



A SCIENCE AND TECHNOLOGY NEWSLETTER

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PROMISING TECHNOLOGIES

Sett way of growing sugarcane for fungal treatment

Owing to practical difficulties in handling voluminous planting material (setts) in sugarcane, the increased duration of fungicide treatment, although effective to manage important fungal diseases could not be practiced.

To address this issue, a modified fungicide treatment through low pressure diffusion technique in a short duration of treatment was evolved with a lab prototype at ICAR-SBI, Coimbatore. The prototype was validated for sett treatment with fungicides and microbes (*Pseudomonas fluorescens*, *Azospirillum*, *Glucanacetobacter* and *Phosphobacterium*) for disease management and growth promotion. During the evaluation for various inputs, the results on tissue bioassay, green house and field experiments indicated that the uptake and efficacy of fungicides/microbes was found to be similar for both the methods of treatment



Sett treatment devices are in operation for effective treatment of fungicides in sugarcane setts to manage red rot and smut.

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PROMISING TECHNOLOGIES

in terms of disease control and growth promotion. The principle involved in STD is vacuum infiltration by creating a negative pressure followed by absorption of the chemicals inside the setts. This novel mechanized sett treatment technology has been filed as a patent (Malathi et al. 3323/CHE/ 2011- The patent office Journal 21/06/ 2013) as 'Rapid treatment for planting materials of sugarcane and other vegetatively propagated crops'. Subsequently, new units of different sizes were developed in collaboration with ICAR-CIAE-RS, Coimbatore and validated for the management of fungal diseases with fungicides/ microbes and agro inputs for raising healthy nursery. For management of red rot, smut and wilt, along with sett treatment, other delivery methods viz., soil application, spray and delivery of fungicides through micro-irrigation systems were evaluated.

Mechanized means of sett treatment

Two/ three budded sugarcane setts were treated with fungicides using the sett treatment device (STD) for field experiments on disease management, while for healthy nursery programme, delivery of different kinds of inputs viz., agrochemicals and microbes (fungicides, insecticides, inducers, micro and macro nutrients, growth hormones, chemicals for abiotic stress tolerance, biocontrol agents, growth promoting bacteria / biofertilizers) were treated in different concentrations and combinations. This method was performed at prescribed vacuum level and duration (15-20 min) in the newly fabricated units.

Disease management

Detailed field trials to manage red rot in susceptible cvCoV 09356 in disease endemic region in Cauvery delta in Tamil Nadu during 2014-15 and 2015-16, indicated that this treatment was able to protect the setts from soil-borne inoculum of red rot and significantly improved the plant survival under sick plot conditions. Due to better crop stand and reduced disease incidence, cane yield increased significantly in the treated plots. Similarly, with



Larger unit of Sett treatment

100 % smut-affected seed cane, delivery of the fungicide propiconazole (100 ppm) through sett treatment device caused drastic reduction in whip emergence and a healthy crop stand, and improved cane yield by 52%.

Mechanized sett treatment for healthy nursery programme

Apart from delivering fungicides and biocontrol agents through the mechanized sett treatment device, studies showed that the mechanized treatment with a mixture of 0.5% super lime, 0.5% urea and 0.1% carbendazim was highly effective in producing vigorous quality seedlings as compared to 2.5% concentration of super lime and urea in the conventional sett dipping practices. Overall, in the new method, the dose of the chemicals was reduced by 1/10th from conventional dipping and it was further reduced for combined application. Production of high quality seedlings was significantly high at the recommended doses of fungicide, insecticide and nutrients also at stipulated vacuum level was validated at sugar factory locations. Depending on the unit, the vacuum level varied from 200-350 Hg/ mm, which had to be optimized without affecting the germination.



Effective management of smut disease in sugarcane through mechanized delivery of fungicides in the setts (Left: untreated plot with poor establishment; Right: treated plot showing excellent crop stand)

Under field conditions the disease problems remain due to breakdown of varieties to the pathogens or continuously growing of susceptible varieties in the region. Hence there is need to reduce the damages caused by the diseases till a varietal replacement is made. To manage the diseases through fungicides, an optimized effective delivery of fungicides in single bud or two budded setts/ bud chips has been developed utilizing mechanized-vacuum infiltration approach and the treatment has resulted in more effective diffusion of the chemicals into sugarcane setts / buds due to reduced pressure created in the treatment chamber. The newly devised sett treatment device is portable and easy to operate. Recycling of the chemicals resulted in huge savings in chemical usage for pre-treatment. Field trials conducted at ICAR-SBI and disease endemic locations showed that effective delivery of fungicides through the new device efficiently protected the crop from red rot, smut and wilt. By effective sett treatment, both soil- and sett- borne inocula of the pathogens were killed or inactivated, thus resulting in a significant reduction in disease development.

By treating the planting material with different inputs through simple, rapid and cost effective method, the industry will be able to produce good quality settlings



Production of vigorous sugarcane settlings in the nurseries after mechanized treatment of single buds with fungicide, insecticide and nutrients

with improved germination, growth promotion and tolerance to abiotic stresses. It is expected that adoption of this new approach will effectively manage sugarcane diseases and help to produce healthy seedlings to sustain sugarcane productivity.

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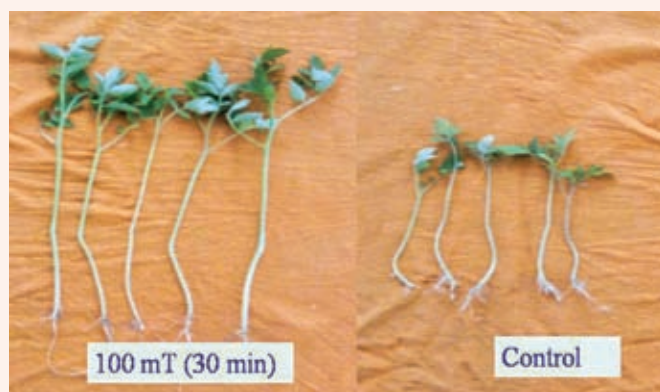
Magnetic field: Physical techniques for enhancing growth and yield in tomato

Magnetic field is one of the physical pre-sowing seed treatment which is not only cost effective but also significantly improves the yield without any adverse effect on environment. Its impact on the seeds can change the processes taking place in the seed and stimulate plant development. In the experiment conducted at IARI, New Delhi, seeds of tomato were exposed to a magnetic field of 50 mT, 100mT and 120mT for 5, 10, 15, 20, 25 and 30 minute in a cylindrical shaped sample holder, made of non-magnetic thin transparent plastic sheet. The required strength of the magnetic field was obtained by regulating the current in the coils of the electromagnet. Gauss meter was used to measure the strength of the magnetic field between the poles. The germination test was carried out following the method of ISTA (1985). Results indicated that exposure of tomato seeds to different magnetic field intensities increased significantly all of its germination related character. Germination percentage improved by 2-16%, the shoot length 0-16%, the root length 2 to 33%, the total seedling length 6-19% and

the seedling dry weight 0-17% in different treatments of magnetic field as compared to corresponding value in untreated control. The calculated vigour indices I and vigour indices II also increased by 12-39% and 4-32%, respectively, in different treatments of magnetic field as compared to corresponding value in untreated control. Among the opted magnetic treatments 100 mT for 30 minutes was found the most effective in increasing most of the seedling parameters. Tomato seeds exposed to magnetic field of 100 mT for 30 minutes and seedling



PROMISING TECHNOLOGIES



Field Experiment at IARI, Research Farm

raised from magnetically exposed seeds along with untreated control were transplanted in the research farm of IARI, New Delhi. Results showed that percentage increase in biomass, plant length and root length was 18%, 7% and 22%, respectively, in the plant raised from magnetically treated seeds as compared to corresponding value in untreated control. Photosynthesis rate, stomatal conductance as well as transpiration rate, radiation interception and radiation use efficiency were also found to be of higher value in plants raised from magnetically treated seeds as compared to the



corresponding value in untreated control. Number of fruits and fruits weight were also found to be significantly higher in magnetic treatment. The improved root parameters suggested that this technique may be useful for raising crop in rainfed or moisture stress conditions.

