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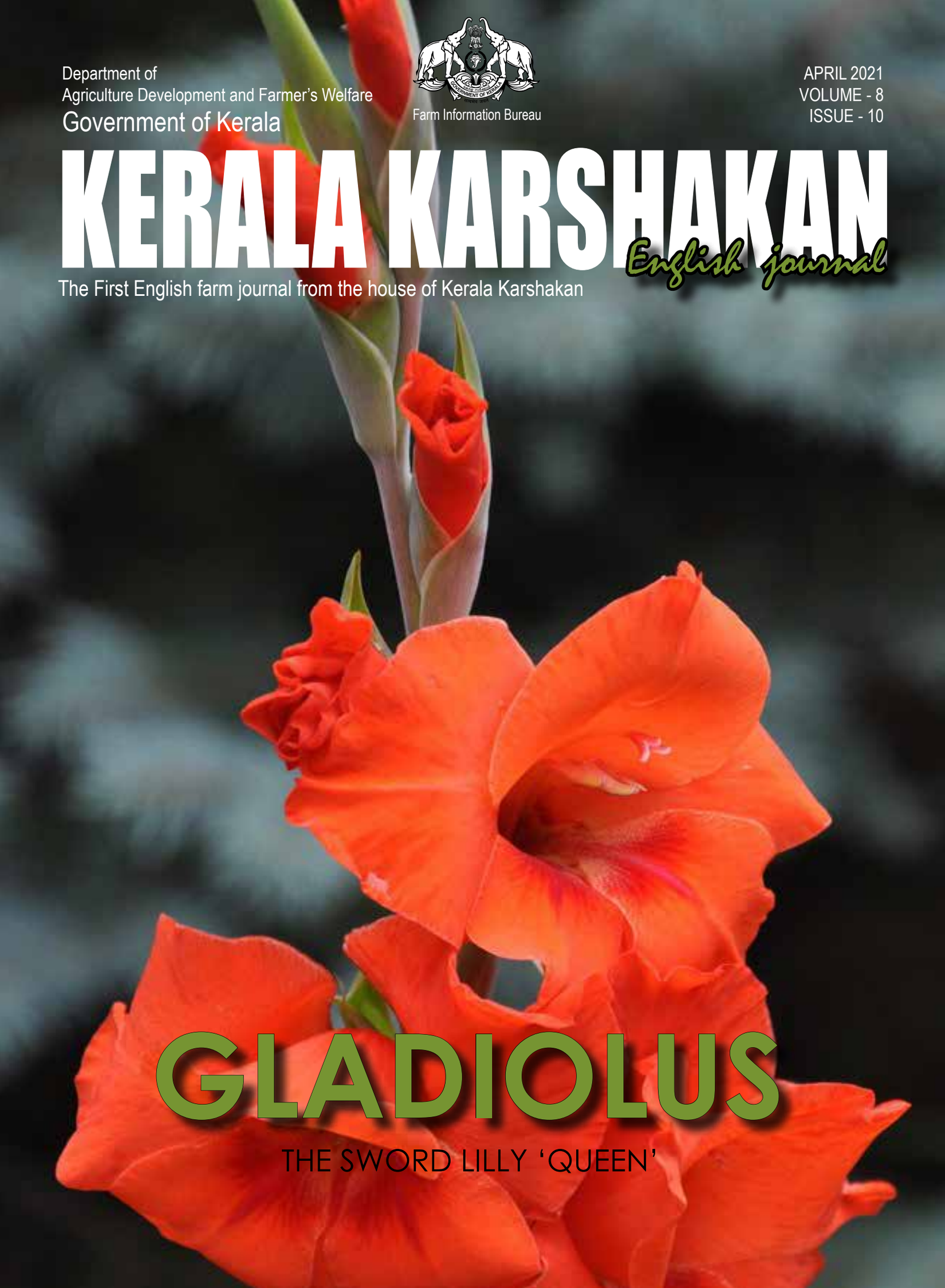
The First English farm journal from the house of Kerala Karshakan



GLADIOLUS

THE SWORD LILLY 'QUEEN'

INSIDE KERALA KARSHAKAN

English journal

APRIL 2021 Volume - 8 Issue - 10

Mail: editorejournalkkfib@gmail.com Log on to http://www.fibkerala.gov.in
Phone: 0471-2314358

The First English farm journal from the house of Kerala Karshakan

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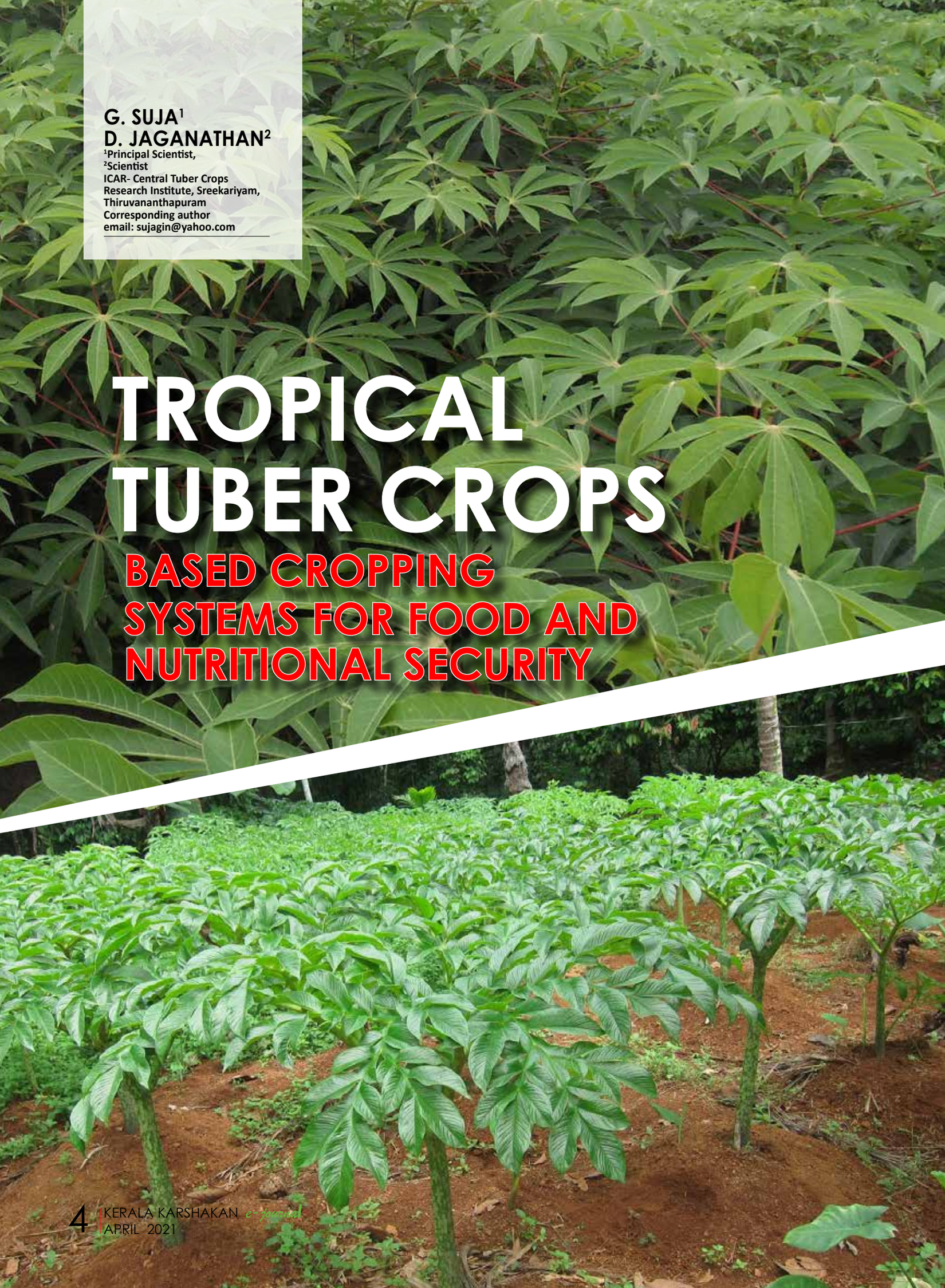
Enquiries : 0471 2314358

G. SUJA[1]
D. JAGANATHAN[2]
[1]Principal Scientist,
[2]Scientist
ICAR- Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram
Corresponding author
email: sujagin@yahoo.com

TROPICAL TUBER CROPS

BASED CROPPING SYSTEMS FOR FOOD AND NUTRITIONAL SECURITY



Introduction

Tropical tuber crops viz., cassava, sweet potato, greater yam, white yam, lesser yam, elephant foot yam, taro and tannia form the most important staple or subsidiary food to about 500 million people in the world. Tuber crops are the third most important food crops which provide about 6% of the world's dietary energy, apart from being good sources of β carotene, antioxidants, dietary fibre and minerals. They have higher yield potential, can tolerate drought and shade, withstand flooding and salinity to some extent, are adapted to low input situations and adverse agro climatic conditions. Hence these crops are called as 'climate resilient' or 'future crops'.

Tropical tuber crops are suitable for cultivation in association with plantation crops (coconut, arecanut, coffee, rubber) and fruit crops (banana, mango, litchi etc.), as these crops are adapted to the same ecological conditions (Nayar and Suja, 2004). ICAR Institutes, State Agricultural and Horticultural Universities under All India Coordinated Research Project on Tuber Crops (AICRP TC) and other research and extension organizations have been working on tuber crops based cropping systems for generation and dissemination of technologies for enhancing the production and farm income from unit area with minimum resources. ICAR-Central Tuber Crops Research Institute, the premier research institute solely dedicated to tropical tuber crops in the world, has been pioneering systematically in the research and field experiments cum demonstrations on cropping systems for popularizing the technologies among farmers and other stakeholders. The following successful tuber crops based cropping system models are to be emulated in large scale in the context of 'doubling farmers' income' and 'self reliance'.

Cropping system: Cropping system aims at crop diversification and intensive cropping in the interspaces available to enhance the productivity of main crop

Table 1. Suitability of tuber crops for intercropping in coconut garden

Age of palms	Tuber crops
< 8 years	Cassava, Elephant foot yam, Yams
8-25 years	Elephant foot yam, Taro, Tannia, Arrowroot
> 25 years	Cassava, Elephant foot yam, Taro, Tannia, Yams, Arrowroot and Chinese potato

Table 2. Management practices for tuber crops intercropped in coconut gardens

Intercrop	Time of planting	Method of planting spacing and plant population per ha	Nutrients FYM (t ha-1)	NPK (kg/ha)	Duration (months)
Cassava	May-June	Mounds, 90x90 cm (9000 plants)	9	50:50:100	8-10
Elephant foot yam	March-April	Pits, 90x90 cm (9000 plants)	20	26:20:33	8-9
Greater yam	April-May	Pits, 90x90cm (9000 plants)	9	80:60:80	8-9
Lesser yam	April-May	Pits, 75x75cm (12000 plants)	8	60:30:60	7
White yam	April-May	Pits, 90x90cm (9000 plants)	9	80:60:80	8-9
Arrowroot	May-June	Raised beds, 30x15 cm (130000 plants)	10	50:25:75	9-10

Source: Nayar and Suja (2004)

Table 3. Plant density and fertilizer savings in banana + tuber crops system (1 ha)

Banana	Tuber crops	Benefits
Nendran Spacing: 3.6 x 1.8 m Population: 1500	Greater yam or Elephant foot yam Spacing: 90 x 90 cm Population: 8000	Saving of 50 % FYM, N and P fertilizers
Robusta Spacing: 2.4 x 1.8 m Population: 2300	Greater yam Spacing: 90 x 90 cm Population: 6000	Saving of 1/3rd FYM and NPK fertilizers

Banana + white yam

Banana + dwarf white yam

Banana + elephant foot yam Fig.

