Open Access Multidisciplinary Online Magazine

Agri-India TODAY

Monthly e-Newsletter

Volume 01 | Issue 02 | February 2021

www.agriindiatoday.in

Editorial Board

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[Article ID : 01/II/01/0221]

JAWAHAR MODEL FOR DOUBLING INCOME OF RESOURCE CONSTRAINED MARGINAL FARMERS: ECOLOGICAL AND ECONOMIC BENEFITS

Moni Thomas*, Shivam Vajpayee, Rahul Patidar, Sumit Kakade, Ankit Khichi, Vishal Raut, Dhaneshwar B Patil, Gopilal Anjana and Sahab K Patel, Niraj Tripathi, P.K. Mishra

Directorate of Research Services, Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur 482004, India
*Corresponding author: moni_thomas@rediffmail.com

Abstract
Small and marginal farmers (SMFs) are the major group of farmers in India, constituting 81 percent. These resource poor and distressed group, together contribute substantially to the national food basket. Yet their mean monthly income is just around Rs.6426. Introduction of cash crops in their crop production system can be one of the storage to increase or double their household income. Jawahar model developed by Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a low input versatile and adoptable option to double income of SMFs in India.

Keywords : Agriculture system, Cash crop, Diversification, Intensification, Socioeconomic

Background
Low net return from crop production especially among small and marginal farmers (SMFs) is one of the many causes of farmers' distress. In India, SMFs constitute about 81 percent and in MP it is 71 percent. The national mean monthly household income of farmers in India is around Rs 6426 and Rs 6210 in MP. The land holdings of SMFs range from less than an acre to five acres, but their contribution to the national GDP significant. Majority of the farmers in this group are resource constrained and practice rainfed farming. Rainfed farmers are sometimes also referred as Critical diverse risk prone farmers (CDR), due to the multitude challenges and constrains they face in their fragile and hostile farming situations.

SMFs, thus are the most productive group and together they contribute 82 percent to the national food basket, overcoming their CDR situations at ground level. Evidently, to improve the micro-economy the need is to be focused on improving the net returns among SMFs. Doubling of farmers income (DFI) and Per drop more crop(PDMC) are the national focal points in the farm sector. Cash crop can play a vital role in DFI as well adoption of micro-irrigation system of SMFs for PDMC. However, inclusion of cash crop as a component in the existing crop production system dominated by cereals and pulses is equally a difficult task. Initial investment for cash crop and drip irrigation system along with the gestation period of at least 2 to 3 years are the main factors that deter many of them, inspite of subsidiaries offered. Having always faced multiple risks, they avoid further risk even at the cost of productivity or net returns.

There is an intense search at local and national level for a reliable solution to the address distress and disparity of SMFs. Based on our over two decades of experience of promoting Lac production among resource poor SMFs and forest dependents in MP, we at JNKVV Jabalpur has developed and evaluated 'Jawahar model for doubling income of resource constrained marginal farmers (JM-DFI)'.

Jawahar model for doubling income of resource constrained marginal farmers (JM-DFI)

1. **Concept and components :** SMFs are rain dependent farmers. *Kharif* (July to October) is the main cropping season of majority of these SMFs, followed by a prolonged lean period till June,

when their fields remain fallow. Migration or non-agricultural activities for survival takes places during this period. Thus, the basic concept of JM-DFI was to help timely sowing of their crop without waiting for the rain; diversify their crop production system to minimise risks while ensuring inflow of cash at short intervals for financial growth; and finally engage farmers throughout the year in their own farm for social well being.

a. Flexibility

JM-DFI promotes flexibility in the choice of cropping pattern and enterprise, in accordance to the local climate, resources and demand. This gives the farmer an opportunity for small scale experimentation and innovation

b. Intensification & diversification

Rainfed farmers grow traditional crops - tolerant to moisture stress, generally as sole crops but many a times also as mixed or with intercrops. In any case the maximum cropping intensity rarely exceeds 125 percent. Farm income and cropping intensity are directly related while diversification ensures regular inflow of cash and minimises economic losses due to crop failures. In JM-DFI, though the main crop is a long duration pigeon pea but short to mid duration intercrops and associate crops add flavour of iintensification and diversification in the Model.

c. Low input

Higher farm productivity with minimum input cost or expenditure is another factor that has been taken care. The substrate mixture of Kapu, FYM and bio-fertilisers gradually drives the farmer to almost organic farming. Wider spacing and intercrops increases the diversity crops and insects that keep the pests under check, reducing the application of pesticides as well as the residue load of pesticides on the harvest.

d. Minimum disturbance

As almost all the crops are grown on substrate filled polypropylene bags of varying capacity and size, the field is not ploughed. No tillage and weeding reduce operational costs; additionally cause minimum disturbances to soil microbes in the rhizosphere. Similarly weeds that covers the soil surface retains soil moisture than the tilled soil it also sequesters carbon.

e. Increases resource use efficiency

Among SMFs, family labour is the most abundantly available resource while land and water are scarcely available resources. Efficiency these resources to increase the productivity were the main concern that was tried to addressed in the JM-DFI. Prolonged lean period that leads to migration, for waged labour and fallow field are the wasted resources of SMFs which can be put into productive use.

f. Components

i. **Physical:** Empty polypropylene bags (PPBs) are used fertiliser bags available with farmers can be used. The size depends on the crops to be taken or local availability. *Kapu* (riverbed basin soil) or light soil is the basic component of the substrate to be used for growing crops in the PPBs. Water is another essential component but required in comparatively in lesser volume, but

ii. **Biological:** Seeds and planting material of the chosen crops to be grown. Use of well rotten FYM (Farmyard manure) enriched with bio-fertilizers (PSB, Rhizobium, Asperigilus, Mycohrizza, *Trichoderma viride*) helps to promote growth and multiplication of soil microbes in the rhizospheric zone of the crops. As the plants grow in height in the JM-DFI,

staking is essentially required. Branches or bamboo used for staking also provides perching sites for birds that prey on the insect pests.