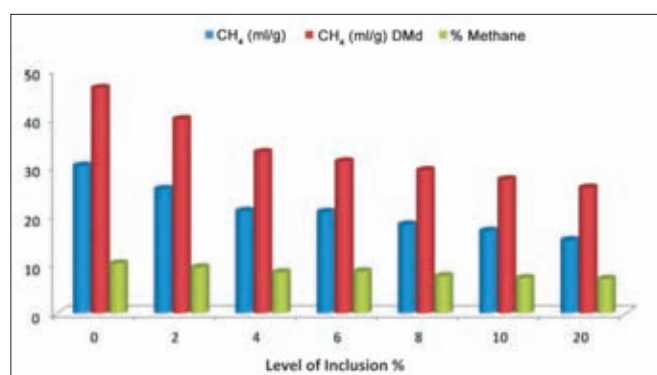
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Strategies to reduce enteric methane reduction from livestock using silkworm pupae oil

The fore-stomach (rumen) of ruminants possesses mini-microbial world that include bacteria, protozoa, fungi, archaea (methanogens), bacteriophages and archaeophages. These microbes reside and work in a syntrophic fashion where the end products of metabolism are utilized by the group of microbes. Methane is produced during anaerobic fermentation of ingested feed through the reduction of CO_2 with H_2 . In spite of the removal of unwanted fatal products (H_2 and CO_2) from the rumen, methanogenesis deprives host animals from a sizable fraction of energy (6-12% of intake) as it consists high calorific value, i.e. 55.65 MJ/kg. Moreover, methane is also a potent greenhouse gas with 25 times more global warming potential than carbon dioxide. Considering the acute shortage of feeds and fodders in the country, there is a need to search alternatives which could be used for the enteric methane amelioration from Indian livestock. The ICAR-NIANP, Bengaluru has initiated the research to evaluate silkworm pupae (*Bombyx mori*) pupae oil as methane suppressants. Silkworm pupae meal as a protein source has been used in animal feed, notably for monogastric species poultry, pigs and fish. Silkworm pupae oil is generally used in many industrial products such as paints, varnishes, pharmaceuticals, soaps etc.,

but there is no report available so far for using it as methane suppressants for livestock. *In vitro* results indicated that silkworm pupae oil can reduce methane emission up to a significant extent if used appropriately



Methane production as influenced by silkworm pupae oil supplementation

with straw and concentrate based diet. The institute has filed patent application claiming the anti-methanogenic properties of silkworm pupae oil.

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NEW INITIATIVES

Sprouted fodder – A revolution in livestock feed

ICAR-NIANP, Bengaluru developed an inexpensive method of producing mould-free sprouted fodder on low cost bedding material with minimum usage of water. The novel method alleviates the problems of hydroponic fodder production such as high cost, handling of very high moisture feed, risk of mould growth and continuous power requirement. Good quality cereal grains like maize/wheat/barley/oat or legumes like cowpea/horse-gram need to be cleaned

day in places with moderate climate, and up to 5 times in very hot and dry places. The sprouts need to be grown for about 6 days till seedlings are about 5 inches tall. A shelf made of shade net, bamboo poles and sticks with 5 racks of 6' length and 3' width will cost about ₹1,600. A more durable shelf of similar size made with iron angles, mesh and monofilament wire will cost about ₹6,000. The entire straw mat with fodder sprouts is rolled, taken out from the racks and



with water by removing floating wastage such as chaffy seeds, husk etc. The grains are soaked in a bucket of water for a day, taken out and dipped in 4% vinegar solution for 30 minutes to prevent mold growth. The grains are tightly wrapped with cloth and stored for 2 to 3 days in a dark place and kept moist to ensure rapid sprouting. Later, these sprouts are transferred on to the beds made of crop residues, placed on a gunny mat. Any of the locally available residues like straw of paddy/wheat/ finger millet/sorghum/bajra or sugarcane trash can be used to make 1 inch thick bed. Water needs to be sprinkled on the sprouts thrice a

used for feeding the livestock. A gunny mat with new batch of sprouted seeds can be placed on the emptied rack on a daily basis to ensure regular production. If maize grains are procured @ ₹14 per kg, cost of production will be over ₹4 per kg of sprouts. This method of sprout production is very useful for feeding lactating animals during lean seasons and also an effective contingency measure to tackle periods of green fodder deficit.

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NATURAL RESOURCE MANAGEMENT

Underutilized leafy vegetables ensuring nutritional security of tribal population of Jharkhand

Jharkhand is very rich when it comes to the variety of underutilized leafy vegetables both cultivated and wild, which constitute an integral part of the diet of resource poor tribal population. A sizable proportion of the consumed leafy vegetables is collected from wild and is sold in local markets in both fresh and dried form. These leafy vegetables most often come from short-lived herbaceous plants and also leaves or flowers of some woody plants. During the rainy season,

a large quantity of these leafy vegetables are harvested and dried in sun, to be consumed with cooked rice water in the form of soup during the lean period when the supply of vegetables is limited and prices are high. Leafy vegetables are considered to be among the most nutritious vegetables and play a significant role in reducing micronutrient deficiency providing nutritional security to the tribal population of rural Jharkhand; however no systematic information

NATURAL RESOURCE MANAGEMENT

Nutritive and antioxidative properties of underutilized leafy vegetables of Jharkhand

Nutrients/Antioxidants	Range	Rich Sources
Calcium (mg/100g)	125.8-1737.8	<i>Amaranthus spinosus</i> L., <i>Cassia tora</i> L., <i>Ipomoea batatas</i> (L.) Lam., <i>Centella asiatica</i> (L.) Urban
Iron (mg/100g)	7.2-61.3	<i>Amaranthus gangeticus</i> L., <i>Ipomoea aquatica</i> L., <i>Chenopodium album</i> L., <i>Amaranthus viridis</i> L.
Magnesium (mg/100g)	254.3-1233.7	<i>Amaranthus gangeticus</i> L., <i>Amaranthus spinosus</i> L., <i>Basella alba</i> L., <i>Ipomoea batatas</i> (L.) Lam.
Potassium (mg/100g)	98.5-4516.1	<i>Chenopodium album</i> L., <i>Centella asiatica</i> (L.) Urban, <i>Amaranthus viridis</i> L., <i>Amaranthus spinosus</i> L.
Phosphorus (mg/100g)	26.7-525.3	<i>Amaranthus gangeticus</i> L., <i>Amaranthus viridis</i> L., <i>Centella asiatica</i> (L.) Urban, <i>Basella alba</i> L.
Zinc (mg/100g)	1.5-9.9	<i>Basella alba</i> L., <i>Centella asiatica</i> (L.) Urban, <i>Chenopodium album</i> L., <i>Amaranthus spinosus</i> L.
Vitamin C (mg/100g)	2.41-56.25	<i>Moringa oleifera</i> Lam., <i>Cissus adnata</i> Roxb., <i>Marsilea minuta</i> L., <i>Hibiscus cannabinus</i> L.
Fibre (g/100g DW)	5.7-29.9	<i>Basella alba</i> L., <i>Cissus adnata</i> Roxb., <i>Bauhinia variegata</i> L., <i>Centella asiatica</i> (L.) Urban
Antioxidant activity (mg AEAC/100g)	151.4-2159.8	<i>Cassia tora</i> L., <i>Amaranthus spinosus</i> L., <i>Hygrophila spinosa</i> T. Anders, <i>Moringa oleifera</i> Lam.
Total phenols (mgGA/100g DW)	6.2-65.74	<i>Ipomoea batatas</i> (L.) Lam., <i>Hygropila spinosa</i> T. Anders, <i>Ficus geniculata</i> Kurz, <i>Hibiscus cannabinus</i> L.



Amaranthus gangeticus L.



Ipomoea aquatica L.



Basella alba L.



Cassia tora L.