Fig. 2. Banana + tuber crops

and intercrops per unit area in a system approach, wherein the available farm resources like soil and water/rainfall resource, farm labour, agricultural inputs (seeds, fertilizers, plant protection chemicals) etc. are utilized to produce both food and non-food agricultural products from the farm in an economical way. Sustainability is the main objective of the cropping system, where production process is optimized through efficient utilization of the inputs in safeguarding the environment and natural resources.

Tuber crops based cropping system

Coconut + tuber crops: The age of the coconut palms decides the choice of tuber crops for intercropping in coconut garden (Table 1). Tuber crops like cassava, yams (greater yam, lesser yam and white yam), elephant foot yam, tannia and arrowroot can be successfully grown as intercrops for which production technologies have been standardized (Table 2 and Fig.1). Experimental results showed that yield could be increased by 5-15% in coconut under intercropping with tuber crops apart from realizing additional yield and income from intercrops.

Arecanut + tuber crops: Cassava, elephant foot yam, greater yam, sweet potato, taro and arrowroot can be successfully grown in arecanut plantations. Higher tuber yield was obtained from elephant foot yam as an intercrop in arecanut gardens. About 7000 elephant foot yam/yams could be planted at a spacing of 90 x 90 cm, leaving 1 m radius from the base of the palms. However, higher yield was recorded in arrowroot indicating its ability to perform well under partially shaded conditions.

Banana + tuber crops: Growing tuber crops like elephant foot yam, greater yam and white yam in the interspaces of Nendran and Robusta banana was found to be productive and profitable, besides saving fertilizers and other resources (Table 3).

Research experiments indicated that in between two rows of Nendran banana, three rows of the tuberous intercrops namely greater yam or elephant foot yam could be planted. Similarly, Robusta banana + Yam (Dioscorea sp.) intercropping system also can be grown successfully. Yams can be either trailed to banana or using

Table 4. Economic impact of tuber crops grown with plantation crops and banana

Production system (Main crop + tuber crop)	Tuber yield (t / ha)	Additional net income (Rs. in lakh / ha)
Coconut + cassava	10-12	0.90 – 1.00
Coconut + yams	12-13	1.25 – 1.50
Coconut + elephant foot yam	14-16	2.00 – 2.50
Coconut + tannia	6-7	1.00 – 1.25
Coconut + arrowroot	15-20	3.00 – 3.50
Arecanut + elephant foot yam	10-12	0.75 – 0.80
Rubber + yams	10-12	0.75 – 0.80
Rubber + elephant foot yam	20-22	3.00 – 4.00
Rubber + tannia	6-7	1.00 – 1.25
Banana + yams	17-18	1.50 – 2.00
Banana + elephant foot yam	16-17	2.50 – 3.00
Banana + tannia	5-6	0.90 – 1.00

Coconut + cassava

Coconut + elephant foot yam

Coconut + greater yam

Coconut + dwarf white yam

Coconut + arrowroot

Coconut + tannia

Rubber + greater yam

Mango + tuber crops

Sapota + elephant foot yam

Mango + cassava

Fig. 3. Rubber/Fruit trees + tuber crops

cassava stems.

Fruit trees/Plantation crops/ Tree crops + tuber crops: Root and tubers can also be successfully grown in association with fruit trees, plantation crops and other tree species viz., mango, sapota, litchi, coffee, rubber, eucalyptus and Leucaena for maximizing the farm income (Fig. 3). Elephant foot yam is the most ideal tuber crop for intercropping in robusta coffee, mango, sapota and litchi orchards.

Elephant foot yam was a profitable intercrop in robusta coffee producing an average yield of 18 t /ha. In young rubber plantations of 3-4 years age, elephant foot yam/yams can be grown successfully as intercrops with a population of 6000 plants in one ha by leaving 1.5 m radius from the base of the rubber plants and manuring at the full dose for both the crops.

Economic impact: Experiments on cropping systems conducted over the years revealed that tuber crops were able to provide an average additional yield of 10-12 t/ha, additional profit of Rs. 1.0-1.25 lakh/ha and employment generation of 150-200 man days ha making the system economical and sustainable.

Cropping systems involving cereals, vegetables, pulses and oilseeds in tuber crops

Short-duration pulses and vegetables were found to be feasible intercrops in tuber crops. In small farms, legumes like groundnut, cowpea, black gram and vegetables like French bean, onion, coriander are ideal for intercropping in cassava in south India (Fig. 4). Sweet potato and red gram strip intercropping (1:1) was found profitable under upland ecosystem. Pulses like green gram, black gram and soybean could also be intercropped in elephant foot yam (Fig. 4). Maize was identified as a suitable companion crop in greater yam which could produce tuber yield of 17.3 t / ha, maize yield of 1425 kg /ha and an additional income of Rs. 22, 055/ha (Fig. 4) (Suja and Nedunchezhiyan, 2018).

Cassava, sweet potato, elephant foot yam/taro can be grown as sequential crops in rice fallows. Sweet potato successfully established under zero tillage after harvest of rice under low land ecosystem. Short-duration cassava varieties, Sree Vijaya, Sree Jaya, Vellayani Hraswa and Kalpaka hold

Cassava + cowpea

Cassava + groundnut

Maize + greater yam

Elephant foot yam + black gram

Elephant foot yam + green gram

Fig. 4. Cropping systems involving annuals in tuber crops

promise for crop intensification (Suja et al., 2010). Sequential cropping of vegetable cowpea with short-duration cassava was a feasible option as it enabled saving of nutrients and provided additional income (Suja and Sreekumar, 2015).

Rice-pulse-short duration cassava proved to be economically feasible (Fig. 5). Short duration varieties like Vellayani Hraswa and Sree Vijaya were suitable for crop intensification. Green gram, black gram and soybean were equally compatible in rice based sequential cropping systems involving short-duration cassava.

There was a possibility to save half FYM and N and full P fertilizers to short-duration cassava, especially when green gram and black gram preceded cassava in rice based system. The tuber yield of cassava (30.82 t/ha) and additional profit (Rs. 95,758 / ha over sole cassava) were higher for rice (var. Aiswarya)-black gram (var. Co-6)-short-duration cassava (var. Sree Vijaya) (at the reduced fertility level with saving of half FYM and N and full P fertilizers).

Rice-short duration cassava + black gram resulted in tuber equivalent yield of 40.19 t ha-1 and additional profit of Rs. 61,736 ha-1 over

First crop of rice

Second crop: Green gram (Co-Gg 7)

Second crop: Black gram: Co-6

Third crop: Short-duration cassava

Fig. 5. Rice-pulse-short duration cassava

sole cassava, besides saving of nutrients to the extent of half farmyard manure and N and full P fertilizers.

First crop of rice
Second crop: Green gram (Co-Gg 7)
Second crop: Black gram: Co-6 Third crop: Short-duration cassava

Fig. 5. Rice-pulse-short duration cassava

Advantages of tuber crop based cropping system

- Efficient use of farm and natural resources (land, water, sun light, labour, capital, etc.)
- Additional yield with minimum resources per unit area
- Reduction in cost of cultivation
- Improvement in soil fertility with abundant soil flora and fauna
- Less incidence of pests and diseases as the concept of 'ecological engineering' inbuilt in the system
- Crop residues can effectively be recycled as organic manure in the system
- Easy to adopt and suitable for different agro-climatic conditions
- Provide high energy food for farm family and feed for farm animals
- Source of raw materials for production of value added products and industrial products
- Behave as insurance crop against risk and natural calamities
- Ensure food security, augment net income and enhance employment opportunities

Conclusion

Adoption of roots and tubers based cropping systems in plantation crops, fruit trees, cereals, vegetables, oilseeds and pulses are economical, feasible and sustainable in the long run. It enhances food production, provides additional farm income and employment opportunities. It also enables better utilization of resources and safe guards the farm family from risks and natural calamities.

MARKER ASSISTED BREEDING

For Precision Crop Breeding

ANUP V. S.
MANJU A.
Dr. P. SINDHUMOLE*

M.Sc. student
Dept of Plant Breeding and Genetics
College of Agriculture
Vellanikkara, KAU.
Ph.D. scholar
Dept. of Plant Breeding and Genetics
College of Agriculture
Vellanikkara,KAU.
Assistant Professor
Dept. of Plant Breeding and Genetics
College of Agriculture
Vellanikkara,KAU
*sindhumole.p@kau.in

Plant breeding involves the improvement programmes of various crops for enhancing the yield, quality, resistance to biotic and abiotic stresses etc. Since ancient times, so many improvement programmes had been conducted in various crops.

Marker assisted breeding(MAB) is a recent approach wherein a marker is used for indirect selection of a particular character viz., quality, productivity, disease resistance etc.

Various types of markers are:

Morphological – These markers are the specific characters which are often detected by simple visual inspection. e.g., presence or absence of awn, leaf sheath colouration, pubescence, grain colour, aroma etc.

Biochemical – A protein, enzyme or any other specific compound that can be extracted from various plant types and used for differentiating between them.

Cytological – These are chromosomal features that can be identified through microscopy. Presence or absence of chromosome bands may indicate a particular character.

Molecular–Based on sequence variations of nucleotides in various organisms. Common DNA-base d are restriction fragment length polymorphism (RFLP), random amplification of polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP), microsatellites or simple sequence repeats (SSR) and single nucleotide polymorphisms (SNPs).

Molecular markers are sequence of nucleotides which forms the DNA segment and are located near to the DNA sequence of a particular gene. Markers are landmarks at the genome that can be chosen for their nearness to the gene of interest.

Advantages of marker assisted breeding over conventional breeding:

In conventional breeding, for development, testing and releasing a variety, usually many years are required to complete and to reach the farmers. The major problem in conventional breeding is the difficulty to confirm the presence of desired gene, usually incorporated by hybridization programmes. Using the markers, testing can be done in the early seedling stage itself, so that only those progenies carrying the desired gene need to be forwarded to subsequent generations. Hence, Marker assisted breeding (MAB) has been identified as a dependable, reproducible, and time saving strategy to confirm the presence of desirable gene

Improved Pusa Basmati-1

and to quicken the breeding cycle.

There are two kinds of selection of marker assisted selection - 1) Foreground selection 2) Background selection.

In foreground selection, in order to select a target gene, those markers which are linked directly to the gene of interest are used. Whereas, in background selection, molecular markers distributed throughout the genome is used to monitor the recovery of genomic regions of the parent, except the target region.

MAB is being used to transfer the useful genes of interest into several crop species. Most of these programmes were conducted for gene transfer related to disease resistance along with high yield and other desirable traits.

Some of the success stories of MAB employed in India are:

Improved Pusa Basmati

India exports around 1.2 million tons of basmati every year and 60% is contributed by Pusa Basmati 1. But this variety is highly susceptible to the most dreaded disease, bacterial leaf blight (BLB). Hence a BLB resistant version of Pusa Basmati 1 viz.,'Improved Pusa Basmati-1' was developed at Indian Agricultural Research Institute (IARI, Pusa, New Delhi) by transferring two BLB resistance viz., xa13(on chromosome 8) and xa21 (on chromosome 11) from the donor line IRBB55 (obtained from the International Rice Research Institute, Manila, Philippines) using marker assisted selection (MAS).The aroma and grain quality of Improved Pusa Basmati-1are very similar to traditional basmati, and hence it is now exported globally.

Improved Samba Mahsuri

Sambha Mahsuri (BPT 5204) is a popular high yielding rice variety, but highly susceptible to BLB. A project was undertaken jointly by scientists from CSIR-CCMB and ICAR, for incorporating three bacterial leaf blight resistance genes, viz.,

Vivek hybrid - 9 QPM version of Vivek hybrid - 9

xa5, xa13 and xa21 into this rice variety, through the MAB programme which resulted in the development of the BLB resistant 'Improved Samba Mahsuri'.