2. Economy

The focus of JM-DFI is improvement in farm economy of SMFs with poor soil and limited irrigation facilities. No till, weeding and application of chemical fertilisers as well as wider spaced plantings (6x6 ft for pigeonpea; 3x3 ft for intercrops) in JM-DFI require much lesser seeds and planting materials. Lesser pest incidences due to wider spacing also reduces pesticides cost. In traditional agriculture these operations and input incur high initial investment in crop production. A major reduction in this high initial investment is the essence of JM-DFI and slowly driving them to organic farming.

Water is another economic component and scarce resource of SMFs. JM-DFI encourages judicious use water and only at the plant bases avoiding spilling even a drop of it. For every drop of water spend there has to be more crops reaped. It can be drip irrigation or by irrigating each plant in PPB. SMFs with their small holdings and sufficient family labour can manage their scarce water resources to improve farm economy by adopting JM-DFI. Regular income and low external input is the core principle of JM-DFI.

Plate 1 : Broadview of crops in early stage

Plate 2 : Survival of water sensitive crops during excess rain

Plate 3 : High poding of pigeonpea in polypropylene bags

Plate 4 : Turmeric, tomato, chili, leafy vegetables in polypropylene bags

Plate 5 : Cotton crop in polypropylene bags

Planting of spices (turmeric, ginger, corriandar, chilli, garlic, mint), tuber crops (potato, colcassia, onion), vegetables (cucurbits, sarson, spinach, fenugreek, brinjal), oilseed (mustard), cash crops (cotton, papaya, sweet corn, betelvine, strawberry, lac) and flowers (marigold, chrysanthemums) as intercrops in between pigeonpea in half acre of land, ensures inflow of cash in shorter intervals. Birds and insects (ants, butterflies, bees, moths, etc) in the field are indicators of increase in bio-diversity. Continuous presence of weeds and grasses promotes soil microbial population and soil moisture. The Model is monitored through "Realtime digital distance monitoring system' installed in the field.

In a recent study (Khichi, 2020) based on Jawahar Model conducted on ten pigeonpea lines including nine local and a released variety TJT-501, the yield of lac was found to varied from 131.8 to 414.5g, seed yield (597.6 to 1433.8g), fuel wood yield (836.1 to 4746.6g) and economics of lac production per pigeonpea plant ranged from 72.5 to 195.9 rupees.

In another study (Vishal, 2020) lac yield was found to be ranged from 283.8 to 397.5g, seed yield (708.7 to 1143.6g), fuel wood yield (1049.8 to 5430.6g) and economics of lac production per pigeonpea plant ranged from 119.7 to 157.1 rupees.

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[Article ID : 01/II/02/0221]

SWERTIA CHIRAYITA: AN ENDANGERED MEDICINAL HERB OF THE HIMALAYAS

Bandan Thapa*, Pushkar Sharma and Sibdas Baskey
Regional Research Station, Hill Zone, Uttar Banga Krishi Viswavidyalaya,
Kalimpong 734301 West Bengal, India
*Corresponding author: bandhan.thapa@gmail.com

Abstract
Darjeeeling and Sikkim falls under the Himalayan hotspots of India and considered as one of the prime region for major biodiversity constituting of variety of endangered medicinal and other important ethnobotanical herbs. *Swertia chirayita* important indigenous medicinal herb has been lost from its natural habitat in the Western Himalayas but is in a vulnerable state in Eastern Himalayas. This plant is a treasure in a hub of medicinal plants in India because of its demand in the national and international market. The use of this plant as traditionary medicine in curing many ailments as well as being archived in the British, and the American pharmacopeias and Indian pharmaceutical codex, and in other traditional medicine like the Ayurveda, Unani, Siddha. Darjeeeling and Sikkim, where the study and efforts for conservation has been made is regarded as the denizen as of many species and population of *Swertia.* If efforts of in-situ and ex-situ conservation are not being made for the dwindling population of this medicinal plant, it is for sure to be getting extinct in the near future. Contemplating for its loss from the wild there has been many intrinsic and extrinsic factors which has to be taken into consideration. Conservation of this species utilizing conventional approaches alone cannot help this herb from being exploited, therefore various well contrived biotechnological strategies must be adopted for sustainable use, cultivation and reintroduction back to its habitat.

Introduction

Swertia chirayita, locally known as Chirauto or Chirayita is one of the highly demanded medicinal herbs from the Himalayan belt in the international and national market. The medicinal use of this herb is documented in the Indian pharmaceutical codex, the British, and the American pharmacopeias. For ages, its use has also been reported in different traditional medicine such as the Ayurveda, Unani, Siddha. *Swertia chirayita* is known for its bitter taste due to its main constituent called Amarogentin, which is the bitterest compound reported till date and other different bioactive compounds. Locally the decoction of this herb is used for malarial fever and indigestion. Regardless of its high requirement in the herbal industry, it is still being collected illicitly from the wild; as such the existing population of *S.chirayita* is dwindling at an alarming rate in the Himalayas. The IUCN (International Union for Conservation of Nature and Natural Resources) has categorized this species as critically endangered and also being listed as endangered in Indian Red Data Book and vulnerable in Darjeeling and Sikkim Himalayas. It has also been listed amongst the 32 prioritized medicinal plants of India by National Medicinal Plant Board, Ministry of AYUSH and also providing 75% subsidy to farmers for promoting its cultivation.

Plant Description

Swertia chirayita is an erect and profusely branching plant with a height ranging from 3 to 5.5feet, with dark green to purple colored stem with yellow colored roots. It is a pluri-annuals (flowering once in the third year) .It is a very slow growing plant which germinates after 3-4 months of sowing and comprises of more than two years of vegetative stage. The vegetative stage is characterized by large radical leaves (20-25cm in length) which sustains for more than two years and starts getting

old and dried at the emergence of the stem , which starts to develop only in the third year after sowing. After the emergence of stem small cauline leaves starts to appear with numerous flowers borne on leafy panicle.

