urea as N source. The increase in urease activity was pronounced in increasing shoot dry weight of maize.

The growth of rice plants was significantly affected by N sources and Ni supply (Gerendas *et al.*, 1998). They reported that Ni did not affect significantly the growth of rice when applied with ammonium nitrate as N source; while dry matter production was significantly reduced in absence of Ni when urea N was applied; and excess urea was accumulated in plant parts. The urease enzyme activity was significantly improved on application of urea in combination with Ni which resulted in higher amino acid content. The similar results were also observed in rape plants (Gerendas and Sattelmacher, 1999).

Physiological role of Ni

Gerendas and Sattelmacher (1997) reported increase in chlorophyll content of various crops *viz*. rye, wheat, soybean, rape, zucchini, and sunflower on application of lower concentration of Ni. Tabatabaei (2009) reported that use of Ni in the nutrient solutions containing urea has an important role to promote cucumber plants growth and increase yield. Ni supplements enhanced the growth and yield of urea-fed plants presumably by increasing Photosynthetic rate.

Quality of produce as affected by Ni

Application of Ni increased tomato fruit quality in terms of titratable acidity, Vitamin C content and total soluble sugar contents at all levels of applications (Gad *et al.*, 2007). Reduction of nitrate concentration of the fruits in urea-fed plant at 0.5 mg L^{-1} Ni improves the fruit quality (Tabatabaei, 2009).

Conclusion

- Ni is an essential component of the enzyme urease
- Elevated levels of Ni hampers yield by disturbing plant metabolic processes
- Application of Ni increases quality parameters in vegetables like Vit. C, protein, TSS etc.
- It helps in reducing nitrate content - an anti-nutritional factor
- Optimum conc. of Ni increases amino acids, chlorophyll content and growth of plants

Future Perspectives

- ✓ Role of Ni in other metabolic processes of plants needs to be established
- ✓ Information on Ni and some other enzymes is lacking
- ✓ There is a need to establish critical limit or toxic level for particular crops
- ✓ Ni favours seed germination/ viability and seedling vigour but reasons are yet to be explored

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SYSTEM OF RICE INTENSIFICATION (SRI) FOR IMPROVED PRODUCTIVITY AND PROFITABILITY OF RICE

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Rice is the staple food for more than half of the world population. Rice is the *King crop of Asia*, because 90% of rice is being produced and consumed in Asia alone. In our country India, rice is grown in about 43.0 mha area with the production and productivity of 154.5 mt and 2.41 t/ha, respectively (USDA, 2016). Rice crop is known to have very low water use efficiency and under irrigated conditions it consumes about 3,000 to 5,000 litres of water to produce one kilogram of rice (Geethalakshmi *et al.*, 2011). So water becomes one of the most important components for sustainable rice production in major rice producing areas of country as well as world. It is unequivocal that over past 3-4 decades, wide spread exploitation of groundwater had helped to overcome country's food security problem but, for sustainability of production system in future, we cannot depend consistently on it, owing to its diminishing levels especially in Punjab and Haryana regions of the country.

The total water requirement for human and animal uses, industrial production and irrigated agriculture would be 104.50 million hectare meter in the year 2025. A comparison of water requirement and utilizable supplies showed that, by the year 2025, the magnitude of the scarcity would be 26.20 million hectare meter. Thus, there will be greater competition between various sectors for the scarce water. It is projected that the global population would be 8 billion and Indian population would reach 1.33 billion by the year 2025. On the other hand, projected global rice demand for such huge population would be 800 and 130 mt across the globe and India, respectively. Thus to safeguard and sustain food security in India as well as in world, it becomes pivotal to increase productivity of rice. Under such conditions, there is need to grow rice with less water without compromising yield. For this, production technologies namely direct seeded rice, aerobic rice and system of rice intensification (SRI) can be advocated as an alternative to traditional transplanted rice.