Swarna sub1

Rice production is badly affected by the submergence due to heavy rain showers during south west monsoon. Rice being a semi aquatic plant is the worst affected. A QTL (quantitative trait loci) for submergence tolerance gene was identified, and mapped on chromosome, and named as SUBMERGENCE 1 (sub1) from the FR13A landrace of rice. IR49830-7, submergence-tolerant breeding rice line, was used as the donor for sub1. Through marker assisted backcrossing, the sub1 gene had been incorporated into Swarna, a mega rice variety. Now, the newly developed Swarna sub1is tolerant to submergence and gives promising yield even under flooded condition.

Jyotsna

Jyothi is the most popular high yielding variety of Kerala, with superior cooking quality. However, it is high susceptible to salinity. Scientists at Rice Research Station, Vytila, successfully introgressed genes which imparts tolerance to salinity into Jyothi, by using the 'Saltol' QTL from pokkali rice. The introgressed variety is as good as Jyothi and showed excellent salt tolerance and it was released as a new variety, Jyotsna, during the year 2017.

Vivek QPM9

Maize lacks two essential amino acids viz., lysine and tryptophan. QPM refer to Quality Protein Maize (maize enriched with protein). Marker assisted breeding was employed by the scientists at IARI to improve the protein quality of 'Vivek Hybrid 9' to produce an extra early quality protein single cross maize hybrid- Vivek QPM9. It possesses all the good qualities of parental

Jyoth


Jyotsna

hybrid (Vivek Hybrid 9), along with added protein i.e., about 30% and 45% higher lysine and tryptophan, respectively.

Rust resistant groundnut varieties

One of the major devastating diseases in ground nut is Leaf rust, caused by the fungus, *Puccinia arachidis* Spp. A QTL region for rust resistance was transferred from the donor cultivar GPBD 4, into three rust susceptible varieties viz., 'ICGV 91114', 'JL 24' and 'TAG 24', through marker assisted backcrossing (MABC). These improved ground nut varieties are able to overcome the huge yield loss caused by leaf rust thereby enhancing their production.

(A – susceptible to rust B – resistant to rust)

Thus, the use of molecular markers in various fields of plant breeding like germplasm evaluation, characterisation and incorporation of traits, genetic mapping, map-based gene discovery etc. has showed that MAB is a powerful and reliable tool in genetic improvement of agronomically and economically important traits in crops.This tool is gaining importance rapidly and is becoming inevitable in crop improvement scenario.

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Whey Protein A Healthy Dietary Protein

Dr. SHRUTI P. G[1]
Dr. BHUVANESHWARI G.[2]
Dr. V. M. GANIGER[3]
Dept. Vegetable Science, University of Horticultural Sciences, Bagalkot – 587 104
Associate Professor and Head, Dept. of Post Harvest and Technology, College of Horticulture, Bagalkot – 587 104
Professor (Vegetable Science) and Technical Officer, Registrar Office, University of Horticultural Sciences, Bagalkot – 587 104

Milk is made of two proteins, casein and whey. Whey protein can be separated from the casein in milk or formed as a by-product of cheese making. Whey protein is considered a complete protein as it contains all 9 essential amino acids. It is low in lactose content. Whey protein is a mixture of beta-lactoglobulin, alpha lactalbumin, bovine serum albumin and immunoglobins (Ritu, 2020).

Whey Protein Nutrient composition (100g)

Nutrients	Composition
Energy	113 calories
Carbohydrate	2 g
Protein	25 g
Fat	0.5g
Cholesterol	5.1 mg
Sodium	50 mg
Potassium	160 mg
Calcium	12%
Iron	2%

Health benefits of Whey Protein

1.Increases the strength and muscle mass

Whey protein increases muscle mass and strength by releasing anabolic hormones such as insulin, which is responsible for our muscle growth. The substance's leucine content stimulates muscle protein synthesis in our body. Its protein and amino acids spur on muscle growth. Whey protein, unlike other protein sources, generates muscle growth faster (Olsen, 2017).

2.Protects against eczema and allergic conditions in kids

Whey protein is beneficial for both adults and kids. Infants, who are made to consume this protein mixture by mouth in the 3-12 month time period from their birth show lower risks of developing red, itchy skin and allergic reactions easily.

3.Helps us feel fuller - eat lesser

Whey protein has an incredible effect on satiety. Protein ranks highest among every macronutrient when it comes to satiety. It increases energy expenditure, balancing the number of calories we consume.

4.Aids in recovery from exercise

Consuming whey protein powder has been proven to improve your athletic abilities. It increases ones running speed and helps to recover better from workouts.

5. Lowers cholesterol

Whey protein can help lower total and LDL cholesterol more effectively than casein protein.

6. Helps to regulate blood pressure

Whey protein powder has been proven to be effective in reducing blood pressure. It also stands as a deterrent against the development of potentially fatal heart risks

7. Other health benefits

It has anti-cancer properties, steps up immune function and also protect against the symptoms of psoriasis.

Types of whey protein

The difference in the

forms of whey protein basically stems from their manner of processing, which also determine the nutrient cotent.

1. Hydrolysate

Hydrolysate or hydrolyzed whey is whey that has been pre-digested. It gets absorbed faster than the other forms. Hydrolyzed whey is responsible for 28-43% more spike in insulin level than whey in the isolate form.

2. Isolate

Isolate whey protein contains 90% or more protein. It contains less fat and lactose as well as lesser beneficial nutrients than is found in whey protein concentrate.

3. Concentrate

Whey protein in concentrate form contains around 70-80% protein. It also contains lactose and fat. It is the most delicious of all the whey protein variants.

Whey protein side-effects

Whey protein intake is generally considered safe for most adults when consumed in a proper dosage. However, overconsumption of the mixture may cause several digestive complaints like bloating, hyperactive bowel movement and diarrhoea. Some may also experience nausea, headaches, thirst, cramps, fatigue and a reduced appetite.

Conclusions

Whey protein powders and supplements form a healthy and effective way to contribute more protein content to the regular diet. It is a stellar source of protein which is seamlessly absorbed by our body. Whey protein works best for weight trainers, athletes, people who lack enough natural proteins in their diet and others, who could do with more muscle mass and strength and less body fat.

Protein is the most effective nutrient, to encourage muscle gain and fat loss. It is one of the best sources of protein there is. So naturally, anybody looking to add more of the nutrient to their diet would do well, to buy themselves some whey protein powder.

Concentrate is the most popular form of whey protein because of its agreeable taste.

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Dr. KARTHIK.V.KUTTAN
Assistant Manager(AH),
Kerala Livestock Development Board,
Livestock Farm, Kainoor P.O., Puthur.
Ph : 9400528255

In Kerala, cattle breeding is mainly done through artificial insemination using frozen semen. Kerala Livestock Development Board undertakes the task of frozen semen production for inseminating the cattle herd of the state. The semen used for artificial insemination is collected from bulls which are selected from the farmers or farms undertaken by Kerala Livestock Development Board. The bull calves selected from the farmers and farms are first maintained

QUARANTINE BULL STATION KERALA SCENARIO

at pre-quarantine and then quarantine station. A quarantine station is an establishment where bull calves kept in isolation, tested for diseases and disorders andshifted to semen stations once the calf meets all standards after testing.

Care and management of bull calves in quarantine station

Male calves born out of nominated mating are physically examined and procured from farmers. Parentage testing shall be done before procurement of the calves. These calves are then shifted to the quarantine station.

1.Feeding

The bull calves are grouped according to their body weight and feeding is based on animal body weight rather than age of the animal. Accordingly, animals are grouped under 5 categories viz 30-60 Kg, 60-90 Kg, 90-140 Kg, 140-175 Kg, 175-200 Kg.

2. Weight recording

Weight recording and evaluation of health status should be carried out at every 14 days in order to assess the weight gain and to fix the ration according to the recorded weight.

3.Deworming

Done on a monthly basis for the control of gastrointestinal parasites. Different deworming agents such as pyrantel pamoate, albendazole, fenbendazole, ivermectin, levamisole, oxyclosanide and closantel are used alternatively for deworming.

4.Temperature monitoring

In order to evaluate the health status of the calves, temperature monitoring is done regularly at two times a week which helps in prompt identification of any infectious diseases.

Disease screening of bull calves

Mandatory tests for diseases transmitted through semen are to be done on calf as well as on dam.

TB and JD screening

Delayed hypersensitivity test:

Done by intradermal inoculation of Bovine tuberculin /Johnin PPD respectively. Difference of skin thickness is evaluated at 72 hrs interval.

- Positive: increase in thickness above 4mm.
- Negative: Increase in thickness below 2 mm.
- Inconclusive: increase in thickness above 2 mm and below 4 mm.

Two tests are done at minimum interval of 42 days between the tests.

Results: Positive calves will be culled and removed from

the stock without further delay. Inconclusive calves will be tested after 42 days and still inconclusive - reject the calf

Karyotyping

Chromosomal abnormalities leads to loss of germ plasm and decrease in animal's reproductive quality. Analysis of the chromosomes in breeding stock prevents the transmission of chromosomal abnormalities.

The Method involves Lymphocyte culture of the fresh blood, harvesting of chromosomes, slide preparation and microscopic analysis and Interpretation.

Screening of genetic diseases

1.BLAD (Bovine Leukocyte Adhesion Deficiency)

Is an autosomal recessive congenital disease characterized by recurrent bacterial infections, delayed wound healing and stunted growth and persistent marked neutrophilia. The molecular basis of BLAD is a single point mutation (adenine to guanine) at position 383 of the CD18 gene. Affected cattle die at an early age due to the infectious complications

2.DUMPS (Deficiency of uridine monophosphate synthase)

DUMPS is a monogenic autosomal recessive disorder in cattle resulting in early embryonic death of homozygous offspring.The only way to avoid the economic losses is early detection of DUMPS carriers

3. Citrulinemia

Homozygous recessive condition of citrullinemia is manifested by increasing ammonia and decreasing arginine concentrations in blood during the first 24 hours after birth leading to enzymatic disruption of the urea cycle. Affected calves display severe neurological dysfunction and death within 1 week as a result of a deficiency of the enzyme argininosuccinate synthetase

4. Factor XI deficiency

Factor XI deficiency is an inherited condition that affects Holstein cattle worldwide. Inherited deficiency of Factor XI results in a bleeding disorder, reduced reproductive performance and increased susceptibility to disease.

The details of the tests done to minimize the chances of diseases transmitting through semen are summarised in table below

Disease	Name of Test	Sample	Collected in	Testing Agency
Brucellosis	ELISA	Serum	Serum \ Vacutainer	NDDB, Hyderabad
IBR	ELISA	Serum	Serum Vacutainer	NDDB, Hyderabad
BVD	ELISA	Serum	Serum Vacutainer	NDDB, Hyderabad
Parentage	Microsatellite based DNA fingerprinting or Microarray	Whole blood sample of calf and dam; semen sample of sire	EDTA vacutainer for blood samples semen straws for semen samples	NDDB
Karyotyping Veterinary	Lymphocyte culture	Whole blood	Heparin vacutainer	NDDB, colleges/National institutes
Genetic disorders	PCR-RFLP for BLAD, Citrullinemia and DUMBS.PCR for Factor XI deficiency or Microarray	Whole blood	EDTA Vacutainer	NDDB
TB	Delayed type Hypersensitivity (DTH). Test using Tuberculin Purified Protein Derivative (PPD)	Intradermal	Not applicable	By project/NDDB/ Designated agency- All tests in pre-quarantine station and quarantine station.
JD	DTH Test using Johnin PPD	Intradermal	Not applicable	By project /NDDB / Designated agency- All tests in pre-quarantine station

Vaccination

Sl No.	Disease	Eligible calves	Remarks
1	Foot and Mouth Disease (FMD)	4 months and above	Booster after 1 month
2	Hemorrhagic Septicaemia (HS)	6 months and above	In endemic areas only, a month before expected occurrence of the disease.
3	Black Quarter(BQ)	6 months and above	
4	Anthrax	2 months and above especially when exposed to grazing	
5	Theileriosis	3 months and above	Only for cross bred and exotic anmals. Once in a lifetime in areas where ticks are prevalent. May be repeated every three years in tick free areas.