Threat Perceptions

Extrinsic Factors:

- Growing demand for raw materials of medicinal plants by the pharmaceutical companies and their depleting resource base.
- More number of households depending economically on this herb for income generation through commercial collection.
- Lack of knowledge about sustainable harvesting and Good Agriculture Collection and Cultivation Practices **(GACP).**
- Habitat destruction due to construction of roads, overgrazing and local endemics like landslides, forest fire is identified as the main threat to its diversity.

Intrinsic Factors

- The major intrinsic factor causing threat to this herb is its propagation. It takes 3 years to complete its life cycle and can be propagated through sexual means only i.e. through seeds
- Due to its slow growth it cannot compete with other plants for nutrition in the wild.
- The seeds harvested also possess a problem of low viability and low germination percentage.
- This herb is highly location and temperature specific as per our observation and can grow suitably only above 1200m msl altitude and difficult to acclimatise in lower elevations.

Strategies for Conservation

Good Agricultural Collection and Cultivation Practices

It has become a necessity for conservation this herb and provide training and conservation program absolute necessary for all stake holders. We have to develop and provide guidelines and training on Good Agricultural Collection Practices (GACP) to the inhabitants dwelling near the forest and those who depend their livelihood for sustainable harvest so to add value to harvest over long time and aim towards conservation. Scalable cultivation is one of the best strategies for conservation meeting high demands of national and international market. Developing Good Agricultural Practices (GAP) for endangered herbs having high commercial demand has become a must and need of the hour. Cultivation of such medicinal plants will decrease the pressure on natural resources and wild collection and impede the use of unauthentic substitutes and adulterants, resulting in the decline of the standard of drugs of Indian systems of Medicine.

Micro propagation

Conservation of this species utilizing conventional approaches alone cannot help this herb from being exploited and on the verge of being extinct from its natural habitat. Tissue culture and micro propagation techniques are promising *in – vitro* techniques showing potential in managing and conserving this herb sustainably. The conventional propagation of the species is too slow and unable to overcome the threat of extinction. Therefore, *in vitro* propagation strategies are the only practical option for the rapid propagation.

***Ex-situ* Conservation and reintroduction in its natural habitat**

Adoption of conservation actions by local Research Institutes and Forest departments and maintaining such endangered plant species in their field gene banks as a measure for *Ex-situ* conservation can help in its management. Also producing quality planting material through seeds

and reintroduction in its natural habitat will reinforce the efforts on resurgence of the species in the areas facing risk of extinction. Trainings can also be provided to various stakeholders to popularize the Field Gene Bank (FGB) in order to strengthen and foster the integrated and sustainable utilization of this plant and its genetic resources.

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Conservation and Maintenance of *Swertia chirayita* being done at Regional Research Station,Hill Zone,Kalimpong, UBKV

Collection of Dried plants for seeds collection for maintaining accessions

Seedlings grown from seeds: FIRST YEAR

Seedlings grown from seeds : SECOND YEAR

Seedlings of different accessions being maintained at RRS,HZ,Kalimpong . Altitude : 1085 m

Maintenance of *Swertia chirayita* Accessions at Polyhouse at Dalapchand KVK Farm Altitude : 1450m

MAINTENANCE OF ACCESSIONS IN OPEN CONDITION AT DALAPCHAND

[Article ID : 01/II/03/0221]

NEED OF AWARENESS PROGRAMME TO CONTROL THE LORANTHUS WEED – *HELIXANTHERA LIGUSTRINA*

S. Romen Singh[1], Ng. Piloo[2], Pushparani Senjam[3] and L. Hemanta[4]

[1]College of Horticulture & Forestry, Central Agricultural University,
Pasighat-791 102, Arunachal Pradesh (India)
[2]Department of Horticulture, College of Agriculture,
Central Agricultural University, Imphal-795004, Manipur, India
[3]AICRP on Rapeseed-Mustard, Directorate of Research
Central Agricultural University, Imphal-795004, Manipur, India
[4]Department of Horticulture, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema-797206, Nagaland
*Corresponding author: romensenjam@yahoo.com

Abstract

Khasi Mandarin which is known for its fine organic quality fruit from East Siang district of Arunachal Pradesh is declining in the last few years. *Loranthus* species *viz*. *Helixanthera ligustrina* is one of major factor for the declining of Khasi Mandarin. It is stem parasitic weed plant. Investigation revealed that to control this parasitic weed citrus grower need to know its habit, mode of seed dispersion, host plants, its life cycle and its management. Investigation also observed that it flowers during the month of April - May and the seed dispersal is mainly done by two birds viz. Plain flower pecker and Fire breasted flower pecker in June-July period under Arunachal Pradesh condition. The study also revealed that it caused lowering down its yield, fruit quality and finally killed the plant within 4-5 years after infestation. This parasitic weed is slowly spreading to other nearby orchards and needs emergency attention for the citrus growers for collaborative approach to control this parasitic weed.

Key words : Loranthus weed, parasitic, khasi Mandarin, citrus decline

Introduction

The North Eastern Himalayan (NEH) region is endowed with favourable agro-climatic conditions for the growth of different citrus species and considered as the centre of origin of several citrus species (Gogoi *et al*. 2004). Citrus is an important crop of the people of the state of Arunachal Pradesh, a hill state in the North East Region of India. Among the different citrus species, Khasi Mandarin is the premier crop grown in all subtropical belt of Arunachal Pradesh. According to different region in Manipur and Mizoram, it is locally called as *Komla* and in Tripura as *Kamla*, Arunachal Pradesh as *Santra* and Meghalaya known as *Soh*. Cultivation of Khasi Mandarin is a source of livelihood to many people in the rural areas by the *Adi* tribe of Arunachal Pradesh. Cultivation of Khasi Mandarin is a source of livelihood to many people in the rural areas of this citrus growing belt of Arunachal Pradesh. Very poor productivity in this region is mainly attributed to unscientific cultivation of crop, injudiciously use of land resources, lacking of quality planting materials, citrus decline, citrus stem borer and loranthus stem parasite weed (Hazarika and Singh, 2013). The khasi Mandarin growing belt of Arunachal Pradesh is heavily infested with Loranthus weed especially in the East Siang district manifested in poor growth, low yield and quality of the fruit and finally death of the host plant within 4-5 years of infestation. Besides, the most infested zone by this parasitic weed is also occurred in the Renging village, which is considered for its fine quality of khasi Mandarin. However,