SRI: History and origin

The SRI methodology was developed in early 1983 by Henri de Laulanie, a French Jesuit working with Madagascar farmers and formed a NGO "Association Tefy Saina", who spent more than three decades in Madagascar trying to devise better production methods that might improve the lives of rural household, who were impoverished and heavily dependent on rice (Laulanie, 1993). With little dependence on external inputs, he sought a methodology that would be both accessible to poor and marginal farmers and environmentally friendly. Cornell International Institute for Food, Agriculture and Development (CIIFAD), New York, in 1994, started working with Association Tefy Saina (ATS) to introduce SRI as an alternative to slash and burn cultivation. From 1998, CIIFAD has become increasingly active

in drawing attention to the potential of SRI also in other major rice growing areas in particular Asia.

The SRI methodology: Basic principle and practices

SRI changes the management of rice plants and of the soil, water and nutrients that support them, in simple but specific ways to create optimal growing environment for rice plants so that their genetic potentials can effectively express. The SRI method encompasses the following agronomic managements:

1. **Transplanting of young seedlings:** SRI methodology gives the highest yield when young seedlings of less than fifteen days duration are transplanted and preferably 8-12 days before the start of the 4th phyllochron (Stoop *et al.*, 2002). This preserves plants potential for tillering and root growth that is compromised by later transplanting.
2. **Transplanting of single seedling per hill:** Planting of one seedling per hill is done within 15-30 minute of uprooting to avoid trauma to the plants. Under SRI, early transplanting provides a longer vegetative growth period and single seedling per hill reduces the competition among the rice plants and helps to minimize the shading effect of lower leaves. Mishra *et al.* (2006) have linked single transplanting per hill to increases in root length, density and activity and their inter-dependence with above-ground canopy development, particularly resulting in prolonged photosynthetic activity by older leaves.
3. **Square pattern of transplanting:** Seedlings are transplanted in square pattern (25 × 25 cm^2). Square planting not only facilitates weeding operation but also promotes the root growth. It also ensures efficient use of all the growth factors like sunlight, nutrient, water and space. Seedlings are transplanted into the puddled fields rather than flooded.
4. **Water management:** During the vegetative phase of crop, soil is kept moist, but not continuously flooding as it creates hypoxic soil condition that causes root degeneration of rice. Under SRI, from transplanting to panicle initiation stage intermittent irrigation is given and after panicle initiation stage a thin layer (1-3 cm) of standing water is maintained in the field.
5. **Weed management**: For weed control the manual weeding or use of mechanical weeder (cono-weeder) is recommended. Mechanical weeding starts from 10 days after transplanting and repeated 2-4 times at 10-12 days interval until the canopy closes. Soil aeration and incorporation of weed biomass *insitu* caused by mechanical weeder stimulates the growth of various soil micro flora.
6. **Preferable use of Organics for nutrient management:** Organic sources of nutrients like farmyard manure, compost and vermin-compost are preferred to inorganics. If organics are not available, SRI practices can be used successfully with fertilizers (Satyanarayana *et al.*, 2007).

A brief comparison between SRI and conventional rice cultivation practice is given below in the table 1:

Table 1. Comparison between SRI and conventional irrigated rice production

Parameter	**SRI method**	**Conventional transplanting**
Nursery area	100 m^2/ha	700-800 m^2/ha
Seed requirement per acre	3-4 kg	25-30 kg

Time of seeding transplanting	8-12 days old	21-25 days old
Spacing	25×25 cm	15×10 cm
No of plants per sq.m	16	66
No. of seedlings per hill	2	1
Recommended water management	Irrigate to 2.5 cm depth (after hairline crack formation up to panicle initiation and after disappearance of Ponded water).	Irrigate to 5 cm depth one day after the disappearance of ponded water
Recommended weed management	Using rotary / cono weeder in between rows in both directions at 10, 20, 30 and 40 DAT and hand removal of left out weeds.	Pre-emergence herbicide + hand weeding at 30 DAT (or) hand weeding at 15,30 DAT

Source: *http://www.agritech.tnau.ac.in/expert_system/paddy/riceecosystem.html#SRI*

Productivity and profitability with SRI method of rice cultivation

Rice shoot and root growth

The above and below ground growth and development of rice plant is affected by method of rice planting. It has been found that under SRI early seedling transplanting gives comparatively longer growing duration to crop, and also planting of sole seedling per hill reduces the intra-specific competition between young rice plants. This practice thus makes lower leave physiologically active for longer time which in turn enhances root growth owing to enhanced supply of oxygen and carbohydrates to them (Horie *et al.*, 2005). Moreover, as a result of higher root activity cytokinins are supplied to lower leaves that help in delaying senescence and maintaining the photosynthetic efficiency in plant during later growth stages.