Ipomoea batatas (L.) Lam



Ficus geniculata Kurz

is yet available regarding the nutritional composition of these lesser known leafy vegetables. A study was undertaken to identify underutilized leafy vegetables both wild and cultivated, consumed by tribal people of Jharkhand and their nutritional profiling including the antioxidant potential. A survey was conducted in eleven districts of Jharkhand (Ranchi, Khunti, Gumla, Lohardaga, West Singhbhum, Ramgarh and Hazaribagh, Saraikela Kharsanwa, East Singhbhum, Bokaro and Giridih) and a total of 30 underutilized leafy vegetable species were identified. The underutilized leafy vegetables identified during the study were found to be a rich source of various minerals (calcium 125.8 - 1737.8 mg/100g; Iron 7.2 - 61.3 mg/100g; phosphorus 26.7 - 525.3 mg/100g; magnesium 254.3 - 1233.7 mg/100g; potassium 98.5 - 4516.1 mg/100g; zinc 1.5 - 9.9 mg/100g), vitamin (vitamin C 2.41 - 56.25 mg/100g) and fibre (5.7 - 29.9 g/100g DW). The high antioxidative potential of these leafy vegetables was indicated by high total

antioxidant activity (151.4 - 2159.8mg AEAC/100g) and high phenolic content (6.2 - 65.74mgGA/100g DW) that helps to reduce the oxidative stress and thereby plays a role in health management. The study indicates the potentiality of these inexpensive, easily accessible but lesser known leafy vegetables as source of unconventional foods. There is good potential to include other popular species identified in this study in the cropping pattern and home gardens of tribal



Local vendors selling fresh leafy vegetables (left) and dried leafy vegetables (right) at a tribal market

farmers of the state. Consumption of such valuable vegetables should be encouraged through awareness so that larger section of population could include these vegetables in their dietary menu to get the nutritional as well as health benefits.

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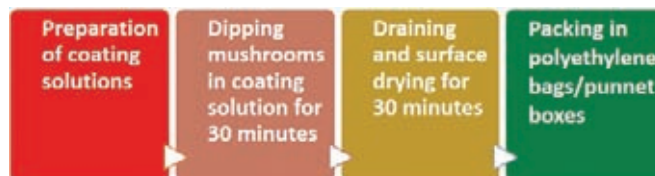
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Edible coating extends shelf-life of button mushrooms

Postharvest browning of *Agaricus bisporus* (button) mushrooms due to enzymes is a serious problem that reduces the acceptability of harvested mushrooms. The intact mushrooms lose their commercial value within a few days due to senescence, water loss, microbial attack and browning. Various packaging and blanching techniques have been tried to prevent browning in mushrooms but to a limited success.

Application of edible coatings can improve the shelf-life of perishable fruits and vegetables including mushrooms. Chitosan, glycerol and CMC (carboxy-methyl cellulose) based coatings incorporated with whey protein and ascorbic acid were tried for mushrooms to prolong the shelf-life and prevent enzymatic browning in harvested mushrooms. After coating, fresh mushrooms were analyzed for quality attributes. The coated mushrooms were stored under refrigerated conditions and analyzed for changes in quality attributes each day for a period of 12 days. Edible coating consisting of 2% ascorbic acid +

Methodology



Quality changes in coated and non-coated button mushroom

Attribute	Coated mushroom	Non-coated mushroom
Tyrosinase activity (units/mg substrate/min)	112.84	317.21
Polyphenolase activity (units/mg substrate/min)	88.21	221.652
Enzymatic browning (OD)	0.147	0.438
Δ TSS (12 th day mushrooms)	1.1	2.8
% Wt. loss (12 th day mushrooms)	18.96	42.36
ΔE (total change in color-12 th day)	14.82	44.46



Freshly harvested mushrooms



Edible coated mushroom in punnet boxes

0.15% CMC was most effective for extending shelf-life of fresh mushrooms up to 12 days at refrigerated conditions.

Urgent Attention of Contributors

For high quality presentation, designing and print quality of the *ICAR News*, We request all our contributors to make sure that following points are taken care of before sending the articles:

- Text matter with photographs and captions may be provided in **MS Word**; no PDF files please.
- Good quality photographs **in original form i.e. high resolution jpeg files** without any effects, need to be given separately also.

– Editor

Salient advantages of the technology

- Edible coated mushrooms demonstrate 87.21% enzymatic browning inhibition.
- Coated mushrooms can be stored well up to 12 days under refrigerated conditions.
- Coating also provides moisture barrier properties to minimize weight loss.
- It is a simple technique that can be practiced at the farmer's level.
- It is a low cost technology.

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PROFILE

ICAR-National Research Centre for Orchids

A premier research institute working on orchids since two decades



The ICAR-National Research Centre for Orchids, Sikkim was established by ICAR, New Delhi on 5 October, 1996 based on the recommendations of the Planning Commission during the VIII Five Year Plan. The basic objective for setting up this centre was to provide research support to upcoming orchid industry, conserve and use orchid genetic resources available in the country.

For this, Sikkim state authorities handed over 19.02 acres of land with all other assets belonging to Regional Agricultural Centre to ICAR at Pakyong on lease basis for 99 years for establishing the centre. After a year during October 1997, the centre also took over the CPRS, Darjeeling from CPRI and established a regional campus for taking research activities on temperate orchids. Lately, one sub centre has been established in Chettali, in the premises of IIHR, Regional station, Karnataka for research on tropical orchids.

With the changing scenario of floriculture in the country,

MANDATE

- Applied and strategic research on conservation, improvement and culture of orchids for enhancing productivity and utilization.
- Transfer of technology and capacity building of stakeholders for enhancing and sustaining productivity of orchids.

VISION

- To act as premier centre for research and development activities related to orchid commercialization and sustainable utilization.

MISSION

- Science and technology driven development of orchid industry in the country.

the centre has modified its approach and thrust areas of research to meet the challenges.

Today, the focus is on development of marketable varieties/hybrids, molecular characterisation, standardisation of agro-techniques, post-harvest management, production of quality planting materials through tissue culture and creation of repository of information related to all aspects of orchids.

ICAR-NRCO Darjeeling campus

The Darjeeling centre has altogether 1.23 acres of land with well-developed tissue culture laboratory and experimental farms including climate controlled



Darjeeling regional centre, Darjeeling

polyhouse. The centre is mainly working on *Cymbidium*, *Coelogyne*, *Calanthe* and *Paphiopedilum* species.

INFRASTRUCTURE

The laboratory cum administrative building, two fibre houses, 18 medium cost polyhouses with micro-irrigation system, four net houses and four low cost polyhouses have been constructed on sloppy land for different experimental and conservation purposes.

The centre is also equipped with a automatic weather station to assist in carrying out research in



Tissue culture lab

different disciplines. Orchid sanctuary has been created on 4 acres of farmland covered with different species of trees for *ex-situ* conservation.

The institute has established tissue culture, genetics, molecular biology, horticulture, physiology and pathology laboratories.



Horticulture Lab

The centre has advance equipments for basic and applied research. Beside this, the institute has good conference hall and training hall.

The Agricultural Knowledge Management Unit (AKMU) earlier known to be ARIS Cell of the Institute is well established having 19 computers interlinked with LAN, photocopier machine, printers, scanner etc. To back up the orchid research in addition to facilities application software packages like SAS 9.3, SPSS, Gen Stat, word processing, database management system are also available.

Library

The library information system has been enriched with the subscription of several national and international journals, magazines and reports of horticultural importance. The library of the centre has a collection of about 1,582 books, 36 Indian journals and 5 international journals and published 3 books, 20 book chapters, 52 technical bulletins. More than 100 scientific research papers and popular articles were also published by the centre.



Journal section

Water harvesting structures (system)

The Institute arranged a perfect water harvesting system for sustainable procurement of rain harvested water to avoid the water crisis problems in unseasonal periods.

Major research programmes

- Conservation, characterization and sustainable use of diversity in orchids
- Genetic improvement of orchids for yield, quality and resistance to biotic and abiotic stresses
- Development and refinement of production and protection technologies for improvement of productivity, marketing and utilization of orchids
- Improvement of knowledge and skill of stakeholders for improving production of orchids

External funded projects

- DUS Testing on Orchids (PPV&FRA).
- Assessment of chemical and genetic divergence of some fragrant orchids of north-east India for sustainable improvement of community livelihood (DBT-TWIN Project-IIT, Kharagpur).
- National Mission on Himalayan Studies (NMHS, MoEF & CC, GOI) – Conservation, long-term ecological monitoring, GIS, DBMS, natural resources accounting methods and chemical profiling.
- Inventorization of gamma irradiation technology for orchid varietal improvement (DAE, BARC, GOI).

SALIENT ACHIEVEMENTS

CROP IMPROVEMENT

Germplasm collection and conservation

A total of 3,130 accessions belonging to 339 species in 87 genera were collected and maintained in orchidaria. The orchids collected from temperate regions were conserved at Darjeeling Campus while the tropical sub-ones were conserved at Pakyong.

Conservation Polyhouses

The institute is maintaining separate polyhouses for



NAGS poly house-1 (Sub-tropical)

conserving state flowers of 5 state orchids and 1 natural simulated polyhouse.