Tick control for bull calves

Type of acaricide	Field	Pre-quarantine	Quarantine station	Eligible animals
Injectable endo-ectoparasiticide	One dose 1-2 weeks before lifting	One dose not exceeding one week before shifting to quarantine station	a)One dose 7-14 days at quarantine station(keeping an interval of 2-3 weeks from the previous treatment) b)One dose at last 15 days at quarantine station All age groups	All age groups.
Topical acaricide	One application not exceeding 2 days before lifting	One application not exceeding 2 days before shifting to quarantine station	a)One application immediately on arrival at quarantine station. b)One application at last 15 days at quarantine station.	All age groups.

Deworming schedule

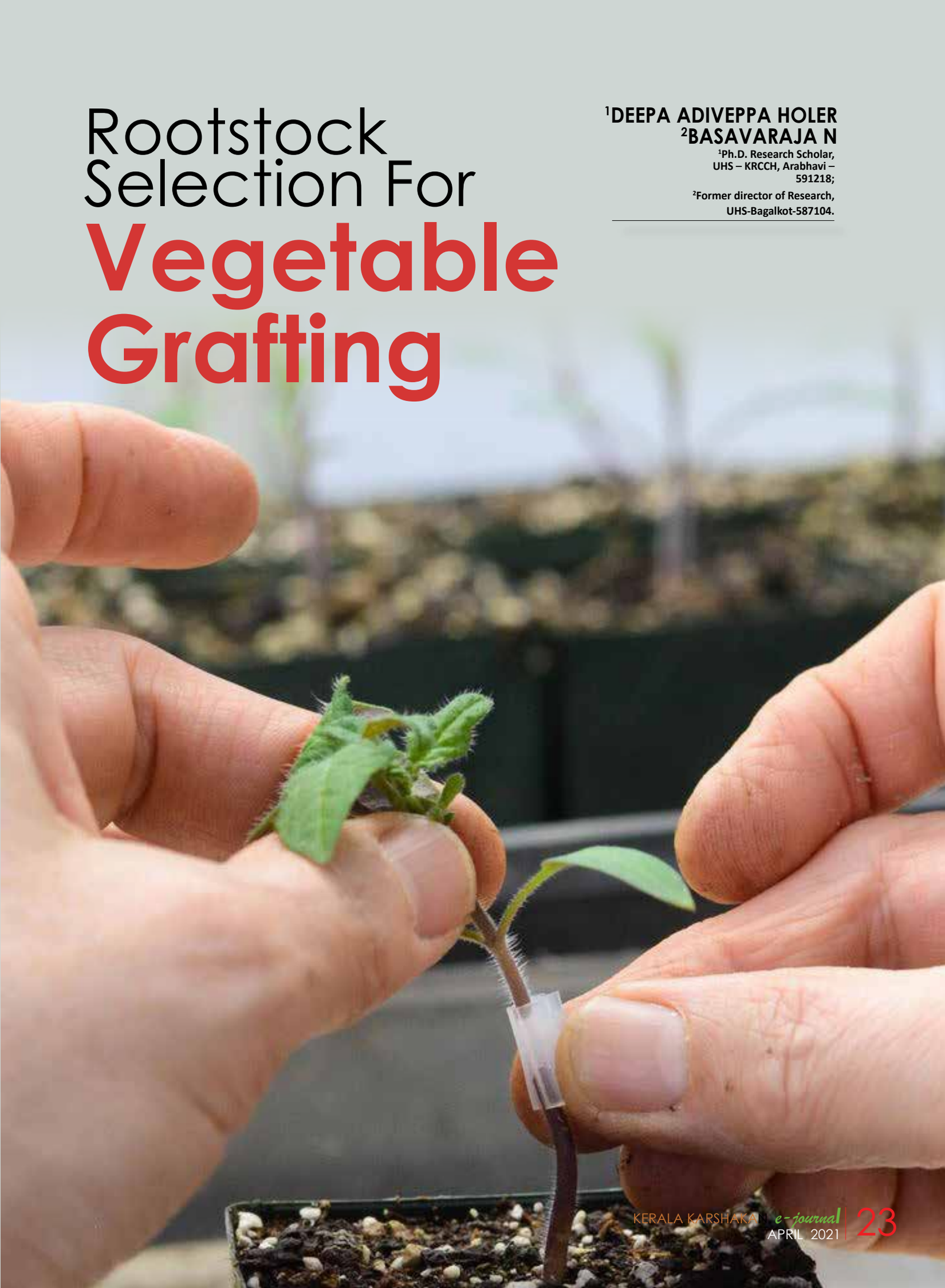
At pre-quarantine station, deworming is done with a broad spectrum anthelmintic immediately on arrival at pre-quarantine station, 3-4 weeks after the first dose and an oral broad spectrum anthelmintic not exceeding one week before shifting to quarantine station.

In quarantine station, a broad spectrum anthelmintic is given immediately on arrival, then between 20-30 days at quarantine station and a broad spectrum anthelmintic not exceeding one week before shifting from quarantine station or two weeks before any vaccination .

Bull calves, thus maintained at the quarantine station are then shifted to various semen stations as high genetic merit bull calves and are used for semen collection for frozen semen producton . Since cattle breeding in the state solely depend on artificial insemination using frozen semen, quarantine bull stations forms an inevitable link between the field/farm and the semen stations.

Rootstock Selection For Vegetable Grafting

[1]DEEPA ADIVEPPA HOLER
[2]BASAVARAJA N
[1]Ph.D. Research Scholar, UHS – KRCCH, Arabhavi – 591218;
[2]Former director of Research, UHS-Bagalkot-587104.



Grafting is a method of propagation technique in which two living parts of different plants i.e rootstock and scion are joined together in such a manner that they would unite together and subsequently grow into a composite plant. Commercial grafting in vegetable crops is relatively new (Sakata et al., 2007) and the first attempt in vegetable grafting was done by grafting watermelon *(Citrullus lanatus L.)* onto pumpkin *(Cucurbita moschataL.)* rootstock in Japan and Korea in the late 1920s (Lee, 1994) to overcome wilt disease caused by Fusarium spp.

The primary motive of grafting vegetable crops is to manage soil borne diseases like Fusarium wilt and verticillium wilt. Grafting with suitable rootstocks provide tolerance to biotic and abiotic stress and also makes grafting a viable tool for early planting and harvest under protected cultivation. Therefore before grafting operation one should select the rootstocks with desirable characteristics.

Important considerations while selecting a rootstock for grafting

- Root system of rootstock should be vigorous
- The rootstock must be highly compatible with scion
- It should not negatively affect fruit quality
- The rootstock should be resistant/tolerant to biotic and abiotic stresses. Ex:

Table 1: Commonly used commercial rootstocks in vegetable crops

Crops	Popular rootstock species
Watermelon	Bottle gourd *(Lagernaria siceraria var. hispida)* Interspecific hybrids Wax guard *(Benincasa hispida Cogn.)* Pumpkin *(Cucurbita moschata L.)* Summer squash *(Cucurbita pepo L.)* *Sicosangulatus*
Cucumber	Fig leaf guard*(Cucurbita ficifolia)* F1 *(Cucurbita maxima x Cucurbita moschata)* *Cucumis sativus L.* *SicosangulatusL.*
Melon	*Cucumis melonL.*
Brinjal	*Solanum torvumL.*
Tomato	Beaufort, Maxifort

some C. *maxima* × C. *moschata* rootstocks bred for resistance to melon necrotic spot virus, a soil-borne virus, can be employed to limit virus infection. When virus disease is prevalent, growers need to be well aware of possible virus resistance or susceptibility of rootstocks, because if the rootstock is more susceptible than the scion, the virus issue can become worse in grafted plants

- It is important to understand the complete disease resistance package of the rootstock for successful use of grafted plants in addressing specific soil-borne disease problems
- Rotation of rootstocks to minimize the emergence of new pathogen race.

Conclusion

Selection of rootstock in grafting play an important role in getting sustainable production. Hence, before grafting the characteristics of rootstocks should be seriously considered to achieve targeted production. As fruit quality is concerned, there is a need to understand the intrinsic impact of rootstock and rootstock scion interaction on fruit quality. Further studies need to be conducted on fruit quality concerns.

References

Lee, J.M., 1994, Cultivation of grafted vegetables: Current status, grafting methods and benefits. Hort. Sci.,29(1): 235-239.

Sakata, Y., Takayoshi, O. and Mitsuhiro, S., 2007, The history and present state of the grafting of cucurbitaceous vegetables in Japan. Acta Hort., 731: 159– 170.

[1]KURAKULA DIVYA
[2]E.SATHYANARAYANA
[2]D. RAJINI
[2]G. JYOTHI
Dept. of Floriculture and Landscape Architecture
[1]Ph. D. Scholar, 2Assistant Professor
[1]SKLTSHU, Rajendranagar
Malla Reddy University, Hyderabad
Email: kurakuladivya@gmail.com

SPECIAL CULTURAL PRACTICES IN IMPORTANT FLOWER CROPS

The aim of greenhouse cultivation is to obtain high yield and good quality flower within a short period. Several methods for forcing flowers can be used successfully to obtain high yield and quality.

Crop regulation

Crop regulation is the basis for the regular and quality crop.A range of methods are used to increase production with enhanced flower quality by crop regulation. It can be achieved through photoperiod regulation, use of PGR's, pruning, pinching,disbudding, desuckeringetc.Flowering is regulated by the integration of environmental cues into an internal sequence of processes. Knowing how the growing environment and cultural practices can affect flowering will help tomanage a crop's growth. Understanding of crop regulation will help to optimize harvest time therebyreducing glut in the market, to obtain higher price for the produce and to avoid spoilage due to excessive production.

Special cultural practices in important flower crops

Rose, Carnation, Chrysanthemum, Gerbera, Anthurium and Orchids

ROSE

Bending, Disbudding, Pinching, Wild shoot removal, Pruning, Removal of faded flowers, Support of the plants, Maintenance of beds, Application of bud caps and Removal of Dieback

Initial plant development/ mother shoot bending

- If the young plant is allowed to flower immediately after planting there is serious risk that the important structural frame work of the plant will be impaired.
- First flower is pinched after one month from the date of planting so that 2 to 3 eyes bud will sprout on main branch to grow as branches and these branches in turn will form buds.
- When the plant attains this stage of growth, the mother shoot is to be bent towards the direction of path between beds.
- This cultural operation in rose plants is done to initiate bottom break ground shoot.
- The maximum leaf area is required to build up a strong root system.
- The mother shoot is bent nearer to the bud joint.

Plant structure development:

- After planting ground shoot will start growing from crown of plant.
- The weak ground shoots

should be bent at ground level, for forming a basic and strong frame work of plant for production throughout their life cycle.

- The strong ground shoots should be cut at 5th pair of leaves after four and half months from the date of planting.
- The medium ground shoots should be cut at 2nd or 3rdpair of leaves.
- The growing suckers should be removed in order to check new growth on the bended stem.
- The buds should be removed from the bended stem in order to check the incidence of thrips and bud rot (botrytis).
- Only weak and blind shoots are selected for bending.
- Bending breaks apical dominance of the plant.
- It is continuous process and hence carried out throughout the life cycle.
- In summer season it is generally advised not to go for bending as it provides favourable condition for mite incidence.
- Bending is done on 1st or 2nd pair of leaves.
- One can also grow roses in greenhouse without bending by keeping some blind shoots on plants in standing position for extra photosynthesis & uptake of water nutrients.
- While bending the stems,care should be taken that the stem will not break and the leaves do not touch the soil.

Pinching:

- Removal of unwanted vegetative growth from the axil of leaf below the terminal bud is called pinching.
- This helps to get good quality flowers and buds and avoids wastage of energy in the development of auxiliary bud if done at right stage and right time.
- It leads to apical dominance.