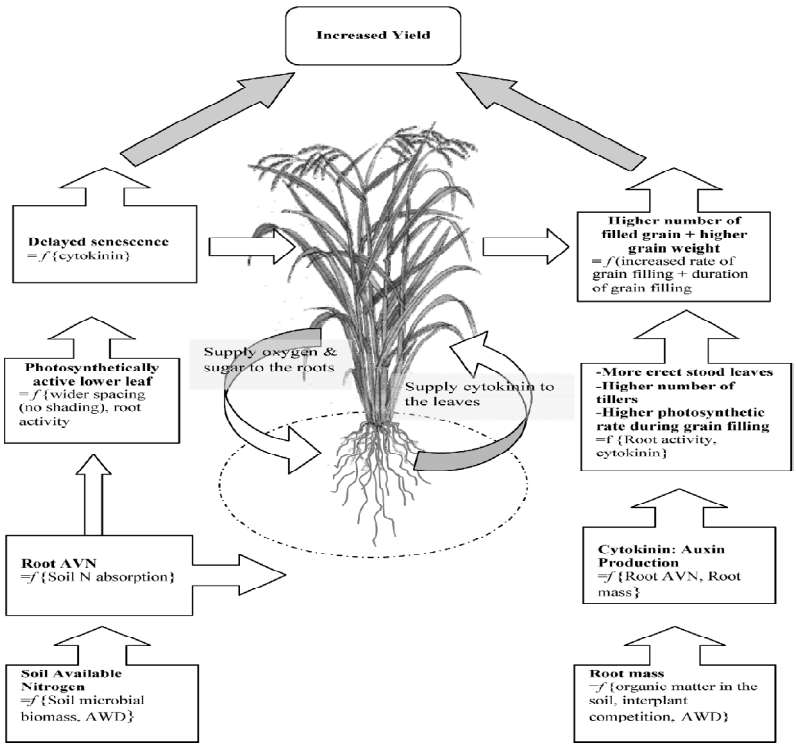

Figure 2 Integrated model of the high yielding rice plant under SRI management practices

All variables are shown as functions (f) of the variables that drive them (AVN = available nitrogen, AWD = alternate wet and dry). *Source: Mishra et al., 2006*

Gani *et al.,* (2002) recorded more vigorous vegetative growth in 7 to 14 days old seedlings of rice plant over 21 days old seedlings. They further noticed that such seedlings produced higher number of effective tillers, biological yield, tall plants and root growth. Lokanadhan *et al.* (2007) found higher leaf area index (LAI) i.e., 1.82 at tillering, 3.65 at panicle initiation, and 4.44 at flowering in SRI over standard rice cultivation method (4.40, 4.78, and 4.16 in the respective stages).

Water savings

Water is the precious natural resource thus it's saving and efficient utilization becomes very much important. Rice is the water hungry crop and consumes a huge quantum of available water resources of our country. Moreover, the farmers are highly habituated flood irrigation in rice crop and maintain high submergence throughout crop growth cycle. It is also reported that consistent submergence of in rice paddies alters soil's physical, chemical and microbiological properties. Adoption of SRI rice cultivation technique lowers water demand of rice crop and improves the water use efficiency of rice crop. The investigation conducted at Indian Institute of Rice Research during 2006 and 2007 revealed that water saving in SRI could be up to 25-38% (Kumar *et al.,* 2009). It was also observed that SRI method received only 91.89 m^3 of water which is around 38% less as compared to standing transplanting of rice (149.3 m^3). Similarly the total water productivity was around 29% higher in SRI over the standard transplanting method of rice growing (Table 2).

Table 2. Water requirement and total water productivity of SRI and conventional rice transplanting

	Method	**Irrigation (m^3)**	**(%) increase**
Water requirement	ST*	149.33	38.0
	SRI	91.89	
Total water productivity (kg/m^3)	ST	0.48	29.0
	SRI	0.68	

**Standard Transplanting*

According to Mevada *et al.* (2016) average water saving under SRI is around 406 mm over farmer's practice (FP). Thus for production of per kilogram of rice nearly 2426 litre of water is found sufficient in SRI, as against 3743 litre under the FP about 35 % higher efficiency of water under SRI over FP.