this destructive stem parasitic weed of loranthus is not common in other citrus belt of North East Region *viz*. Manipur, Nagaland, Tripura and Assam citrus belt. Keeping in this view, it is important to identify the *Loranthus* species found in East Siang region, its biology of life cycle and its dispersion factor to the host plant so that proper steps can be taken up for effective control of this destructive weed which cause the declining of citrus belt in Arunachal Pradesh.

Status of Loranthus stem parasite in East Siang district of Arunachal Pradesh

The khasi Mandarin growing belt zone is mainly located in the East Siang district and West Siang district of Arunachal Pradesh. It was observed that maximum infestation of this weed was found in the Renging site and lesser infestation in the Bodak village, Oyan village and Panging village and still not reported or sighted of this weed in the orchards of Boying village. Out of this growing belt zone, khasi Mandarin grown in Renging village under the East Siang district is considered to be the best quality mandarin in Arunachal Pradesh. However, at present Renging which is famous for this fruit is heavily infested with this parasitic weed resulting in fruit quality decline, small size fruit and less number of fruits per plants and finally death of the infested plants after 3-4 years of infestation on it. Besides, the citrus orchards it was observed that loranthus infests many other non-citrus species like fig, neem tree, elephant apple and *Albizia* species. It infestation is also found in the shade tree of neem in the tea plantation also in Arunachal Pradesh (Singh et al., 2016). From the investigation, it was observed that the main dispersing agents of this weed were two small birds namely, Plain Flower pecker (*Dicaeum conculor*) and Fire-breasted flowerpecker (*Dicaeum ignipectus*) which cause declining of citrus belt of Arunachal Pradesh.

Control methods to control parasite Loranthus weed

I. Deepu and Habeeburrahman (2012) reported 1% of 2,4-D (auxin) around the pest trunk with cotton cloth strip soaked in herbicide, at the point of attachment to the host, after removing the outer skin to about 0.5 cm length.

II. In India*, Loranthus pulverulentus* was successfully controlled by injection of Copper sulphate (CuSO4) and feroxone into the host plant (Kadamdi, 1954).

III. Under East Siang district, it is mainly control by cutting down the affected branches of host plants before the maturity of fruit (June-July month) and applying with bordeaux paste to prevent the infection in the wounded part of the plant (Hazarika and Singh 2013).

IV. In the heavily loranthus infested tree, there is high incidence of ants (*Crematogaster spp.)* at the citrus – mistletoe union and which make it difficult for pruning by climbing the tree. So, using standard tree pruner is the best way to control this noxious weed from the beginning of infestation. Similar opinion has been recorded (Ansare *et al*. 2013).

V. Once the Loranthus infestation is heavily infested then it is difficult to prune the branches. Therefore, at the initial stage of infestation removal of the infected portion is the suitable method to control it.

VI. Awareness program among the citrus growers is needed since its seed is spread by birds from one orchard to other as well as other non-citrus host plants are also there for this destructive weed.

Extension programmes needed for control and management of Loranthus stem parasite

Helixanthera ligustrina Syn. *Loranthus ligustrinus is* a noxious weed particularly in the citrus growing areas under East Siang district of Arunachal Pradesh, which is a major Khasi Mandarin production zone. Heavy financial losses incurred to the citrus growers every year due to this parasitic weed. Till

date no effective and popular control measures and methods are developed for proper controlling and eradication of this weed. Scientific methods of control and management along with awareness programmes are needed to eradicate this weed as well as preventing from spreading to other orchards. The only available control methods with the growers are to prune the infected branches a few centimeters away from the point of infestation as the haustoria that penetrate deep inside the branches needs to be removed. Therefore, effective awareness program among the citrus growers are necessary in order to provide the knowledge about the weed biology and mode of dispersion and method of controlling of this weed inorder to control the declining phase of citrus belt in Arunachal Pradesh.

Conclusion

The destructive effect of this weed is increasing at an alarming rate in these regions. The infestation of loranthus (*Helixanthera ligustrina*) weed in the orchard belt of East Siang and West Siang district of Arunachal Pradesh is increasing day by day affecting many citrus growers which is known for its organic fine quality of mandarin. The economy of many farmers is mainly depended on this citrus crop which is declining day by day. But recently the citrus crop is badly affected by stem parasitic loranthus weed infestation. Planned trainings and management programmes should be taken up by the concern departments in liaison with the research institutions for a complete eradication of this weed and from further spread to other nearby unaffected orchards. That day will not be far where all the citrus belt of Arunachal Pradesh will be destroyed and no citrus fruits will be produced in this state if proper steps and control measures are not taken up timely by the competent authority and the researchers which need to educate the citrus growers to control this parasitic weed effectively.

Fig. 1 Declining citrus orchard in Renging Village by Loranthus infestation

Fig 2. Pruning of infected branches as effective control measure

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[Article ID : 01/II/04/0221]

SURVEY FOR THE KEY PESTS OF CHILLI (*CAPSICUM ANNUUM* L.) IN DIFFERENT AGRO-CLIMATIC ZONE OF WEST BENGAL

Pranay Rai and P. K. Sarkar *
College of Agriculture, Susunia, Bankura
(Extended campus of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia)
***Retired Professor**
Department of Agricultural Entomology
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia

Abstract
A survey was conducted to find out the key pests infesting chilli in major chilli growing districts under three different agro-climatic zones of West Bengal *viz*., *New alluvial zone*, *Old alluvial zone* and *Coastal saline zone*. The survey revealed the incidence and occurrence of chilli thrips (*Scirtothrips dorsalis* Hood), Yellow mite or Broad mite (*Polyphagotarsonemus latus* Banks) and *Helicoverpa armigera* Hubner as key pests causing appreciable damage in all the three agro-climatic zones with sporadic populations of other sucking pests like aphids, jassids and whiteflies.