Wild shoot (root stock) Removal

- Wild shoots emerging at the union on the root stockshould be removed at the earliest as these will deplete nutrients and checks growth and development of plant.
- They should not be cut but removed from its union by pressing it with thumb in order to check its further sprouting.

Pinching

Support toplants:-

- The support system consists of bamboo/ GI pipes inserted on both sides of bed at start and end of the bed.
- Post are placed at intervals of 3m along the sides of bed, fastened with 14 gauge GI wires or plastic string at the posts at 30 cm – 40 cm intervals to support the plant.
- Between the wires across the bed, thin strings can be tied to keep the width of the bed constant.

Pruning or under cutting

- Rose plant pruning or under cutting is necessary to decrease height of the plant.
- This is done in the month of June-July.
- Pruning or under cut is practiced to avoid short stem and weak sprouts.

Maintenance of beds:

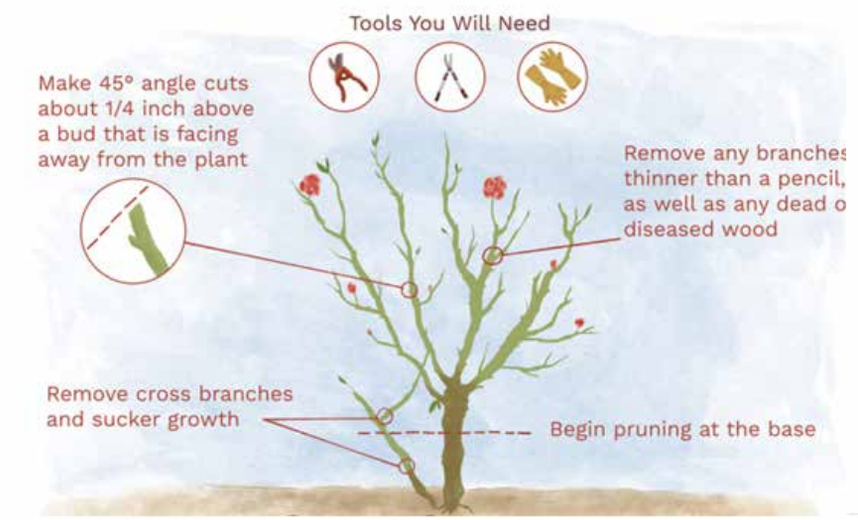
- In green house roses are grown on raised beds.
- The fertile soil of the beds has a tendency to collapse into the path due to hosing by pipe, weeding and hoeing, friction with spray pipe during spray etc.
- Hence maintenance of bed is to be done by adding fresh soil to bed or by shifting fertile soil from path to bed.

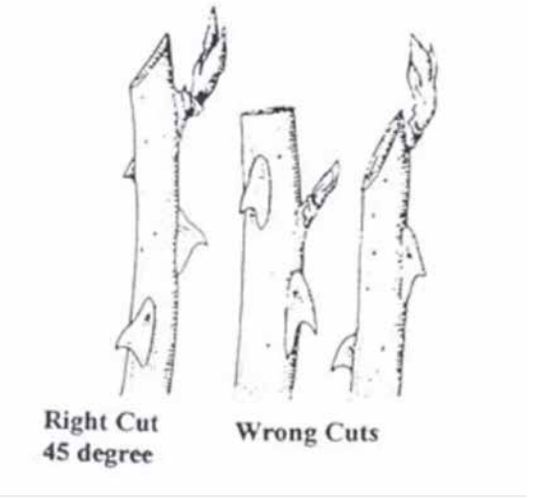
Application of bud caps

- Bud caps are generally placed on the bud when they are of pea size.
- This helps to increase the bud size and shape to meet customer demand.

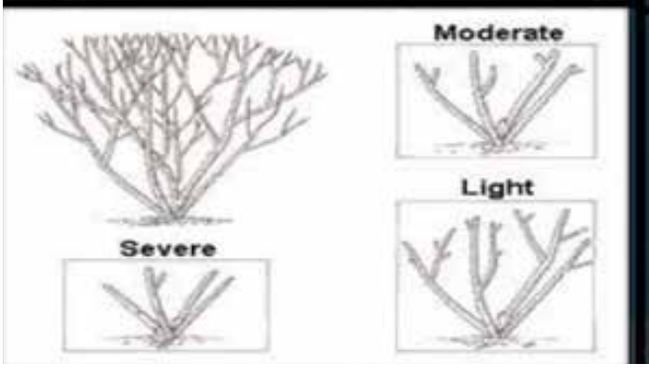
Removal of Dieback

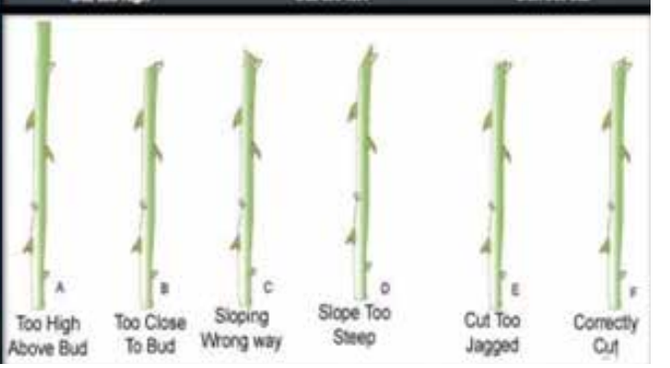
- As the crop gets older (aged) dieback appear in the crop due to use of infected secateurs or wrong pruning

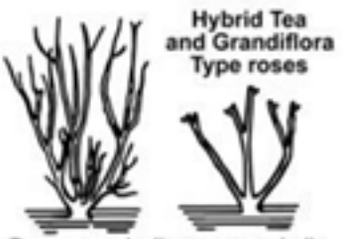

Tools You Will Need
Make 45° angle cuts about 1/4 inch above a bud that is facing away from the plant
Remove any branches thinner than a pencil, as well as any dead o diseased wood
Remove cross branches and sucker growth
Begin pruning at the base

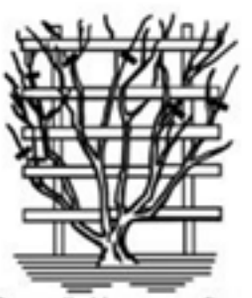

Right Cut
45 degree
Wrong Cuts

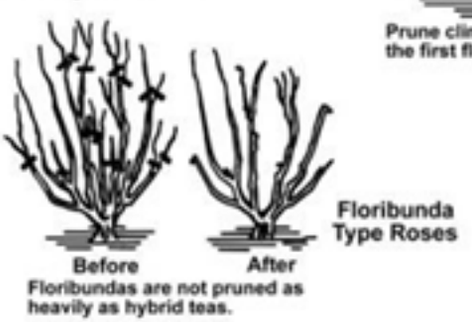

Cut too high
Cut too low
Correct cut

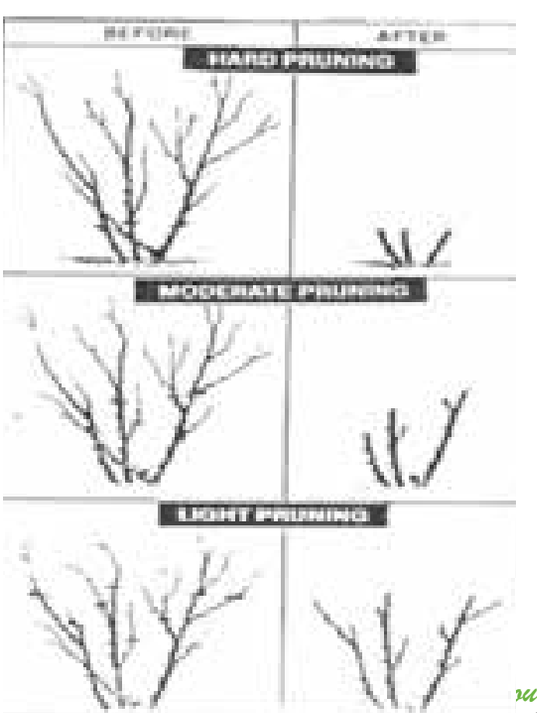

Moderate
Light
Severe


A
Too High Above Bud
B
Too Close To Bud
C
Sloping Wrong way
D
Slope Too Steep
E
Cut Too Jagged
F
Correctly Cut


Hybrid Tea and Grandiflora Type roses
Remove weak, diseases or spindly wood and leave three to five of the most vigorous canes.


Prune climbing roses after the first flush of bloom.


Floribunda Type Roses
Before
After
Floribundas are not pruned as heavily as hybrid teas.


HARD PRUNING
MODERATE PRUNING
LIGHT PRUNING

Wild shoot (root stock) Removal

- practice or hard pruning due to which stem starts drying from place of cut towards bottom of the plant.
- The secateurs should be dipped in bavistin solution todisinfectevery day before starting and after harvest.

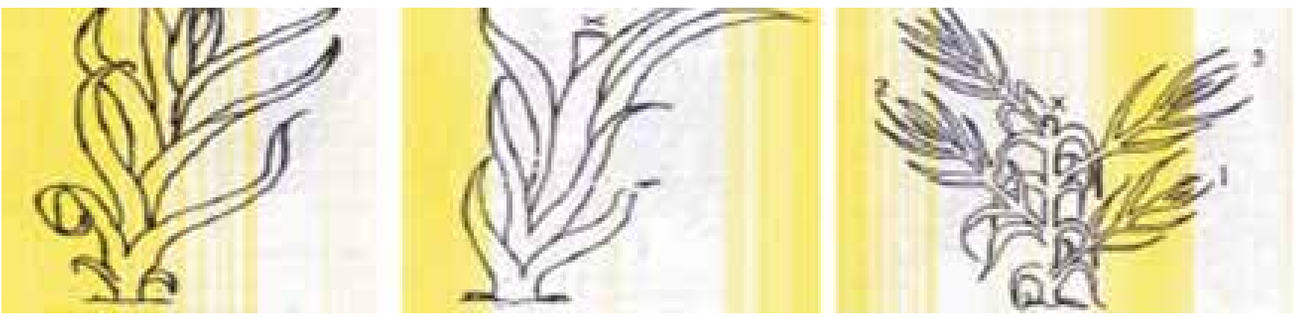
CARNATION

Netting, Pinching and Disbudding

Netting

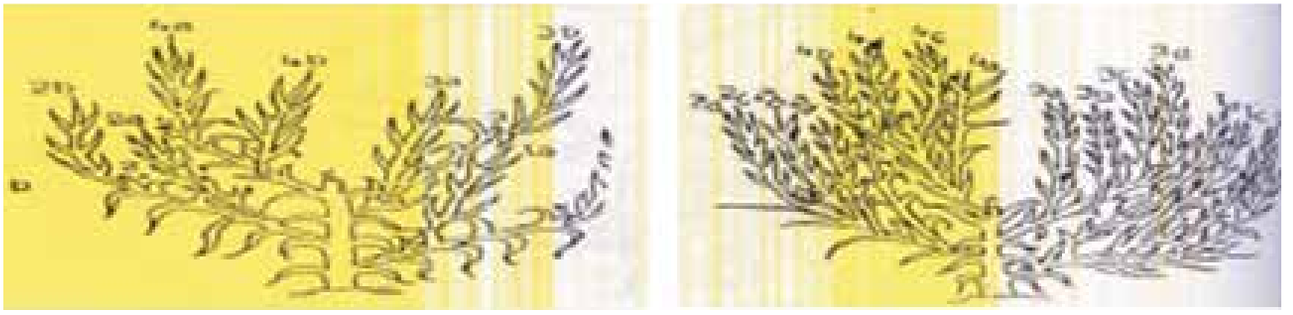
- Carnation crop has the tendency to bend unless supported properly hence

Single pinching in standard carnation



Before pinching **After pinching** **35 days after pinching**

Pinch and a half (2+4 laterals) **Pinch and a half (2+6 laterals)**



Doble pinch (8 laterals) **Doble pinch (16 laterals)**

the crop needs support while growing.