Yields and economic performance

Various on-farm experiments conducted at farmer's field in Telangana state showed improvement in productivity of rice crop grown by SRI method over conventional transplanting. A perusal of data in table 3 highlights significant yield advantage of 18% under SRI rice cultivation over conventional paddy growing methodology. Moreover, it also decreased the total expenditures by 32%, and due to yield increase farmers' net returns were improved by on an average by 52% over conventional returns.

Table 3. Yield and economics of alternative rice cultivation methods

Parameter	**Conventional method mean**	**SRI method mean**	**SRI compared To conventional Difference**
Total cost (Rs./ha)	28,476	19,289	-9,187 [-32%]

	(10,622)	(5,851)	
Grain yield (t/ha)	4.55 (0.65)	5.39 (1.06)	8.38 [18%]
Straw yield (t/ha)	2.87 (1.21)	2.32 (1.53)	-5.45 [-19%]
Straw value (Rs./ha)	10,261 (4,825)	6,825 (3,000)	-3,436 [-34%]
Grain value (Rs./ha)	45,472 (6,524)	53,853 (10,623)	8,381 [18%]
Gross returns (Rs./ha)	55,732 (8,861)	60,678 (12,002)	4,946 [9%]
Net returns (Rs./ha)	27,257 (8,508)	41,389 (11,619)	14,132 [52%]

Figures in parenthesis are standard deviations; figures in brackets are the differences, in percent, between SRI and conventional method of cultivation *Source: Adusumilli and Laxmi (2011)*

Insect pest influences

A variety of pests including different insects, fungus and other influence rice crop and cause severe reduction in overall yield of crop. Only handfuls of studies are available on the insect pests and disease scenario in SRI system (Karthikeyan *et al.*, 2007). It has been reported that under SRI incidence of pest is low owing to healthy and vigorous plants. Under wider spacing the individual plant gets more space for prober growth and development. Visalakshmi *et al.* (2014) studied the occurrence of yellow stem borer (*Scirpophaga incertulas* (Walker)) at tillering and reproductive stages whereas; the incidence of gallmidge (*Orseolia oryzae* (Wood Mason)) was recorded only at tillering stage. In their investigation they found lower incidence of stem borer in SRI method (6.1% dead hearts and 7.2% white ears) than conventional rice transplanting (15.6% DH and 11.9% WE). The same trend continued in case of gall midge too with 4.1% silver shoots in SRI method against 7.1% in conventional method.

Issues in adoption of SRI

As many new techniques proposed by SRI are often greeted with scepticism by farmer who has been cultivating rice for decades. Therefore, in order to bring the SRI at farmer's door we must convince them through demonstrations and training. In present time, labour shortage is becoming a serious problem. Thus the fragmentary mechanisation in SRI must be enhanced further to mitigate labour requirements. In areas where agricultural labourers are still dependent on rice cultivation, efforts to train them in SRI are essential. Some of the common problems faced by farmers in adopting SRI are:

- SRI demands more personal attention and constant involvement by farmers.
- Apprehensions about the new way of raising seedlings, handling young seedlings and square planting.
- Difficulties in leveling the main field properly.
- Resistance of contract labourers to planting.
- Labour scarcity for transplanting.
- Drudgery of using a weeder.

- Unsuitability of weeder for some soils.
- Unavailability of weeders.
- Potential pest attack due to lush growth of the crop.

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RICEBEAN: AN UNDERUTILIZED POTENTIAL MULTIPURPOSE GRAIN LEGUME CROP

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Introduction: Ricebean [*Vignaumbellata* (Thumb.) Ohwi and Ohashi] is one of such underutilized warm season annual vine legume crop with diploid chromosome number (2n=2x=22) which belong to subgenus *Ceratotrapus* in the genus *Vigna*. It has recently gained attention as an additional grain legume/pulse crop and possess immense potential due to its high nutritional quality, high grain yielding ability and multi-purpose usage such as food, animal feed, cover crop and as soil enricher.In India it is mainly distributed in the tribal region of the north-eastern hills and theWestern and Eastern Ghats in peninsular region, often inhilly tracts.In the marginal areas resource poor farmers cultivates the ricebean. Therefore, this crops is directlyrelated with the population who is really suffersfrequent food shortage and many nutritional disorders. Although having good nutritional quality, there is hardly any institute specifically working for the development of this crop, therefore as a result there is limited research on development of this potential pulse. Thus, there is a need to focus on this crop to establish it as a potential pulse crop.