Conservation under Simulated Natural Habitat

In this method orchid plants were tied on the trees or planted under the shades of trees as that of nature.



recover from the other.



Conservation at low cost polyhouse

Thus the collections were duplicated and in the event of loss of the germplasm at one place helped to

Rehabilitation of Orchid Species of Sikkim in the Natural Habitat

Digital herbarium

Conventional herbarium has the disadvantage of getting spoiled overtime. Thus the concept of digital herbarium has been introduced by the Centre and till date around 30 species has been digitalized for future reference.



Compilation of the species photo plates

The orchid species were dissected properly and compilation of species was done by using photo plates digital photography. Currently, compilation of 70 species have been completed.



NAGS poly houses-2 (Tropical)

Varieties

Three (3) varieties were released and 12 new varieties were identified for release.

Documentation of traditional crop diversity of Sikkim

DNA Bank and NCBI Deposits: DNA isolated from 260 species. 65 DNA barcode sequences (ITS, matK, rbcL, trnH-psbA) were submitted to NCBI.

Patent Filed

Efficient method DNA extraction protocol for orchids (No. 826/KOL/2013).

DNA repository of orchids: The DNA of native orchids are being preserved under -80°C . Nearly 250 species samples were preserved carefully.

PPVFRA & DUS Guidelines

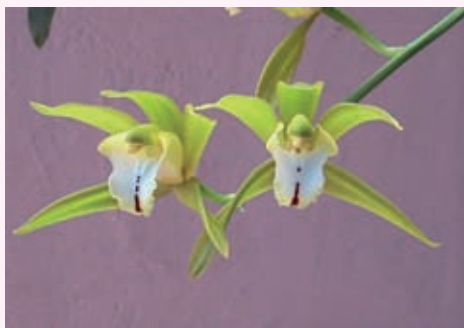
The centre has also developed the test guidelines for testing Distinctness, Uniformity and Stability for orchids by studying various phenotypic traits. DUS test guidelines for *Cymbidium*, *Dendrobium*, *Vanda*, *Oncidium*, *Cattleya* have been notified and completed. The DUS test guidelines for *Paphiopedilum* are being developed.

SALIENT ACHIEVEMENTS

Crop Production

Mass multiplication of tissue cultured plants: For production of quality planting material the tissue culture laboratories were strengthened at main Centre and Darjeeling Campus. The protocols for mass multiplication of six *Cymbidium* hybrids have been standardized. Presently, 25,000 - 30,000 tissue cultured orchid plants are produced annually.

VARIETIES



Cymbidium 'B. S. Basnet'



Aranda 'Kung Gyatso'



PL x PW 19



Sheetal 1



Sheetal 2



PL x PW 10



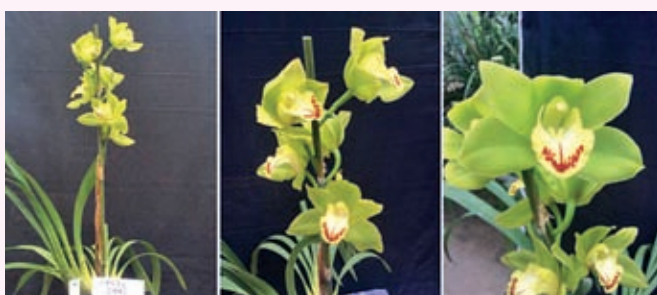
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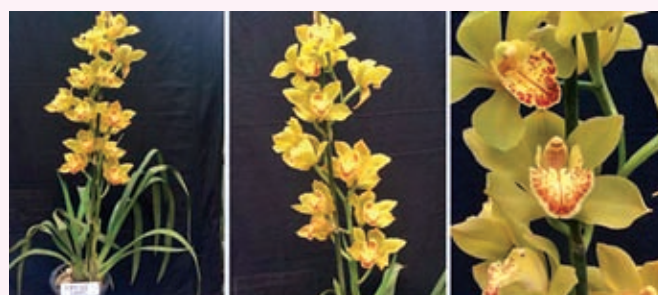
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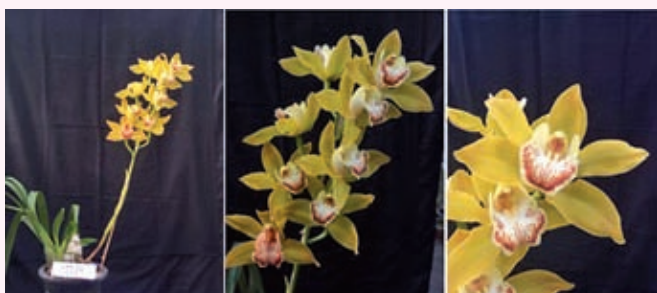
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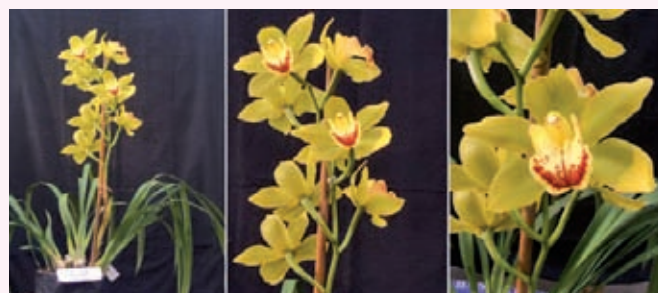
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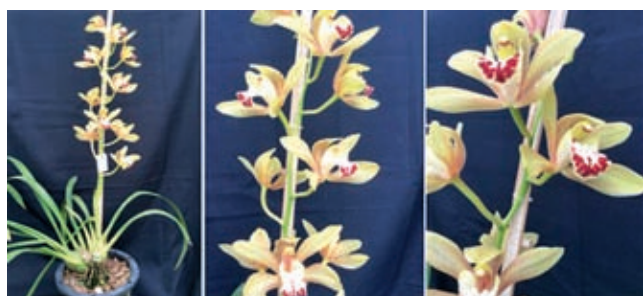
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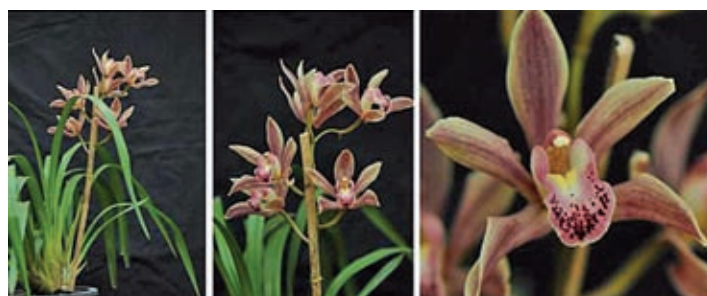
NRCODC/CMYH/1/6/91



NRCODC/CMYH/1/6/204



NRCODC/CMYH/2/6/1



NRCODC/CMYH/2/6/2

Success story: > 1,00,000 Quality planting material distributed in NEH region (under DBT project).

Propagation techniques: *In-vitro*, plantlets from back bulbs (*Cymbidium*) and *Lillium* propagation and *in-vitro* flowering developed.

Production management of tropical and sub-tropical orchids

- Orchid hybrids of *Cymbidium*, *Dendrobium*, *Vanda*, *Phalaenopsis*, *Cattleya*, *Mokara*, *Oncidium* and *Aranda* suitable for different altitudes identified.
- Techniques for round the year cultivation of *Dendrobium* developed by selecting different hybrids developed.

Standardization of growing media

Studies on different media and nutrition have helped to standardize different growing mediums in appropriate ratio and evolve optimum dose of fertilizers required to realize potential yield of selected orchids.

***Cymbidium*:** Leaf mould, coco chips and brick pieces (4:2:1)

***Dendrobium*:** Brick pieces and coconut husk (1:1)

***Coelogyne*:** Coco chips, tree bark, chopped sphagnum or green moss and brick/stone chips (1:1:1:1).

***Cattleya*:** Cocochips, tree bark, cocopeat and brick pieces (4:2:2:2)

***Zygopetalum*:** Leaf mould, charcoal, coconut husk, rotten logs (2:1:1:1).

***Phalaenopsis*:** Gravel stones and brick pieces (1:1)

Optimization of nutrient requirement

Cymbidium

- A solution of 30:10:10 NPK at 0.1% at 15 days interval (1 year old plants).
- 20:20:20 NPK at 0.1% at 15 days interval (2 year old plants).
- 15:25:25 NPK at 0.1% at 15 days interval (reproductive stage).