- Good support material is metallic wire woven with nylon mesh.
- At every two meters the wire should be supported with poles.
- Metallic wire is tied around the bed along the length with the support from supporting poles.

Staking

Netting for plant support

1st layer: 7.5 x 7.5 cm
2nd layer: 10 x 10 cm
3rd layer: 12.5 x 12.5 cm
4th layer: 15 x 15 cm

- Across the bed, nylon wires are woven like net.
- For an optimum support, an increasing width of the meshes can be used.
- Bottom net can be of 10x10cm, then two nets of 12.5x12.5cm and the upper most can be 15x15cm.

Pinching

- Depending upon the need of crop spread, single, one and a half or double pinch method is adopted.
- Ideal time for pinching is early morning.
- When the plant attains 5 nodes, the first pinch is given and is called 'single pinch'.
- This would give rise to six lateral shoots.
- For a 'one and half pinch', 2-3 of these lateral shoots are pinched again.
- For the 'double pinch', all the lateral shoots are pinched off.

Disbudding

In standard carnations, side buds should be removed whereas in spray carnations, the terminal bud has to be removed

CHRYSANTHEMUM

Pinching, Disbudding, Staking, Desuckering and Photoperiod Regulation

Pinching

- After planting, the growth of plant is upward with very little branching.
- To arrest such tall growth, pinching or stopping is practised.
- Only soft vegetative shoot tips 1.5 to 3 cm long are removed.
- It is most essential for small flowered chrysanthemum.
- It increases the number of flowering stems in each plant.
- It also indirectly controls flowering date and bloom quality.

Type of pinching

1.Soft pinching

The soft tip of the shoot along with 2-3 openleaves are removed. This is done to reduce height.

2.Hard pinching-done in potted plants.

A longer portion upto hard shoot is removed to reduce plant height & keep plant compact.

3. Rollout pinching –

Removal of terminal tip is done in nursery itself. Done on short plants or soon after cuttings are planted.

Disbudding

- Standard types are disbudded by removing all the lateral flower buds and retaining the terminal flower bud to allow it to develop into a big flower.
- For spray types, the terminal flower bud is removed to develop a spray of large uniform flower buds from lateral buds.

Staking

- Since spray and standard chrysanthemums may be as tall as 75 cm to 90 cm, it is necessary to support the stems as the crop matures.
- Lack of support leads to bending of stems ultimately causing decline in market quality.
- Various kinds of plastic mesh, strings, bamboo canes etc are used for plant support.
- Sucker growth must be checked by removing the side suckers periodically to avoid wastage of nutrients.
- Without de-suckering plant will lose vigour and become weak.

Photoperiod regulation

- As it is a short-day plant, initiation of flowering occurs in uninterrupted darkness rather than the period of light.
- For year-round production under controlled environment, altering the light periods to ensure ideal photoperiodic conditions, apt mechanism like black polythene coverage for dark period and artificial illumination for long light period has to be practiced.
- Short day treatments are given preferably a minimum of 12 hours for a period ranging from 6 to 15 weeks.

Crop regulation

- Darkening
- Cover black polythene (150 gauge) from 4-5 pm to 7 am in the morning
- Inverted 'U' frame
- Lighting
- 60 watt lamp, 4 ft apart, 2 ft above i.e 10 ft cd/unit (4 hours extra).
- Temp : 10-300c
- If < 100c – flower bud initiation inhibits
- >300 c – hinders bud development
- Growth regulators
- GA3 50- 100 ppm- early flowering
- MH 1000 ppm- delays.

GERBERA

Dis budding

It helps to maintain plant health and size of flowers. Flower production starts 45 days after planting but initial production will be of inferior quality hence these flowers should be removed from the base of the flower stalk.

De-leafing

It is a part of sanitation and helps in bud initiation.It helps in keeping the disease and pest infestation below the economic threshold level.This practice allows producing good healthy new leaves and better aeration in the crop.

Raking

To loosen the top soil of beds toincrease aeration in the root zone of the plant and weed removal.This should be done regularly, twice in a month.

Anthurium

Leaf pruning, De-suckering

Leaf pruning

- The older leaves should be removed periodically in order to maintain the equilibrium of plant
- It would also improve the health of plants by improving air circulation.
- Generally, 3-5 leaves are maintained on the plant. The number of leaves retained and the frequency of cutting also depend upon the size and orientation of the leaves.

De-suckering

- Anthurium plants naturally

Replanting and Repotting

Chrysanthemum

produce suckers at the base of plant.

- These young suckers take energy from the parent plant.
- This results in crooked stem and decrease in flower size.
- When the suckers become large, they will cause too much damage to the base of the plant when removed.
- It should be removed at an early stage.

ORCHIDS

Replanting and Repotting

- When the media is broken into very small pieces leading to poor aeration and drainage then repotting should be done.
- Also when plants are overgrown repotting has to be done.
- Repotted plant should be kept in shade for some days.
- The original media can be used after treating with fungicides if they are in good condition.
- Manuring /media should be filled only after some days.

Shade and ventilation

- For orchids, maximum spike production occurs in 75% shade.
- Air movement helps to evaporate stagnant water trapped during watering where fungi and bacteria breed without ventilation.
- Orchids may die from lack of continues CO_2.

PERACETIC ACID

A POTENTIAL DISINFECTANT FOR FRUITS AND VEGETABLES

ADITYASHIVANANDAHEGDE
SADANANDA G. K

Fresh produce is desired by consumers for its high organoleptic and nutritional quality. Postharvest cleaning and disinfection are a critical unit operation for preserving the quality of fresh produce by controlling microbial contamination. An initial washing removes soil and other debris, improves the product appearance and lowers the product temperature. Secondary application of sanitation or disinfection methods prior to packaging can further reduce the presence and transfer of spoilage and pathogenic microorganisms on produce surfaces, preventing physiological changes and risks of foodborne illness.

Generally, there are three uses of chemical sanitizers in fresh and fresh-cut produce processing: wash water disinfection, product sanitation and equipment sanitation. Wash water disinfection prevents cross-contamination within the recycled water used by large scale washing equipment. As microorganisms removed during washing may be transferred to subsequent products washed in the same water, the presence of antimicrobial agents in the washwater maintains the water quality by eliminating microorganisms in suspension. Sanitation of product surfaces after washing and prior to packaging can be done using physical or chemical methods, which have been previously reviewed with respect to their efficacy in removing microorganisms on fresh and fresh-cut produce.

Chlorine and chlorine-based compounds have been proven capable disinfectants in wash water, several limitations have prompted the search for alternative antimicrobial agents. Excess use of chlorine reduces its efficacy and results in the generation of residues, corrosive to equipment and harmful to employees. Alternative antimicrobial agents and mixtures of agents have been demonstrated to be equally or more efficient than chlorine and are gaining adoption for use in postharvest handling and disinfection.

Peracetic Acid (PA)

Peracetic acid, also known as peroxyacetic acid, is an equilibrium mixture of hydrogen peroxide and acetic acid. The peracetic acid was patented in 1950 for the treatment of fruit and vegetable surfaces, via dip or spray, both in the field and postharvest, to reduce spoilage from bacteria and fungi. The peracetic acid has been approved by the US FDA for use as a sanitizer for equipment food contact surfaces and direct washing of fruits and vegetables, meat, poultry, and seafood (FDA, 2017).The peracetic acid is particularly promising for the food industry because it has strong oxidizing capabilities, does not produce harmful by-products and is accepted for use in organic production.

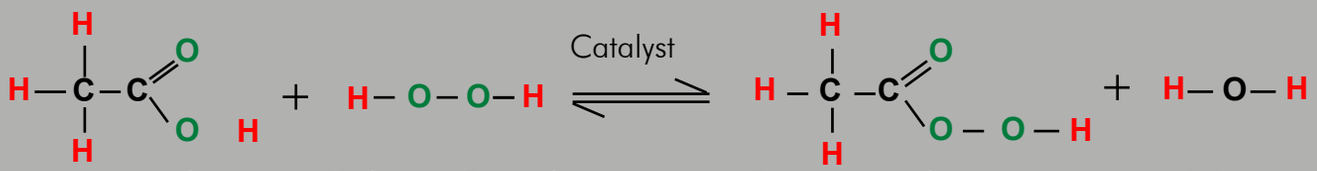
Physico chemical characteristics

Peracetic acid (CH3-CO-OOH) is the most active antimicrobial agent of the organic peracids, having strong oxidation and disinfectant properties with oxidation potential of 1.81eV. When used as an antimicrobial agent and disinfectant, 0.03%–2% solution is typically sufficient to give this strong oxidation activity. The biocidal form is considered to be the undissociated acid, which is predominant at pH4.7 and has shown a wide spectrum of efficacy against bacteria, viruses, bacterial spores and protozoan cysts. The commercially available peracetic acid is a quaternary equilibrium mixture containing acetic acid and hydrogen peroxide.

On contact with organic substrates, peracetic acid decomposes to produce oxygen and acetic acid, the peracetic acid is gaining increased interest as an alternative to chlorine disinfectants because it does not produce damaging by-products. Also, peracetic acid is more potent than hydrogen peroxide.

Mode of action

The mechanism of oxidation is the transfer of electrons, therefore the stronger the oxidizer, the faster the electrons are transferred to the microorganism and the faster the microorganism is inactivated. peracetic acid causes further disruption of cell function by oxidizing proteins, enzymes, DNA, and metabolites in the bacteria, ultimately disrupting all life functions and causing rapid death of the bacteria. Its action as a protein denaturant may help to explain its characteristics as a sporicide and ovicide. An important advantage of peracetic acid is that it may inactivate catalase, an enzyme known to detoxify free hydroxyl radicals, which could result in rapid oxidant decomposition under catalytic conditions. It is suggested that peracetic acid disrupts the chemiosmotic



Acetic Acid (ethanoic acid) | Hydrogen Peroxide | Peracetic Acid (ethaneperoxic acid) | Water

function of the lipoprotein cytoplasmic membrane and transport through dislocation or rupture of cell walls.

Formation of Peracetic Acid

Peracetic acid solution is produced from the reaction of acetic acid or acetic anhydride with hydrogen peroxide in the presence of sulfuric acid, which acts as a catalyst. The reaction is allowed to continue for up to10 days in order to achieve high yields of peracetic acid as the product. Peracetic acid is also produced by oxidation of acetaldehyde. Peracetic acid is usually produced in concentrations of 5-15%.

Application of Peracetic acid

Food & Beverage Industry Disinfectant

They are used to disinfect or sterilize equipment, surfaces, tanks, pipes and plastic bottles. In food and beverage packaging applications, many types of products are packed in plastic bottles made from PET or PE. Juices, soft drinks, tea and liquid dairy products require perfect hygienic conditions during the packaging process to guarante e a long shelf life.

Veterinary Hygiene and Animal Health

They are highly effective in very low concentrations even at low temperatures and in presence of organic impurities. Applications include general surface and equipment disinfection, treatment of water supply systems and thermal fogging. The product is applied by mechanical sprayers or pressure washers.

Medical Sterilizer and Disinfectant

Typical uses of peracetic acid in medicine includes disinfection of medical equipment, cold sterilization of dentures, plastic implants, syringes, thermally sensitive nutritive media, disinfection of hemodialysis systems and decontamination of liquid and solid medical wastes in hospitals.

Agriculture Disinfectant and Slimicide

Solutions of peracetic acid have been proved to be a highly effective and environmentally friendly biocide in agriculture. Pulse cleaning of drip lines in the absence of plants, disinfection of tools, tables and containers as well as washing of harvested goods with peracetic acid are typical examples of the broad range of possible applications.