Origin and Distribution: Ricebean is a native of South and South East Asia. It occurs in India, China, Myanmar, Malaysia,Korea, Indonesia and Philippines. It has been introduced as cover crop in Fiji, Bangladesh, SriLanka, Mauritius, Ghana and Nepal. It is also cultivated to a limited extent in west Indies, U.S.A., Australia and East Africa.

Morphology and Taxonomy: It is annual crop characterized by erect or sub erect stem, tending to be viny, usually clothed with fine deciduous deflexed hairs, stipules lanceolate, leaflets entire or lobed. It has auxillaryreceme inflorescence with bright yellow, medium sized clustered flowers. Mature pods are brown to black in colour on maturity, glabrous, 8-12 seeded. Cylindrical and considerably curved. Seeds are oblong with varying seed coat colour such as red, green, yellow, brown, black, speckled or mottled. Normally, it is sown in late May to end June. Ricebean is susceptible to frost but tolerant to high temperature. It is best adapted to drought prone sloping areas and flat rain fed conditions. Black soil which is moderately fertile is considered best for ricebean cultivation.

It is an annual legume which comes under subgenus *Ceratotropus* with genus *Vigna*. Genus *Vigna* form a complex taxonomic group along with genus *Phaseolus*. This is known as *Phaseolus- Vigna* complex. Later on, Ricebean and its relatives were shifted to genus *Vigna* from genus *Phaseolus.*

Uses: It is promising multipurpose crop with good potential to be used as food, fodder, green manure and cover crop. The dried seeds are usually eaten boiled or as pulse. Young immature pods are used as vegetable. The nutritional quality of it has been reported to be the best

among all the traditional pulse on account of its high protein and appreciable quantities of two limiting amino acids *i. e.* methionine and tryptophan. It contains high quality of vitamins, thiamine, niacin and riboflavin. Calcium and iron contents are also appreciably high. The whole plant can be used as forage for livestock. The foliage, green pods, immature seeds and flowers are readily eaten by animals. It is grown as a green manure and is excellent cover crop.It is immune to Yellow Mosaic Virus (YMV), a prominent disease in green gram and black gram and thus can easily replace green gram in plains if short duration varieties are developed. The crop can also be used as a donor parent for incorporating disease resistance in other *Vigna* species.

Breeding Approaches: Similar to other *Vigna* species of Asian origin, ricebean is also a truly diploid species with 2n=2x=22 chromosomes. However, the primary base number for vigna umbellate is n=11. It is largely an autogamous plant species. The rich genetic diversity already being exhibited in its enormous forms provides ample scope for breeding and selection. The importance of pureline, bulk and pedigree method can be gainfully utilized for affecting improvement. Transfer of disease resistance to bruchids, can be carried out by using backcross breeding. Early maturing and dwarf cultivars can also be developed through chemical mutagenesis.

Prospects: Ricebean is valuable crop that deserves more testing throughout the tropics, because of its tolerance to high temperature and humidity, resistance to diseases and pests, nutritious seeds and multiple uses. Limitations of ricebean production are indeterminate growth and easy shattering of pods, which make harvesting difficult. Limited availability of germplasm and lack of technical information on its cultivation are serious problems. The possibilities of industrial processing of the seeds into derived products, such as flour, are still poor. Research priorities of ricebean include the development of quick-maturing day-neutral, high yielding and non-shattering erect cultivars that are nematode resistant. Moreover, investigations are needed on agronomical aspects and post-harvest technology also.

Constraints: The productivity of ricebean is very low due to lack of high yielding varieties, which is the major hindrance of the crop getting unique production. This crop has been left as a neglected one due to lackof attention and limited amount of scientific breeding. Thus, the major aim is to select promising variable germplasm. Availability of limited germplasm, late maturity, indeterminate growth habit and easy pod shattering are the major constraints which kept this crop away from becoming major pulse crop.