Post-harvest technology

Post-harvest studies on vase life, standardization of

harvesting stages, pulsing and impregnation, holding solutions, and effect of chemicals on bud opening for a number of orchid species and hybrids have been evaluated.

- Pulsing with 5% sucrose increases the vase life of *Cym. 'PCMV'* (56 days).
- 3.2% cane sugar as holding solution had maximum longevity of first floret (54 days), zero per cent of flower dropping, maximum solution uptake (24 ml) and highest vase life (61.2 days) followed by 4% cane sugar.
- In opening of tight bud of *Cymbidium* hybrid, treatment with 4% sugar + 200 ppm salicylic acid gave highest per cent (75%) of fully opened flowers with maximum vase life (45 days).

Packaging of spikes and single flowers

ICAR-NRCO developed different packaging and drying techniques for making other economic products. The spikes can be utilized as loose flowers and can be made into single flower packages or small arrangement packages as souvenirs and gifts.

Crop Protection

Management spotted mites, *Tetranychus urticae* Koch in orchids

All active stages (nymph and adult) feed on under surface of leaves and flowers by sucking the cell sap from epidermal layer, especially along the midrib and the base. They remove plant juices from leaves which cause white to yellow stippling to occur on the foliage as chlorophyll is removed.

For management apply entomopathogenic fungi *Paecilomyces fumosoroseus* @ 2g/L of water. In severe conditions spray the crop alternatively with dicofol (Kelthane) or fosmite or omite (propagite) or bifenthrin (talstar) at 0.025% and repeat the spray at 10-15 days interval to provide effective control against mites.

Management of Anthracnose disease in orchids

The disease is caused by *Colletotrichum gloeosporioides* and *Colletotrichum orhiidacearum*.



Spikes after 30 days



Single flower packing and drying



Single flower clear box packing

Initial symptoms appear as small oblong to circular, oval, sunken and reddish brown to dark brown or gray coloured spots. On the spots black, raised dots are found with target board appearance. Die back of leaves are also observed if the leaf tip is attacked.

For management apply biocontrol agents *Trichoderma harzianum* 2% WP @4g/litre or *Pseudomonas fluorescens* @4g/litre at 15 days interval. In case of higher incidence of the disease, spraying of captain @ 2g/L/Blitox @2-3 g/Litre or Carbendazim+Mancozeb at 15 days intervals, will help.

EXTENSION SERVICES/HRD

Tribal Sub Plan (TSP)

- To create basic infrastructural facilities for promotion of orchid cultivation as an integrated approach with floriculture.
- To supply quality planting material / seeds, manures and pesticides keeping in view of organic cultivation.
- To train and demonstration on orchid production and pest management under IPM at both off-site and on-site.
- Consultation with state institutions and departments.
- Survey and assessment for selection of different locations.
- Awareness programmes.
- Polyhouses for demonstration.
- On-site and off campus training on orchid cultivation and floriculture.
- Asset transfer to SHGs/ farmers.
- Monitoring and evaluation.
- Feedback and re-orientation.
- Expansion to other North-Eastern states/ other location.



Demonstration and Distribution of kits

Mera Gaon Mera Gaurav

- Baseline survey conducted.
- Telephonic advice and email communications – 51.
- Total no. of farm visits – 46.
- Gosthis / meetings conducted – 7.
- Total general awareness programme arranged – 8.
- No. of farmers benefitted by creating linkage with state department officials and all other programmes – 716.

Memorandum of Understanding (MoU)

- CAU-NRCO signed MoU for collaborative orchid research
- ICAR-NRCO signed MoU with JNTBGRI, Trivandrum, Kerala for orchid research to promote and develop collaborative linkages to share their technologies.

Future Thrusts

- Collection, maintenance, documentation and conservation of germplasm.
- Morphological and molecular characterization of important germplasm to safeguard valuable indigenous generic resources.
- Strategic development of new improved varieties with genetic potential.



Growth Chambers



Growth Chambers – Inside

- Development of potential hybrids with high yield, quality and tolerance to biotic and abiotic stresses.
- Development of protocol for mass multiplication of improved varieties/hybrids of orchids and bulbous flowering plants.
- Development of production technology for increasing productivity of new hybrids/varieties of commercial orchids.
- Standardization of pre- and post-harvest techniques for reducing the storage and transport losses.
- Promotion of integrated disease and pest management programme.
- Disseminate technologies through vibrant training programme, demonstration, publication and mass media.
- To prepare the database and compilation of data by providing micro processing facilities.
- Promoting human resource development on relevant discipline.
- Strengthening floricultural research information system with special reference to orchids.

D.R. Singh

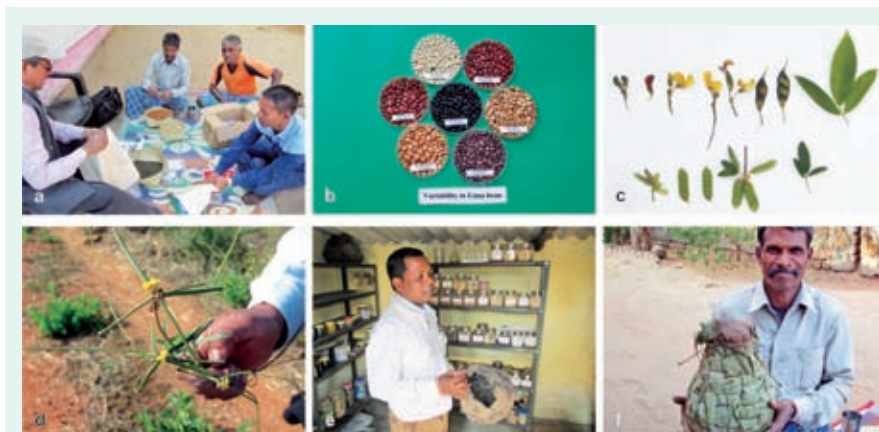
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Collecting germplasm in legumes and their wild relatives from Bastar Region of Chhattisgarh, India

Legumes play an important role in meeting the food and nutritional requirement of the tribal communities/marginal farmers. Diversity in several leguminous crops has been maintained in rainfed upland/ *jhum* lands/backyards/kitchen garden since long past by the tribal communities (Dugga, Usendi, Nag, Salam, Dhruva,

to this region was occurring naturally with sparse population in dense and open forest areas at 970m in Bailladila Range, Dantewada district, which is considered as home of this wild legume and first time collected from this region; *Cajanus scarabaeoides* and *Mucuna pruriens* var. *pruriens* observed in natural/ disturbed and partially

disturbed forest area in all the districts; while *Vigna stipulacea* was occasionally found in partially disturbed area mainly in moist locality around field border in Brehebeda area of Narayanpur district only. Being tribal dominated area, the local tribes are rich in traditional culture and apply their own indigenous method/process in preparation of food recipes, like 'Pej' – a local dish mainly prepared from horse gram seeds, a very delicious and energetic dish, supposed to be an emergent food because if taken once; there is no feeling of hunger throughout the day. Similarly, a storage bin made up of leaves of *Bauhinia vahlii*



Collecting legumes from farmers (a) diversity in wild legumes (*Cajanus scarabaeoides*, *Cajanus cajanifolius* and *Vigna stipulacea*); (b,c,d) grain variability in *Phaseolus lunatus*; (e) local seed genebank maintained by farmer and (f) tribal farmer with seed bin made up of *Bauhinia vahlii* leaves

Potaie, Matlam, Morya, Baghel, Kashayap, Atami, Bhaskar, Vanzam, Midyam, Sodi, Mandavi, Koram) inhabiting remote localities of Bastar Region of Chhattisgarh. Considering the richness and importance of crop diversity in the region, an area specific exploration was undertaken as per National exploration plan 2016-17 and a total of 71 accessions in cultivated species comprising horsegram (11), urdbean (11), pigeon pea (9), cowpea (9), lima bean (9), rice bean (4), sem bean (4), yard long bean (3), mungbean (3), velvet bean (1) and wild legumes namely *Cajanus cajanifolius* (1), *Cajanus scarabaeoides* (1), *Vigna stipulacea* (1), *Mucuna pruriens* var. *pruriens* (4) were collected from Narayanpur, Bastar, Dantewada and Sukma districts of Chhattisgarh during January 2017.