Environmental Disinfectant and Slimicide:

Waste water is usually disinfected prior to discharge to remove pathogenic species. Products containing peracetic acid offer an alternative to common chlorine-based disinfectants such as sodium hypochlorite.Utilization of a chlorine-free disinfectant prevents the formation of toxic chlorinated side products.

Pulp and Paper Slimicide

In the pulp & paper industry there is a need to disinfect the white-watersystem to prevent microbial contamination of fibrous material in the circulation water.

Advantages of Peracetic Acid

- It has been shown that peracetic acid produces no to little toxic or mutagenic by-products after reaction with organic material present in treated waste water effluents or surface waters used for drinking water. Carboxylic acids are formed through the oxidation of natural organic matter in the water by peracetic acid
- No halogen containing disinfection by-products (DBPs) were observed for peracetic acid -treated water
- Chlorine-based disinfectants result in the formation of toxic and mutagenic halogenated by-products (chlorinated and/or brominated) after the reaction of chlorine and organic material.
- Peracetic acid is effective at the inactivation of pathogenic bacteria in suspension at lower concentrations than the ones required when using chlorine.

KARTHIKA NAIR A.S.
Dr. BEENA THOMAS
College of Agriculture, Vellayani

GLADIOLUS

THE SWORD LILLY 'QUEEN'

Synonyms: Gladiolus (plural gladioli or gladioluses), gladiola, glad, sword lilly

Flowers are closely associated with human from the dawn of civilization. Floriculture is a lucrative enterprise having an edge over other horticulture and field crops. Flowers, the crowning beauty of God's creation, are an inseparable part of human joy and sorrow. Gladiolus is one of earth's most beautiful creations and is an important flower crop, grown commercially in many parts of the world.

Gladiolus, the queen of bulbous flowers, is top in its beauty, availability of various colours, keeping quality and shapes. This makes gladiolus one of the most valuable ornamental crop in the International cut flower trade. Gladiolus originated from the Latin word 'gladius' meaning 'sword', is a herbaceous plant belonging to the genus of

Classification

A. Classification based on spike length and floret number

Type	Spike length (cm)	Floret number
Fancy	>107cm	16
Special	>96cm to ≤ 107 cm	15
Standard	>81 cm to ≤ 96 cm	12
Utiliy	≤ 81 cm	10

B. Classification based on size of the

Type	Floret size (cm)
Miniature	<6.4 cm
Small	≥6.4 cm to <8.9 cm
Decorative	≥8.9 cm to < 11.4 cm
Large	≥11.4 cm to <14.0 cm
Giant	>14.0 cm

C.Horticultural classification

Large flowered hybrids	Peacock hybrid
Primulinus	Star flowered
Miniatures	Nanus

D. Based on colour

Red, green, yellow, white, salmon, pink, violet, orange, red rose, tan, smokes and brown colours of gladiolus are available where in each color pale, medium, deep etc., are available.

fire cracker

Her Majesty

Gladiolus Violet

perennial cormous flowering plant in the family Iridaceae. It is one of the most cultivated, economically important and common flowering plant cultivated all around the world due to its value as a cut flower and for decoration. Gladiolus occupies fifth position in the international floriculture trade.

Scientific classification

Kingdom	Plantae
Division	Magnoliphyta
Class	Liliopsida
Order	Asparagales
Family	Iridaceae
Genus	Gladiolus

Centre of origin

Gladiolus is domestic to sub-Saharan Africa, mostly South Africa. The major centre of diversity is in the cape floristic region and it also occurs in Asia, Tropical Asia and Mediterranean Europe. The genus gladiolus contains about 260 species.

Soil and climate

Gladiolus usually grow well in sunny climatic situations and should be protected from stormy winds. It prefers well drained fertile loamy to sandy soil with a pH which is not to acidic nor to basic i.e., 6.5-7. Favourable temperature range is between 27°C- 30°C. Water logging should be avoided and gladiolus flourishes well in areas with moderate humidity. Judicious use of organic matter such as manure and fertilisers also favours its growth.

Propagation

Gladiolus are usually propagated by using corms and cormels, however propagation by corms is most suited for cut flower production. Corms should be healthy and disease free. Conical shaped corms are preferred over flat shaped corms. Corms ranging from 4-7 cm in diameter produces the best results.

Time of planting and managementpractises

Gladiolus grows well in moderate weather conditions, it can be grown round the year except summer season when sun burn will be severe.

Gladiolus is generally grown in winter season. Shallow planting of corms is preferred for more cormel production but it can result in lodging during severe winds. Corms are planted down the base in rows and are covered with soil. Most suitable depth of planting range from 6-10 cm. The frequency of irrigation mostly depends on the existing weather condition and the type of soil. During warm condition irrigation is generally done twice a week, whereas in winter it can be reduced to once a week.

After harvest watering should be reduced for the easy lifting of corms and cormels.

Purple flora

Application of fertilisers' especially organic manures is very important as it leads to corm development and flower production. Fertilisers such as FYM, NPK, and Zinc is applied time to time during the growth period of plant.

Diseases and pest management

1. Fusarium rot and yellowing This is commonly caused by Fusarium spp. and also known as dry rot or vascular rot.

Major symptoms are leaf infection and yellowing of leaves with age, discrete brown lessions or general rotting on corms.

Treatment: Use healthy corms and dip corms in carbendazim

American beuaty

(1g/L water) for 60 minutes after harvesting and before storage of corms.

2. Grey mould

This is caused by *Botrytis chinerea*. This is a fungal disease and initial symptoms include pale brown spots on leaves, which gradually becomes dark. Large oval or round spots are also seen in stem and flowers. Soft brown rotting occurs at the base of florets after rainfall and in humid conditions the whole flower may get covered with the brownish grey fungal growth.

Treatment: Corm treatment before planting and storage using carbendazim in hot water, removing older florets from the plant, use of any organic sprays such as neem oil spray during the course of growth.

3. Pests

a. Thrips: Thrips are small insects which feed on leaves, florets and spikes. They are normally not seen by naked eye but silver or white sticks are seen in affected area.

They could be controlled by using 0.1% Malathion spray.

b. Aphids: Aphids generally suck the sap from developing areas such as tender leaves and emerging florets.

Spraying monocrotophos at 0.05% can be effectively used for controlling

c.Mites: Mites are generally seen in hot season in soil and usually attack corms, which gives a pale appearance to leaves and flowers. Application of kathane (0.5%) is done to prevent the attack.

d. Caterpillars and various cut worms:

These occasionally attack the foliage. Manual collection and destruction is done to prevent the infestation

4. Viral diseases

For Viral diseases such as mosaic viral diseases, the affected plant should be uprooted and destroyed. Harvesting of spikes and lifting of corms Spikes are ready for harvesting from 60-120 days depending on the size of corms during planting, variety and planting season.

The spikes should be harvested at bus stage with one to five florets showing color and atleast four leaves on the plant for the corm development. So, if corms are planted in September, spikes could be harvested at November/December. Planting of corms are adjusted in such a way to maintain continuous flower harvesting in the year.

Corms are lifted after one and a half month to two months after flowering to attain maturity. Corms are lifted after attaining maturity that is when 25% of cormels turn brown and leaves turn yellow and drying.

[*1]GAYATHRY K. S
[2]JENNY ANN JOHN
[*1] Research Scholar and 2Assistant Professor
Faculty of Ocean Science and Technology
(Department of Food Science and Technology),
Kerala University of Fisheries and Ocean Studies
(KUFOS), Panangad, Kochi -682506, Kerala
email: gayathrykshankar@gmail.com
Tel: +91-9895201829

Banana Pseudostem

Prospects of Value Addition

Introduction

Banana (Order: *Zingiberales;* Family: *Musaceae;* Genus: *Musa*) is a very popular tropical fruit native to South Pacific region. The most commercially cultivated banana species is *Musa x paradisiaca,* which is a hybrid of two wild species *Musa acuminata* and *Musa balbisiana*. Interestingly, banana plant is not a tree but a herb. The wild banana species *Musa ingens* can grow as tall

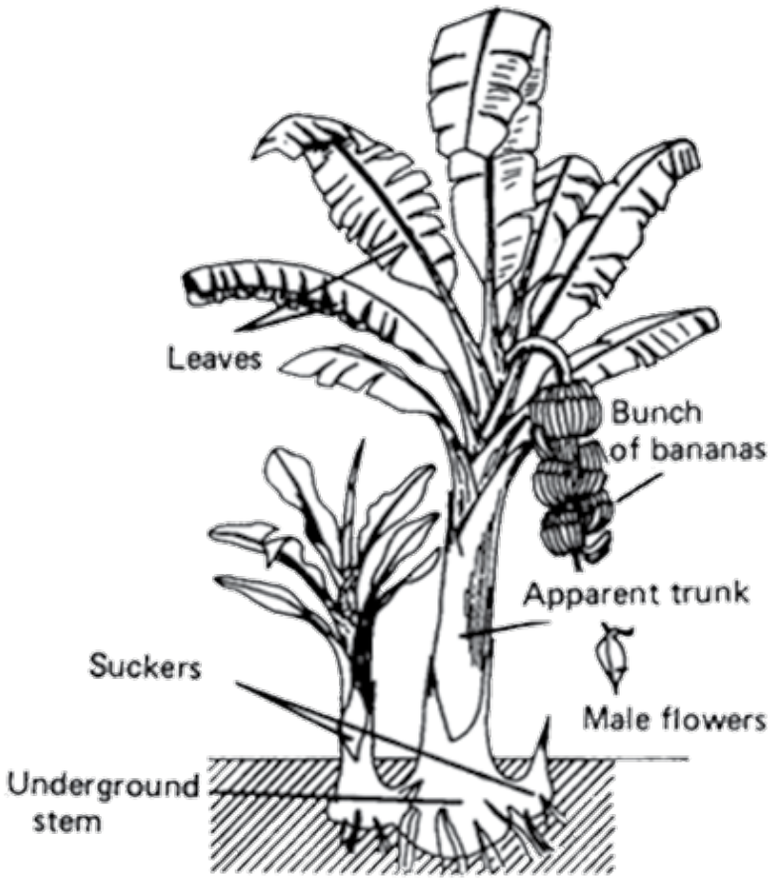


Fig 1: Parts of plantain plant (FAO, 2021)

as 15 meters, making it the largest herb on earth. Banana is commonly known as *Kela* in Indian subcontinent and regionally as *Vazhappazham* in Kerala, *Vazhakkai* in Tamil Nadu, *Aratipandu* in Andhra Pradesh, *Kola* in Bengali and *Kol* in Assam. Bananas are predominantly cultivated in Asia, Africa and South America. India is the largest producer and consumer of banana globally, producing about 30.46 million tonnes in the year of 2019 (FAOSTAT, 2021). Banana plants are large perennial monocotyledonous herbaceous plants up to 9 m long with a long pseudostem, that arises from the underground rhizomes (Ghag & Ganapathi, 2018). The leaves are elongated oval and dark green in colour with each plant producing a single inflorescence, which is ovate in shape, fleshy, dark red in colour and which opens in succession. The fruits are oblong and fleshy with very small black seeds (Imam & Akter, 2011)(Fig 1).

All parts of plantain plants namely fruits, leaves, pseudostem, rhizomes and inflorescence are useful. Thus, it is known as a 'Kalpatharu' in India, which is a Sanskrit term meaning 'wish granting tree'(Ghag & Ganapathi, 2018). The fruit part is most commonly used either as raw fruit or in desserts, breakfast dishes when it is ripened. Unripe fruits are used commonly in curries, fried chips etc. The plant is also traditionally used as a medicinal herb. The leaves serve as a wrap for cooking, wrapping and serving food in certain cultures. Pseudostem and inflorescence are ingredients in many traditional cuisines. Rhizomes and the outer layer of pseudostem are utilized as animal feed. The fruit is generally cheap and considered as a staple food in developing countries. Banana fruit is a great source of nutrients, including carbohydrates and minerals, especially potassium. The unique taste of the fruit also makes it popular all over the world.