Introduction
West Bengal is broadly divided into six Agro-climatic Zones, which fall within three Agro-climatic Regions *viz.,* Eastern Himalayan Region, Lower Gangetic Plain Region and Eastern Plateau & Hill Region among the 15 regions in India, as classified by the Planning Commission, Government of India. Farmers of West Bengal have been growing chilli in highly diverse agro-climatic situations from Hilly and Terai soils of Himalayan foot hills in the North, Red lateritic and gravelly soils in the West, coastal saline soils in the South to rich alluvial soils in the Central region (Paul *et al*., 2013).

Chilli belongs to the family Solanaceae and includes 31 known species (Moscone *et al.*, 2007). Among the 31 species included in the *Capsicum* genus, only five - *C. annuum*, *C. baccatum, C. chinense*, *C. frutescens* and *C. pubescens* have been domesticated and cultivated (Heiser and Pickersgill, 1969; IBPGR, 1983). The Indian germplasm is mainly represented by two species, *C. annuum* and *C. frutescens* with a number of varieties (Thul *et al.,* 2009). In India, chilli is cultivated in an area of 7.67 lakh hectares and the production is estimated at 12.34 lakh tonnes (Priyadarshini *et al.*, 2018). Chilli accounts for 40 percent of the total spices exported from India and 23 percent in terms of value. Chilli is known to be affected by 57 insect and non-insect pests of which the Tarsonemid mite, *Polyphagotarsonemus latus* (Banks) (Acari:Tarsonemidae) and thrips, *Scirtothrips dorsalis* are most destructive sucking pests and are considered as major pests (Berke *et al.*, 2000; Reddy and Puttaswamy, 1984). The productivity of the crop is decreasing sharply day by day mainly due to leaf curl complex associated with the infestation of *Scirtothrips dorsalis* Hood and *Polyphagotarsonemus latus* Banks (Mondal and Mondal, 2012). The objective of this study is to ascertain the incidence of key pests of chilli in three different agro-climatic zones of West Bengal under the farmer's agronomic practices and crop protection strategies.

Materials and Methods
Fixed plot survey was conducted during rabi season of 2013-14 in major chilli growing districts under three different agro-climatic zones of West Bengal to find out the key pests infesting chilli. The agro-climatic zones considered for the survey were the *New alluvial zone*, *Old alluvial zone* and *Coastal saline zone*. Farmer's field were considered for observation under the survey in each of the agro-

climatic zones selected. In each zone, 1,000 meter square area of chilli field was selected and divided into four quadrates. Then, 10 plants were randomly selected and tagged for observations in each quadrate. The observations were taken at fortnightly intervals on the key pests of chilli under farmer's chemical interventions.

Both adults and nymphs of thrips were counted in situ from half to fully opened top three leaves with the help of 10 X hand lens. For observation of mites, one leaf each from upper, middle and lower position of the selected plants were collected in perforated zip lock polythene bag (16 x 18 cm) and the samples were brought to laboratory and examined under 20 x magnification stereo zoom binocular microscope. The data were then subjected to ANOVA following necessary transformations.

Details of the experiment were as follows:

Agro-climatic zones (NARP)	Old alluvial zone	New alluvial zone	Coastal saline zone
District	Murshidabad	Nadia	South 24-Parganas
Block	Jiaganj	Chakdah	Kakdwip
Village	Chandipur	Simurali	Kakdwip
Crop	Chilli	Chilli	Chilli
Season	October-February	November-March	November-March
Variety	Beldanga lanka	Bullet lanka	Krishnachura lanka
Total area	2 bigha approx.	3 bigha approx.	2 bigha approx.
Fertilizers used	Urea, SSP, MOP	Urea, SSP, MOP	Urea, SSP, MOP
Pesticides used	fipronil (Regent) spinosad (Tracer)	imidacloprid (Confidor) emamectin benzoate (Missile)	acephate (Asataf) imidacloprid (Hilmida)

Results and discussion

The survey revealed the incidence and occurrence of chilli thrips (*Scirtothrips dorsalis* Hood), Yellow mite or Broad mite (*Polyphagotarsonemus latus* Banks) and *Helicoverpa armigera* Hubner as key pests causing appreciable damage in all the three agro-climatic zones. Further, small and sporadic populations of other sucking pests like aphids, jassids and whiteflies were also observed but their population being negligible, were not considered for study in this experiment.

a) Key pests of chilli in Old alluvial zone of West Bengal.

Table 1 represents the population of key pests of chilli recorded at **Old alluvial zone of West Bengal**. From the table, it is clear that the population of pests in chilli was very low during the month of December which may be due to the fact that the ambient temperature in this region was low and unfavourable for the growth and development of the crop plant as well as the pests concerned. However, when the environmental conditions turned optimum, the highest number of mites (19.30/ 3 leaves) and % leaf curl (65.84 %) was recorded during second fortnight of February. Similarly, the highest number of thrips (7.84/ 3 leaves) and % leaf curl (32.61 %) was as well recorded during second fortnight of February whereas the highest number of defoliator, *Helicoverpa armigera* (1.95/ plant) and % defoliation (28.41 %) was recorded during second fortnight of January when the crop had entered the reproductive phase.

b) Key pests of chilli in New alluvial zone of West Bengal.

The population of key pests of chilli recorded at **New alluvial zone of West Bengal** has been depicted in Table 2. The population of mites increased gradually throughout the month of January

and February to reach the peak population (15.74/ 3 leaves) causing highest % leaf curl (51.22 %) during first fortnight of February while the highest population of thrips (6.60/ 3 leaves) and the subsequent leaf curl damage (30.08 %) was recorded during second fortnight of February. On the other hand, the number of defoliator, *Helicoverpa armigera* (1.83/ plant) and % defoliation (26.41%) was highest during second fortnight of January when the crop was in the reproductive phase.

c) Key pests of chilli in Coastal saline zone of West Bengal.