Considerable variability in seed shape, size and colour was observed mainly in lima bean, which has been perhaps introduced as kitchen garden crop from southern India. Other crops such as cowpea, lablab bean and pigeon pea were also collected with significant variability. Most of the legumes namely horse gram, mung bean, urd bean, lima bean, yard long bean, pigeon pea, rice bean are sold in the local markets (*Haats*) by the tribes as a source of income. Of the wild relatives, *Cajanus cajanifolius*, a close relative of pigeon pea and endemic

– a huge leguminous climber locally known as 'Denda' – is used for storage of grains legumes, which keeps seeds insects and pests free till next season. It is a well known fact that grain legumes are highly prone to bruchid insects, and pest free storage is a major problem.

Factors like introduction of improved cultivars, change in food habits, climate change, least interest of young generation in agriculture, low income and fast modernization are weaning away the young generation from their traditional systems. Owing to these reasons, a significant loss of valuable crop diversity and indigenous traditional knowledge has been noticed during the survey in the region. However, realizing the reduction of local crops diversity and wild plant genetic resources many framers are putting their sincere efforts in maintenance of crop diversity in the form of community gene bank and are mobilizing and creating awareness among others to conserve the valuable plant genetic resources on farm for sustainability.

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Pre-harvest sprays of ethylene inhibitors improved the postharvest shelf life and quality of Amrapali mango fruits

Mango (*Mangifera indica* L.) is an economically important fruit crop, known for its delicious taste, exceptional flavour and high nutritive value. Being metabolically active even after harvest, the fruits keep well only for 5-6 days as they attain full ripe stage and deteriorate eventually. Several postharvest

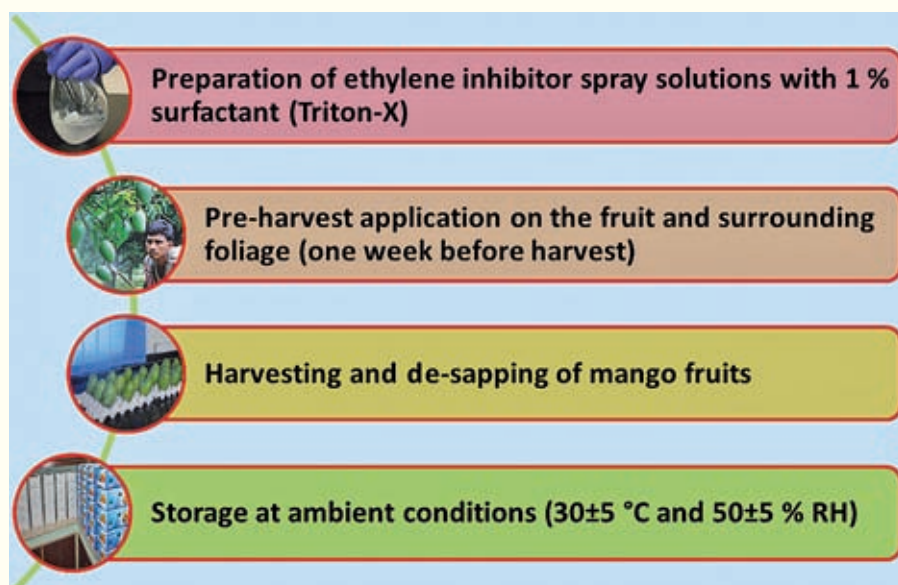


Treated fruits

Untreated fruits

Mango fruits after 9 days of storage

Methodology



treatments are in vogue for enhancing the shelf life of fruits, yet research is going on to find out still better approach(es) for extending the shelf life and maintaining the postharvest quality of fruits during storage and subsequent marketing. Late pre-harvest exogenous application of various compounds is gaining importance as this provides enough pre-harvest interval (PHI) for the chemical residues to disintegrate. Under this paradigm, we have tried three different plant growth regulators viz.

Comparison of the quality of treated and untreated fruits

Parameter	Control fruits	Treated fruits
Storage life (days)	6.0	9.0
Physiological loss in weight (%)	9.46	5.07
Texture (N)	9.09	22.73
Total colour change (ΔE)	20.12	10.47
Ethylene production rate ($\mu\text{l C}_2\text{H}_4 \text{ kg}^{-1} \text{ h}^{-1}$)	2.32	0.21
Respiration rate ($\text{ml CO}_2 \text{ kg}^{-1} \text{ h}^{-1}$)	176.52	75.31
Soluble solids content ($^{\circ}\text{B}$)	22.18	17.70
Titrateable acidity (%)	0.54	1.38
Total antioxidant activity ($\mu\text{mol Trolox g}^{-1}$)	639.16	694.20
Malondialdehyde content (nmol g^{-1})	4.48	1.12
Pectinmethylesterase activity ($\mu\text{mol acid min}^{-1}$)	0.186	0.122
Ascorbic acid content ($\text{mg}/100 \text{ g}$)	21.39	23.25

amino ethoxy vinylglycine (AVG), salicylic acid (SA) and sodium nitroprusside (SNP) as an NO donor each at three different concentrations.

Major advantages and practical implications

- Sodium nitroprusside @ 100 μM extended the shelf life of treated mangoes up to 9 days.
- Pre-harvest application of SNP would enable the farmers to harvest the mango fruits at optimum maturity and allows them to ripe at the will of stake holders.
- Helps farmers/wholesalers/traders to store or transport their perishable mangoes to longer distances at ambient conditions.
- Facilitates processors to procure raw materials from longer distances with low investment on non-refrigerated carriers.
- Cost-effective with Benefit : Cost ratio 7.94.

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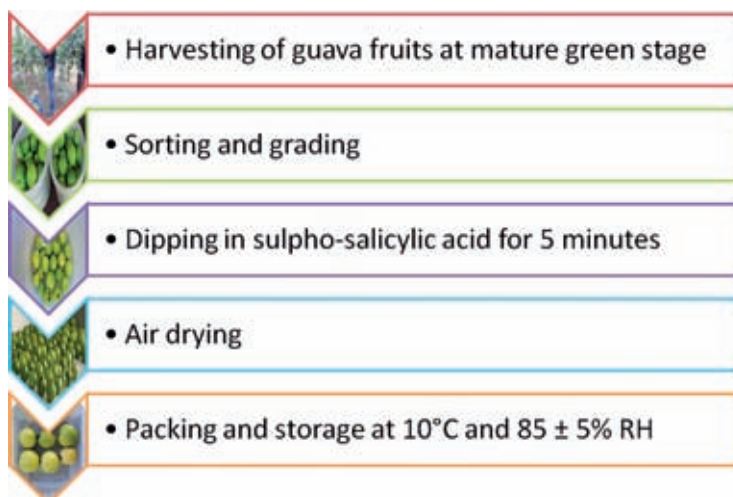
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Sulfo-salicylic acid for maintaining freshness of guava fruits

Guava (*Psidium guajava* L.) is the fifth most important fruit crop of India and is consumed fresh or processed into juices, purees, jams and jellies. It is a climacteric fruit and ripens rapidly after harvest making it a highly perishable fruit with a short shelf-life of only 2 to 3 days at ambient temperature. The short postharvest life and susceptibility to chilling injury during cold storage and incidence of postharvest diseases limits the potential for long distance transportation and commercialisation of guava. Hence, postharvest interventions are required to make it available for longer time in the market. Although, several postharvest treatments have been attempted but 5-sulfosalicylic acid (SSA), a derivative of salicylic acid (SA), has not been attempted in our country. SA has been reported to delay the ripening and softening, reduces lipid peroxidation and chilling injury in fruits. An attempt has been made for extension of storage life of guava fruits cv. Allahabad Safeda by application of SSA. The treated fruits after every storage interval of 3 days, were transferred to ambient conditions ($20 \pm 2^\circ \text{C}$) for three