Conclusion: It can be concluded that the ricebean is a multipurpose potential legume crop which can be used as a pulse, fodder, green manure or as a cover crop and can be grown on

wide range of environments with lesser incidence of diseases and pests. Development of varieties having early maturity and determinate growth habit can help to popularise this crop.

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AGRONOMIC STRATEGIES FOR DROUGHT MANAGEMENT IN SUGARCANE

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Drought, one of the most important water-related problems in the sugarcane cultivation, mainly caused by conditions; where annual precipitation is less than the normal, uptake of water is less than evaporation, late onset and early withdrawal of monsoon, long intervening dry spell during the monsoon period, decline in ground water levels is becoming more serious problem owing to lesser yield, quality and productivity, Gautam and Bana 2014.

Management options

Following agronomic management practices used for mitigation of ill effects by drought are written as under:

✓ **Trash mulching**

Trash mulching soon after cane planting followed by urea spray @ 55 kg N/ha, three spray at 90, 105 and 120 days after planting (DAP) overcomes the ill-effects of drought during formative phase of growth cycle. This practice gives higher cane yield besides a nitrogen economy to the tune of 25 % approximately. Soaking setts in saturated lime solution for 2 hours induces drought hardiness and improve cane yield (Plate 1). Anonymous 2014.

Plate 1: Trash mulching in sugarcane

Planting method, time and spacing

- Planting of sugarcane setts on trenches is advantageous so as to facilitate and utilize much less quantity of irrigation water than a flat planted sugarcane crop. Automatic trench cutter planter (Plate: 3) can be used for planting of sugarcane setts as this implement become very popular which opens the tranches of desired height and depth in the field, applies definite amount of fertilizers, places the three/two budded setts in the trenches and covers it with the soil, **Anonymous 2014.**
- In peninsular India, early planting (in February) and closer spacing (60 cm) proved beneficial under moisture stress conditions in formative stage.
- Increasing planting density by narrowing row-to-row spacing ensures the build-up of necessary shoot population density (in sub-tropical India).
- Under restricted soil moisture, however, higher N levels were counterproductive.

Plate 2: Sugarcane activities **Plate 3: Automatic trench cutter planter**

✓ **Nutrient management**

- A crop well fertilized with N was affected to a lesser extent (10- 45%) than unfertilized one (15- 60%) under drought conditions.
- Spray of urea and KCl (2.5 % each) at 60, 90 and 120 DAP (in tropical India) is also recommended to overcome drought as K is an important element whose role in maintaining water balancing by providing potentiality to resist drought and opening and closing of stomata.
- Spray of 2.5 % potassium sulphate (aqueous) during the hot summer also provides better results.

✓ **Use of growth regulating substances**

Foliar spray of low concentration of Ethrel (50 ppm) before likely onset of drought or soaking seed canes in it improve drought tolerance and reduce the loss of cane and sugar yield (Plate 4), Yadav *et al*., 2016, Bendigeri *et al*., 1986.

Plate 4: Ethrel

✓ **Water management**

- Skip-furrow method of irrigation: It economizes approximately 42 % of applied water as compared to flood irrigation thus improves sugarcane productivity (Plate 5)
- Drip irrigation: It economized water use, improves water use efficiency and sustains sugarcane productivity to a considerable extent (Plate 6), Kumar *et al*., 2011.

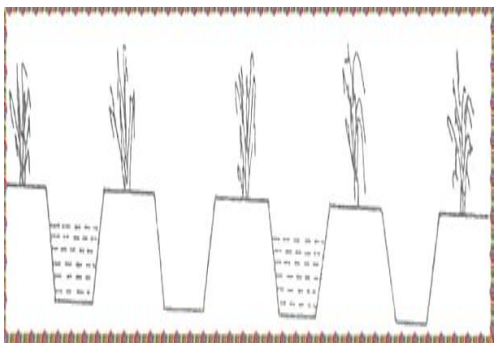

Plate 5: Skip furrow irrigation **Plate 6: Drip irrigation**

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