Table 3 represents the population of key pests of chilli recorded at **Coastal saline zone of West Bengal**. In the table, it can be seen clearly that the population of the chilli mites started to increase gradually to reach the peak population (25.71/ 3 leaves) and their subsequent leaf curl (76.71 %) during second fortnight of January whereas the number of thrips (9.08/ 3 leaves) and % leaf curl (36.71 %) reached the peak during second fortnight of February. Further, the number of defoliator, *Helicoverpa armigera* (2.37/ plant) and % defoliation (32.28 %) touched its peak during first fortnight of February.

Numerous scientists have conducted experiments throughout the year for assessing the occurrence of key pests of chilli in different seasons in India. The findings of this experiment was in conformity with the findings of Sunitha *et al.* (2007), Kumar *et al.* (2007), Nandini *et al.* (2010), Reddy *et al.* (2011), Kumar and Gupta (2014), Chintkuntlawar *et al.* (2015), Sarkar *et al.* (2015) and Priyadarshini *et al.* (2018) who reported that the mite, *Polyphagotarsonemus latus* Banks; thrips, *Scirtothrips dorsalis* Hood; *Spodoptera litura*, whitefly, jassids, aphids, *Helicoverpa armigera* Hubner and *Spodoptera exigua* were the major pests infesting chilli in India. The findings of the present author were also supported by the findings of Karmakar (2016) who reported that *Polyphagotarsonemus latus* Banks was the most widely distributed mite in West Bengal, while Mondal and Mondal (2012) reported that the yellow mite, *Polyphagotarsonemus latus* Banks and chilli thrips, *Scirtothrips dorsalis* Hood are considered the most devastating pests in West Bengal.

Table 1. Key pests of chilli in Old alluvial zone of West Bengal during Rabi season, 2013-14

Month		Mean no. of mite/ 3 leaves	% leaf curl (mites)	Mean no. of thrips/ 3 leaves	% leaf curl (thrips)	Mean no. of defoliator*/ plant	% defoliation (Fruit borer)
December 2013	1st FN*	0.97	13.18	0.66	10.21	0.87	15.21
	2nd FN	2.02	17.36	1.34	11.25	1.24	21.36
January 2014	1st FN	5.93	23.24	3.05	16.02	1.16	18.66
	2nd FN	8.66	34.98	3.98	20.87	1.95	28.41
February 2014	1st FN	14.31	50.71	4.82	23.92	1.38	21.69
	2nd FN	19.30	65.84	7.84	32.61	1.10	20.72
Mean		8.53	34.22	3.62	19.14	1.28	21.01
S.Em (±)		7.15	20.59	2.59	8.47	0.36	4.34

***FN: Fortnight,* *defoliator encountered was *Helicoverpa armigera* Hubn**

Table 2. Key pests of chilli in New alluvial zone of West Bengal during Rabi season, 2013-14

Month		Mean no. of mite/ 3 leaves	% leaf curl (mites)	Mean no. of thrips/ 3 leaves	% leaf curl (thrips)	Mean no. of defoliator */ plant	% defoliation (Fruit borer)
December 2013	1st FN*	1.03	12.34	0.93	11.05	0.76	15.85
	2nd FN	1.65	18.31	1.47	12.58	0.67	15.28
January 2014	1st FN	6.82	27.90	1.98	16.36	1.37	22.75
	2nd FN	9.57	34.37	3.11	18.74	1.83	26.41
February 2014	1st FN	15.74	51.22	3.93	25.22	1.12	21.50
	2nd FN	12.67	48.65	6.60	30.08	0.87	16.07
Mean		7.91	32.12	3.00	19.00	1.10	19.64
S.Em (±)		5.90	15.76	2.07	7.38	0.43	4.58

**FN: Fortnight,* *defoliator encountered was *Helicoverpa armigera* Hubn

Table 3. Key pests of chilli in Coastal Saline Zone of West Bengal during Rabi season, 2013-14

Month		Mean no. of mite/ 3 leaves	% leaf curl (mites)	Mean no. of thrips/ 3 leaves	% leaf curl (thrips)	Mean no. of defoliator */ plant	% defoliation (Fruit borer)
December 2013	1st FN*	1.36	14.13	0.86	12.44	0.60	14.71
	2nd FN	3.23	19.68	0.65	9.81	0.81	17.24
January 2014	1st FN	7.97	32.94	1.87	16.57	1.88	28.10
	2nd FN	25.71	76.71	2.49	24.83	2.06	30.13
February 2014	1st FN	17.47	54.40	6.46	28.65	2.37	32.28
	2nd FN	19.08	68.78	9.08	36.71	0.75	14.80
Mean		12.47	44.44	3.56	21.50	1.41	22.87
S.Em (±)		9.72	26.06	3.42	10.35	0.77	8.14

**FN: Fortnight,* *defoliator encountered was *Helicoverpa armigera* Hubn

Conclusion

The infestation of *Scirtothrips dorsalis* Hood and *Polyphagotarsonemus latus* Banks is associated with the devastating leaf curl complex of chilli which is one of the prime limiting factor causing extensive yield loss especially in southern districts of West Bengal. It is therefore advisable to adopt proper prophylactic measures or detect the early infestation by the pest and initiate proper management because the disease spreads quickly arresting the growth and development of the crop ultimately leading to poor yield.