The cultivation of plantain is mainly carried out for fruits and the other parts such as leaves, inflorescence, pseudostem, peels and rhizomes are practically wasted. However, currentlythey have gained the status of valuable by-products generated from banana cultivation (Padam *et al*., 2014). It is estimated that, for each tonne of banana fruit harvested, approximately 4 tonnes of biomass wastes including rotten fruit, leaves, pseudostem, rhizome and fruit bunch stem are produced (Subagyo & Chafidz, 2018). Conventionally, there are a few constraints in utilising them, for instance pseudostem and inflorescence are considered as a vegetable in certain cultures, but the acceptance is very limited when compared to other leafy vegetables due to discolouration and taste. Other than the medicinal and culinary uses of banana, recent researches identified plantain and its parts as a great source of phytochemicals (Reddy & Hemachandran, 2014). Several applications of the banana pseudo stem in functional food and nutraceutical industries have been explored. Some uses are depicted in Fig 2.

2.0 Banana Pseudostem

Pseudostem is the part of plantain plant, which is formed by tight overlapping of leaf sheaths one over another and a tender core in the centre(Fig3). It constitutes the major waste

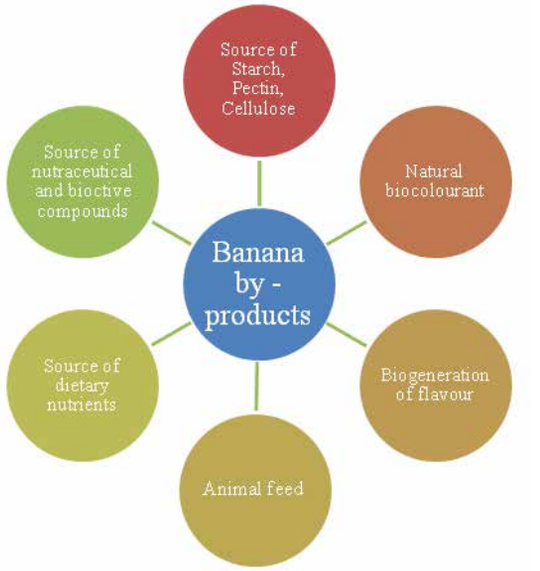


Fig2: *Different innovative uses of banana by-products (Source*:**Thorat & Bobade, 2018, Padam** *et al*., **2014)**

portion of plantain cultivation which is either left as such or incinerated after fruit harvesting. Plantain stem is a low cost agricultural waste, which can find applications in the current scenario. This review focuses on the current food and non-food applications of banana pseudostem and those studies which are in the art of research.

2.1 Banana Pseudostem: Non-food applications

The usage of agricultural wastes contributes to the concept of green technology and hence paves the way towards sustainable development. Moreover it

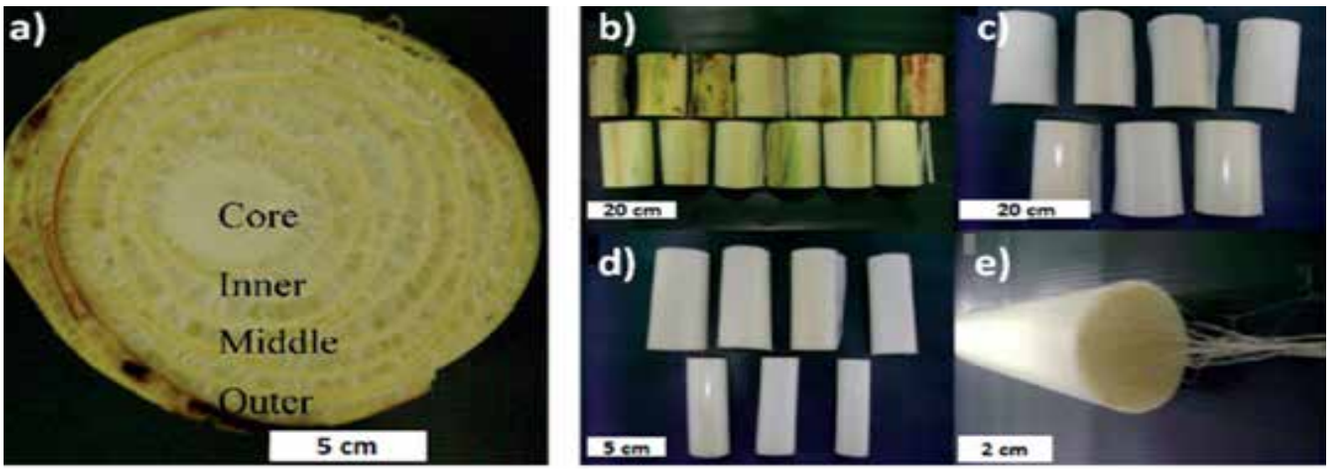


Fig 3: a) Banana pseudostem trunk cross and its part: b)outer parts c)middle parts c)inner parts e)core parts (Subagyo & Chafidz, 2018)

Table 1: Various non-food applications of banana pseudostem

Natural fibre	The pseudo stem fibre is used for making several value added products namely rope, cordage, fishing net, mat, packaging material, paper sheets, textile fabrics, bag, table cloth, handicrafts, absorbent, polymer/fibre composites etc. (Subagyo & Chafidz, 2018) (Fig 2). The fibre is extracted by using a decorticator machine then retting and degumming processes are done.
Fuel	Bio ethanol can be produced from banana pseudostem by fermentation process. Similarly banana waste methane can also be produced using anaerobic fermentation.
Substrate for edible	Banana pseudo stem can be utilised as a good substrate for mushrooms mushrooms because of its high cellulose content.
Heavy metal and dye adsorbers	Studies reported that banana pseudostem can be powerful of mercury and lead. Similarly it is also reported that banana pseudostem adsorbed methyl red in aqueous solution.
Organic manure	Banana pseudostem outer peels are used as organic manure for banana plantations itself.

Table 2: Recipes of various banana pseudostem dishes

DISH	RECIPES
Stir fry	Cooked banana stem centre tender core seasoned with chilli, garlic, curry leaves, shallots and / or fresh grated coconut.
Curry	Banana stem tender core cooked well and tempered with coconut paste and curd and tadka.
Soup	Pseudostem tender core pieces cooked well with fennel seeds, ginger, garlic and chilli under pressure, strained, blended smoothly, mixed with a little of corn flour and salt and heated until it boils.
Stew	Banana stem tender core cooked in Toor dal and then tempered with fresh grated coconut paste and tadka.
Thor ghonto Kol posola	Traditional Bengali dish in which stem is stir fried and seasoned with spices. Traditional Assamese dish with pseudostem and dal or fish which is prepared in gravy of onion with various Indian spices like ginger garlic paste, cardamom and chillies.
Stem bajji	Tender core cut into disc shape marinated with coriander paste. Marinated discs are dipped in gram flour rice batter and deep fried.

Fig 4: *Banana fibre mat, handicrafts, shirt and rope***(Image courtesy: www.boontoon.com, The Japan Times, Times of India, Indiamart)**

Fig3: a. *Banana pseudostem stir fry*(www.smithakalluraya.com) b. *Juicec. Candy d.Pickle*

Table 3: Studies showing potential nutraceutical activities of banana pseudostem

VARIETY	STUDY / BIOACTIVITY	REFERENCES
Musa spp. (8 cultivars)	*Invitro* Anti-oxidant activity	Saravanan & Aradhya, 2011
Musa sapientum Linn	*Invivo* Anti-diabetic and Anti-lipedemic activity	Dikshit et al., 2012
Musa parasidiaca Linn	*Invitro* Anti-oxidant activity	Joyetal., 2016
Musa acuminata	*Invitro* Anticancer activity	Nindia*etal.,* 2019
Musa spp. (10 cultivars)	Antimicrobial activity	Jouneghani *et al.*, 2020

Table 4: Studies that showing promising antidiabetic activity by banana stem & other parts

VARIETY	*PLANT PART*	*BIOACTIVE COMPOUND*	*REMARKS*	*REFERENCE (Dong et al., 2017)*
Musa × *paradisiaca* L.	Stem juice	*p*-Hydroxybenzoic	In vitro study showed antidiabetic activity and gallic acids	
*Musa sapientum*L.	Stem	Phenolic compounds, saponin, terpenoids	*In vivo* antidiabetic and antihyperlipidemic activity in rats	(Dikshitetal.,2012)
Musa paradisiaca	Inflorescence Leaves Pseudostem Unripe fruits		*In vitro* antidiabetic activity shown by stem and fruit ethanolic extract	(Reddy & Hemachandran, 2014)

is an additional income for both small scale farmers and processing industries (Padam *et al*., 2014). Various novel non-food applications of banana pseudostem are depicted in Table 1.

2.2 Banana pseudostem: Food applications

The tender core in the centre of the banana pseudostem is edible. In India and certain other cultures, the pseudostem cooked along with spices is a part of traditional cuisine.In southern part of India, pseudo stem is cooked both as gravy and stir fry seasoned with ginger, garlic, chillies, shallots, curry leaves and/or grated coconut (Fig 3a). In Assam, a dish called *kolposola* is prepared from young banana pseudostem. Some commonly prepared dishes using banana pseudostem and their recipes are provided in Table 2.

Recently, innovative value added products from banana pseudostem are being developed by pioneer institutes like CFTRI. Juices, pickles and candies (Fig 3 b,c,d) of pseudostem are available commercially. Extensive studies are underway to explore various possibilities of value addition of banana pseudostem. Banana pseudostem can be dried into powder and can be utilized for carbohydrate and mineral fortification in different bakery products like bread, biscuits, cookies and dairy products like shrikhand, paneer and cheese (Thorat & Bobade, 2018). Stem juice is also prepared with or without addition of other juices like lemon or grape and sugar or jaggery (Kumar & Reddy, 2015; Ravi *et al*., 2011).

2.4 Health benefits of Banana pseudostem

The tender inner core of plantain pseudo stem has been known to be nutritionally superior and associated with several health benefits.

Fig 5.Health benefits of banana pseudostem and juice

Several studies threw light andidentified that banana stem juice can be used as a source ofstarch, pectin, cellulose, natural bio-colourants, biogeneration of flavours and nutrients like dietary fibre, carbohydrates and minerals(Padam et al., 2014). Recently researchers are more focused on identification, quantification and isolation ofdifferent bioactive components present in the pseudostem which have potentialnutraceutical applications. Some are listed in Table 3.

2.5 Banana stem extracts: Potential hypoglycaemic properties

Banana stem extracts are traditionally used as anti-diabetic agents. Extensive researches are underway to prove the anti-diabetic activity of banana pseudostem extracts(Table 4). A comparative study among various plant parts of plantain plant for hypoglycaemic effect showed that the banana stem juice extract exhibited highest antidiabetic activity than other plant parts as fruit, rhizome and peels (Reddy & Hemachandran, 2014).

Similarly an attempt was made to formulate a beverage using banana pseudostem and rhizome and compared for the presence of total phenolics and flavonoids. However the higher presence of phytochemicals were shown in banana rhizome juice and subsequently higher antioxidant activity (Saravanan & Aradhya, 2011).

Conclusion

Banana pseudostem is considered as an agro waste of plantain cultivation. Recent innovative attempts for value addition are established that there is a great possibility of utilising banana pseudostem, both in food and other industries thereby providing an additional income for both small scale and large scale farmers. At the same time, the problem of waste management is also addressed to a limit.

The presence of various bioactive components in the pseudostem not only enhances the nutritional quality but also the therapeutic values of the products. This provides a new scope for the efficient utilization of banana pseudostem which is usually considered as a waste product.

Abbreviations

CFTRI: Central Food Technological Research Institute
FAO: Food and Agricultural Oraganization
FAOSTAT: Food and Agricultural Organization Corporate Statistical Database

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