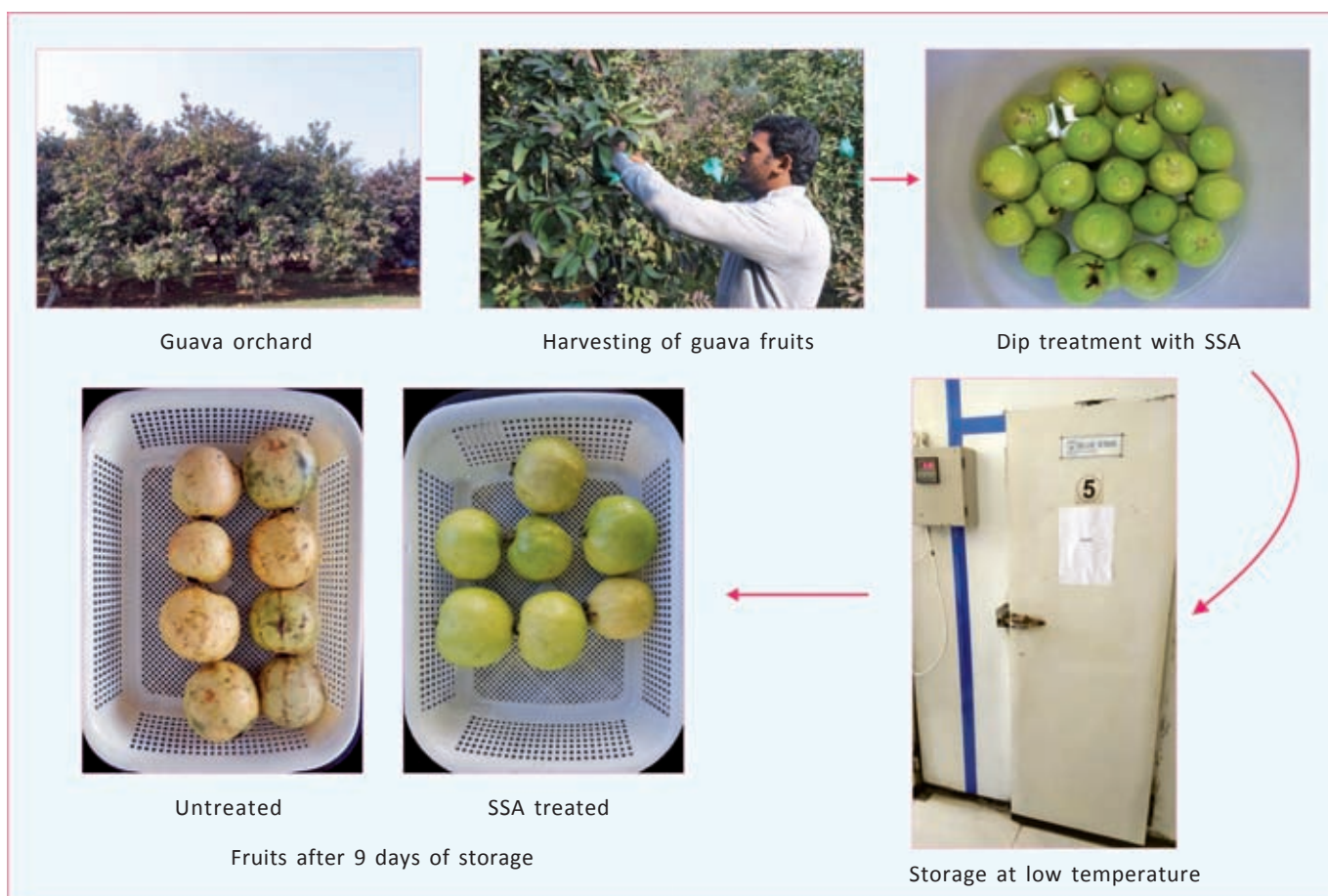
Methodology



days to simulate the market conditions and check the effectiveness of the treatment.

Advantages of the technique

- Sulfo-salicylic acid treatments extends marketability of guava fruits up to 9 days.



Fruit quality of sulfo-salicylic acid treated vs untreated fruits

Quality attribute	Treated	Untreated
Total soluble solids (°B)	8.5	10.5
Ascorbic acid (mg/100g)	213	202
Total phenols (mg GAE/100g)	138	106
Total antioxidant activity (µmoles TE/g)	10.89	6.66

- Postharvest treatment delays weight loss, fruit softening and colour change.

- The treatment can help in long distance marketing of guava fruits with minimal quality loss.
- It is a farmer friendly technique that can be carried out easily on the farm itself.
- It is a cost-effective technique.

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Resilience capacity of goats to multiple environmental stresses

In the present changing climate scenario, there are numerous stresses other than the heat stress, which constrain the livestock and have severe consequences on their production. The projected climate change seriously hampers the pasture availability especially during the period of frequent drought in summer. Thus, livestock suffer from drastic nutrition deficiency. Both the quantity and the quality of the available pastures are affected during extreme environmental conditions. Further, with the changing climate, animals have to walk long distances in search of pastures. This locomotory activity also put the livestock species under enormous stress. The majority of domesticated ruminants are raised solely or partially in semi-extensive or extensive production systems in which most nutrients are derived from grazed forage. The grazing animals in the tropical areas usually have access to poor quality food available at lower densities per unit area, and to counter such hardship, animals increase their grazing time and disperse widely. Hence it is not only the heat stress that need to be counteracted but the nutrition and walking stress are also of great concern. Though the animals live in a complex world, researchers most often study the influence of only one stress factor at a time because comprehensive, balanced, and multifactorial experiments are technically difficult to manage, analyze and interpret. When exposed to one stress at a time, animals can effectively counter it, based on their stored body reserves and without altering the productive functions. However, if they are exposed to more than one stress at a time, the summated effects of the different stressors might prove detrimental to these animals. Such a response is attributed to animals' inability to cope with the combined effects of different stressors simultaneously. In such a case, the animals' body reserves are not sufficient to effectively counter multiple environmental stressors. As a result their adaptive capabilities are hampered and the animals struggle to maintain normal homeothermy. Thus it is concluded that

if two or more stressors occur simultaneously, the total cost may have severe impact on biological functions of the animals.

A study was conducted to assess the resilience capacity of Osmanabadi goats subjected to combined stress (heat and nutritional). The primary objective of the study was to evaluate the influence of two environmental factors, heat and nutritional stress simultaneously on the adaptive capability of goats. The study was conducted for a period of 45 days. Twenty-four adult bucks were used in the study. The bucks were randomly allocated into four groups of six animals each, viz. C (n = 6; control), HS (n = 6; heat stress), NS (n = 6; nutritional stress), and CS (n = 6; combined stress). The animals were stall fed with a diet consisting of 60% roughage (hybrid napier) and 40% concentrate (maize 36 kg, wheat bran 37 kg, soybean meal 25 kg, mineral mixture 1.5 kg, and common salt 0.5 kg/ 100 kg of feed). The C and NS bucks were maintained in the shed in thermo-neutral condition while HS and CS bucks were exposed outside to summer heat stress between 10:00 am and 4:00 pm to expose them to heat stress. The C and HS bucks were provided with *ad lib.* feeding while NS and CS bucks were provided with



Control and nutritionally stressed groups



Heat and combined stress groups

restricted feed (30% of intake of C bucks) to induce nutritional stress. All four groups of animals were fed and watered individually throughout the study period. Blood samples were collected at fortnightly interval. The animals were slaughtered at the end of study for collecting important organs for selective gene expression. The study was conducted after obtaining approval from the institute ethical committee for subjecting the animal to both heat and nutritional stresses.

The results from the study indicated that summer season-related heat and nutritional stress influenced the adaptive capability of Osmanabadi goats. The findings from the study indicated that bucks subjected to HS and NS separately had less detrimental effects on buck's adaptive capability. However, when both these stresses were coupled in the CS group, it had serious consequences

on adaptive capability of these bucks. Hence, it is very pertinent to conclude that when two stressors occur simultaneously, the total impact on biological functions necessary to adapt to the stressful conditions may be severe. The study also indicated the significance of providing optimum nutrition to improve the adaptive capability of Osmanabadi goats to heat stress.

Multiple stressors

The study indicated that lying time, drinking frequency, respiration rate (RR), rectal temperature (RT), plasma cortisol, tri-iodo-thyronine (T_3), thyroxine (T_4) and HSP70 may act as ideal biological markers for assessing the impact of CS on the adaptive capabilities in bucks. Further, plasma growth hormone (GH), interstitial growth factor 1 (IGF-1) and leptin and growth hormone receptor (GHR) gene were identified to be the biological markers to assess the multiple stresses impact on the productive performance of goats. In addition, the significantly higher expression of HSP70 in PBMC, liver and adrenal indicated that this gene can act as typical molecular marker for assessing the resilience capacity of goats to multiple environmental stresses. Furthermore, the higher expression pattern of TLR3, TLR4, TLR6, and TLR8 in lymphoid organs indicated that these genes may act as immunological markers for multiple environmental stresses in goats.