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[Article ID : 01/II/05/0221]

LIFE CYCLE OF CITRUS BUTTERFLY *PAPILIO POLYTES* LINNAEUS (LEPIDOPTERA: PAPILIONIDAE) ON SWEET LEMON

Aryaman Modak and Yendrembam K. Devi[1]*
B.Sc. (Agri) Scholar, Lovely Professional University,
Jalandhar-Delhi G.T. Road (NH-1) Phagwara-144411 India
[1]Department of Entomology, Lovely Professional University,
Jalandhar-Delhi G.T. Road (NH-1) Phagwara-144411 India
*Corresponding email: kismon1987@gmail.com

Introduction

The genus Citrus is unique in its diversity of forms and no other fruit crop can parallel it. Citrus crop posses great adaptability to various climatic conditions and hence grown equally both in tropical and subtropical regions as well as some favorable parts of the temperate regions of the world. Citrus industry is the third largest, in the world after mango and banana. In India citrus crop occupies a prominent place covering an area of about 8.5 L ha with an annual production of 74.64 L tonnes with a productivity of 8.8 t/ha (NHB, 2011).

Citrus crop is being infested by around 165 species of economically important insect pests in India causing up to 30 per cent yield loss. In India about 250 species of insects have been found attacking and spoiling various citrus species. Among various insects citrus butterfly, *Papilio polytes* Linnaeus commonly known as the common mormon, has a successful dispersal and is a major economically important pest of citrus plants throughout Asia. *P. polytes* larvae feed on the foliage of citrus trees and are regarded as a major citrus pest especially in nurseries. The larval forms cause serious damage to citrus family by devouring large quantity of foliage during the later stages of their development, particularly in Southern and Southeast Asia.

The biology and developmental period is mainly dependant on the climate, location and plant species on which they are feeding. Information on the morphometric and biology of citrus butterfly on sweet lemon will be useful to evolve effective management strategy, against citrus butterfly. Here, the life cycle of the *Papilio polytes* (Papilionidae) is reported. The measurements of egg, larva, pupa and adult reported here are based on four samples and the samples were collected in Jalpaiguri district, West Bengal, India.

The different stages in the life cycle of *P. polytes:*

Egg stage : Eggs are spherical, smooth, cream-colored, and were laid on the under surface of sweet lemon (*Citrus limetta)*. Its measurement was taken from the reference research papers.

Fig 1 : Egg stage

Larval stage : The larvae were brown with a white strip and looked like bird dropping from 1st to 4th instar and were green in the 5th instar. Their lengths were measured with the help of scale and divider and were recorded. The larvae posses a "Y" shaped red structure called **osmeterium** which they take out when they feel threatened. During this process they emit a stinky smell. They have hypognathous head and biting and chewing mouth parts. They have three pairs of thoracic legs and four to five pairs of pseudo legs in the abdomen which look like spongy sticky pads. These pseudo legs help them to stick to a surface. Their body has abdominal segmentations and each of these segments contain a pair of pseudo leg. In the 5th instar larva, the ecdysial line which is inverted "Y" shaped could be seen prominently on the head. The pictures of different stages are given below.

1st instar larva

2nd instar larva

3rd instar larva

4th instar larva

5th instar larva

5th instar larva showing osmeterium

Ecdysial line in 5th instar larva

Photograph by: Aryaman Modak

Fig 2 : Different larval stages of citrus butterfly

Pupal stage : The pre-pupal stage and the pupal stages were observed carefully and the measurements of both the stages were recorded with the help of scale and divider.

In the pre-pupal stage the 5th instar larvae shrink and become "C" shaped and gets attached to a twig with the help of a web like structure.

In pupal stage, the larva forms pupa on the basis of their position on the twig. If the pupa is made on a twig where there are leaves around, then they form a green pupa, but if they form a pupa on a brownish twig which either has low foliage or is dead then they are likely to form a brownish pupa. This is a type of protective mechanism.

In the later stages of pupa i.e. before the emergence of butterfly, the pupa becomes translucent and the wing colour of the butterfly could be seen.

Early pre-pupal stage

Post pre-pupal stage

Early stages of pupa (Crysallis)

Later stages of pupa (Crysallis)

Photograph by: Aryaman Modak

Fig 3 : Pupal stages of citrus butterfly

Adult stage : The fully developed butterflies inside the pupal cases emerged out by splitting the case dorsally. Newly emerged adult butterflies were found to possess weak wings hence, were unable to fly for 45minutes to 1 hour. Later they started to fly. Adult butterflies were large and beautiful with wide wing spread. Their body could be divided prominently into head, thorax and abdomen. The thorax contained the three pairs of legs. The butterflies had capitates or club shaped antennae and had siphoning mouth parts.

Citrus Butterfly *(Papilio polytes)*

Photograph by: Aryaman Modak

Fig 4 : Adult stage of Citrus Butterfly *(Papilio polytes)*

Conclusion

The family Papilionidae is widely spread in every almost continent around the world except Antarctica. The butterflies of genus Papilio being an economically important pest is important as well as hazardous to the citrus industries globally including India.

This species is useful in many ways viz. - Pollination- Swallowtail butterfly benefits include their work as efficient pollinators. As they drink nectar from the flowers, they also pick up pollen, which they carry with them to other flowers. Deterring predators- Some species of Papilio deter other animals like birds, lizards from conquering the citrus orchards. Some of them taste bad, release foul odour, mimic other species which are non-desirable to predators, produce toxins etc. which ward off other unwanted pests in the orchard.

Besides these advantages, they are hazardous too. During their larval stage, they feed voraciously on the citrus leaves, mainly the young. This results in defoliation and decreased growth of the plant. As a result of this the fruiting of the plant is affected and the production per hectare decreases.