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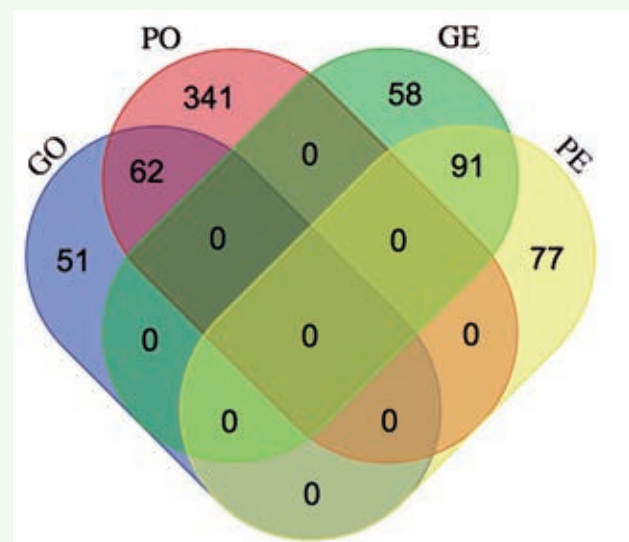
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RNA profile in sheep oocytes and embryos to assert developmental competence

To improve the success rate of *in vitro* embryo production, the quality of oocyte is utmost important. Whole transcriptome analysis of the BCB screened germinal vesicle (GV) stage sheep oocytes (N=10) revealed a total number of 14,350 and 16,657 transcripts, respectively in BCB+ (developmentally competent) and BCB- (developmentally poor) oocytes. A significant differential expression (≥ 1.5 fold) of 2,369 transcripts was observed between the groups. GO-ontology analysis of the significantly up-regulated genes in each sample indicated that the processes/functions related to blastocyst development, cell division, mitosis and meiosis, cell proliferation and differentiation, chromosome segregation, nucleic acid metabolic process, establishment of organelle localization, histone modification and protein ubiquitination, and translation

were enriched in BCB+ oocytes. Based on KEGG pathway analysis, 23 enriched pathways/functions in BCB+ oocytes were identified that hold promise for manipulating oocyte/embryo development competence.

Whole transcriptome analysis of the 2-cell stage embryos (N=10) generated from BCB screened GV stage sheep oocytes was performed. Total number of 17,480 and 16,642 transcripts were detected, respectively in the embryos generated from BCB+ and BCB- oocytes. A significant differential expression (≥ 1.5 fold) of 1,631 transcripts was observed between the groups. GO-ontology analysis of the significantly up-regulated genes in each sample indicated that the processes/functions related to the regulation of macromolecule metabolic process, nucleic acid metabolic process, post-translational



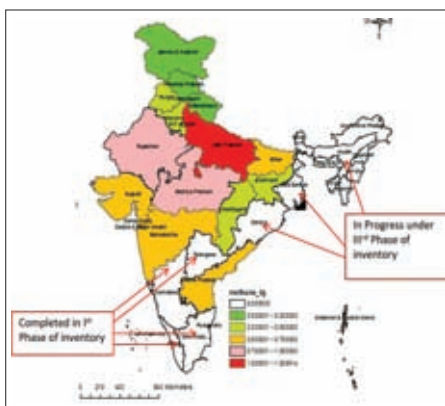
Presence of unique transcripts in oocytes and 2-cell embryos in sheep. GO: BCB+ GV oocytes; PO: BCB- GV oocyte; GE: 2-cell embryos generated from BCB+ GV oocytes; PE: 2-cell embryos generated from BCB- GV oocytes

protein modification, germ cell migration, protein transport and localization, chromosome segregation, cell division and mitosis were enriched in the embryos generated from BCB+ oocytes. Based on KEGG pathway analysis, 19 enriched pathways/functions in the embryos generated from BCB+ oocytes were identified that hold promise for manipulating oocyte/embryo development competence. When gene expression profiles were compared between oocytes and embryos, 149 and 168 transcripts could be detected only in good and poor embryos respectively, but not in oocytes. Results indicated that these transcripts were either delivered through sperm during the process of fertilization or contributed through the embryo's own gene activation.

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State wise enteric methane emission inventory

The ICAR-National Institute of Animal Nutrition and Physiology has made an attempt to develop state wise annual enteric methane emission inventory based on the methane production potential of representative feed samples and diet combinations, feeding practices being followed in different agro-climatic zones of the country. While developing the inventory important factors such as livestock population (19th census, DAHDF, GOI), sex, physiological stage (growing, lactating, adult), seasonal variability in feed resources were also taken into consideration. So far enteric methane emission inventory has been developed for 18 states from North, West and Southern India.



WAY FORWARD

*S*KILL development plays a vital role in improving labour market outcomes and economic growth. India currently faces a severe shortage of well-trained, skilled workers. It is estimated that only 2.3% of the workforce in India has undergone formal skill training as compared to 68% in the UK, 75% in Germany, 52% in USA, 80% in Japan and 96% in South Korea (National Skill Development Mission).

India is one of the youngest nations in the world, with more than 54 % of the total population below 25 years of age and over 62 % of the population in the working age group (15-59 years). The country's population pyramid is expected to bulge across the 15-59 year age group over the next decade. It is further estimated that the average age of the population in India by 2020 will be 29 years as against 40 years in USA, 46 years in Europe and 47 years in Japan (National Higher Education Mission, Ministry of Human Resource Development, 2013). In fact, during the next 20 years, the labour force in the industrialized world is expected to decline by 4%, while in India it will increase by 32%. This poses a formidable challenge and a huge opportunity. This demographic advantage is predicted to last only until 2040.

India's annual skilling capacity was estimated at approximately 7 million during the period 2013-2014. Apart from meeting its own demand, India has the potential to provide a skilled workforce to fill the expected shortfall in the ageing developed world.

National Policy for Skill Development and Entrepreneurship 2015, which supersedes the policy of 2009, aims to meet the challenge of skilling at scale with speed, standard (quality) and sustainability. Skill development is the shared responsibility of the key stakeholders viz. Government, the entire spectrum of corporate sector, community based organizations, those outstanding, highly qualified and dedicated individuals who have been working in the skilling and entrepreneurship space for many years, industry and trade organisations and other stakeholders. The policy links skill development to improved employability and productivity in paving the way forward for inclusive growth in the country. The skill strategy is complemented by specific efforts to promote entrepreneurship in order to create ample opportunities for the skilled workforce.

The Indian Council of Agricultural Research (ICAR) is contributing to the needs of skill development of young farmers and farm women through its network of 673 Krishi Vigyan Kendras (KVKs) across the country. KVKs impart training to farmers, farm women and rural youth in broad based agricultural production systems. The KVKs organize



Dr T. Mohapatra, Secretary (DARE) and Director General (ICAR)

vocational training courses through innovative training approach based on the principle of "learning by doing and practicing" and systematic follow-up activities like ex-trainees sammelan, personal visits, village and block level meetings, etc. Moreover, the courses are need-based and flexible to cope with the needs of the young farmers, practicing farmers and farm-women of the area.



The commodity based ICAR Institutes are also regularly conducting long duration training programmes on mushroom production, scientific dairy farming, clean milk and milk products preparation, honey production, farm machinery, etc. for rural youth and farmers to develop entrepreneurship. Many of the institutes are successfully running incubation centers to groom entrepreneurs and develop their profit making ventures in agriculture and allied sectors.

The Agricultural Extension Division of ICAR is implementing the Skill Development Training programmes on the Qualification Packs (QPs)/Job Roles developed by Agriculture Skill Council of India with the financial support from RKVY of DAC&FW. During 2016-17, 100 KVKs conducted 200 courses of 200 hours each on 34 QPs for development of skills in rural youth with the budgetary support of ₹3,21,62,400 from RKVY. During 2017-18, 250 KVKs, 38 SAUs and 42 ICAR Institutes will organize 986 such courses on 78 QPs.

The Council is thus augmenting the Government initiatives and providing sustainable delivery mechanisms for efficient skilling in agriculture by involving various stakeholders by identifying their training needs and also by providing handholding so as to enable Indian agriculture more professionals and profitable.

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