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[Article ID : 01/II/06/0221]

INHIBITORY EFFECT OF AUXIN ON CORM MEDIATED EMERGENCE IN YACON (*SMALLANTHUS SONCHIFOLIUS*)

Bablu Paul[1], Moumita Mallick[1] and Hossain Ali Mondal[1*]
[1]Discipline of Genetics and Plant Breeding, Uttar Banga Krishi Viswavidyalaya,
Cooch Behar-736165, West Bengal, India
*Present address-
School of Crop Improvement (SCI), College of Post Graduate Studies in Agricultural Sciences (CPGS-AS), Umiam, Meghalaya-793 103.
Central Agricultural University, Imphal, Manipur.
E-mail: mondal.cpgs.cau@gmail.com;
*Orcid id- http://Orcid.org/0000-0001-5181-0300 (HAM)

Abstract
The yacon (*Smallanthus sonchifolius*) tuber is enriched with metabolite, fructo-oligosaccharides (FOS) having proven health benefits. The FOS has multi health benefit effect on reducing glycemic index, body weight, the risk of colon cancer, blood sugar levels, cholesterol level. it was also proved that FOS boosted-up immune system as well as weight loss. The quality planting material production (QPM) from tuber corm is very common practice. For the first time, it is being reported that 0.477±0.033g corm will potentially give new emergence in the formulated artificial soil under controlled environment. Further, it was revealed that auxin inhibited leaf development recorded at 14 days. Characteristically, root diameter was higher in auxin treated corm. Auxin did not any effect on 'total weight, 'number of roots' and 'highest root length' at 14 days. But there is no significant difference in 'total weight', 'total plant height', 'number of roots', 'highest root length' and 'root diameter' at 28 days. Characteristically, there was no initiation of leaf in auxin treated corm at 28 days, hence number of leaves, leaf length and leaf breadth were higher in auxin untreated corm. In conclusion, auxin showed inhibitory effect on initiation of emergence. Therefore, auxin is not recommended for corm treatment for new emergence in formulated artificial soil under controlled environment on smaller sized corm having average weight of 0.477±0.033g.

Key words : *Smallanthus sonchifolius*; Corm; Quality planting material (QPM); Above ground and below ground character.

Introduction
Yacon (*Smallanthus sonchifolius*) have high medicinal merit for the diabetic patients. This crop is cultivated in Hill zone and availability of the rhizome is very much limited. Moreover, the price of yacon rhizome is very high throughout the year. Yacon (*Smallanthus sonchifolius*) is a perennial herbaceous plant belongs to the family Asteraceae with having a medicinal value in tuber. The below ground tuber is enriched with fructo-oligosacharides (FOS) which constituted 6.4% to 70% of the dry matter and 0.7% to 13.2% of the fresh weight. The FOS is an excellent health benefits like reduced glycemic index, body weight, the risk of colon cancer, the control of blood sugar levels, control of cholesterol level, boosting immune system and helping in weight loss. With the increasing demand for quality planting material (QPM) in the market due to its medicinal properties, farmers demand for sufficient QPM. Normally, yacon was conventionally propagated by the propagating roots (corms). The reduced flowering emergence as well as subsequent fruit set in the cultivated yacon were common problem in cultivated *Smallanthus* species (Leon., 1964). Moreover, high proportion of the seeds were also non-viable and/or low vigor. Aerial stem cuttings were also

reported for its propagation conditioned with desiccation protection (Robinson, 1978; Castañeto and Inhumang, 2004). But this process needs the destruction of the mother plant. As alternative for multiplication and maintenance of germplasm of this species, efficient techniques have already been reported (Corrêa et al., 2009). Direct organogenesis from stem cuttings and leaf segments had been reported as a tool for germplasm conservation (Estrella and Lazart, 1994; Niwa, 2002). Even, somatic embryogenesis was also reported in this species (Corrêa et al., 2009). The present research takes an attempt for auxin treatment in corm to evaluate the early time point below and above ground growth benefit.

Fructooligosacharides (FOS) are fructans consisting of linear short chains of fructose molecules. Fructans are synthesized from sucrose in the cell vacuoles of plant leaves, stems and roots. They help protect against drying out and are carbohydrate reserves in a wide number of plant families. FOS are natural food components that can be found in garlic, onion, asparagus, artichoke, banana, wheat and yacon. However, the highest concentrations of FOS are found in yacon. FOS are able to escape enzymatic digestion in the upper gastrointestinal tract, reaching the colon intact before undergoing microbial fermentation. FOS intake elicits a bifidogenic effect by selectively stimulating the proliferation of *Bifidobacteria*, a group of beneficial bacteria naturally found in the human colon. Short chain fatty acids (SCFA), the end products of FOS fermentation by the intestinal microbiota, can also favour the growth of health-promoting bacteria such as *Bifidobacterium spp*. and *Lactobacillus* spp., while reducing or maintaining pathogenic populations (e.g., *Clostridium spp*. and *Escherichia coli*) at low levels. Thus, FOS are small soluble dietary fibres that exhibit prebiotic activity.

In the present research, the effect of auxin was evaluated in the corm at the early time pint below and above ground growth benefit in the formulated artificial soil under controlled environment.

Material and methods

Field experimental location and mother plant

The yacon corm was collected and experiment was performed in the controlled environment located at 28°19'N latitude and 89°23'E longitude and at an altitude of 43 m above the mean sea level.

Artificial soil formulation

Artificial soil (AS) was formulated with perlite, peat moss and vermiculite (1:1:1). Perlite was reported for maintaining aeration to ensure an excellent air/water balance which impact on better root growth including better uptake of nutrients in more effective manner. Peat Moss retained moisture for better plant growth which also saves irrigation frequency. Moreover, releases of water and nutrients to the right proportions for optimum plant growth of plant, and reduce the application of manuring. Vermiculite was reported to improve soil porosity as well as act as a medium for water and nutrient Exchange. The water soluble NPK (20:20:20) @1g per liter of water, PSB and Tricoderma power @5g (2.5g+2.5g each) per 100 ml were used for irrigation in artificial soil for 2 kg. Both PSB and *Tricoderma* power were used only once. This AS was known as supplemented artificial soil (SAS).

Treatment of axial bud

The collected corm was cut and touched with auxin enriched power (cutting aid).

The controlled environment for emergence

The initial environmental incubation was very crucial for new plant emergence. The transparent box with tight lid was used for maintaining the humidity. The pot was filled with SAS and kept in

transparent box which was again incubated in the environment of 6000 LUX light intensity, 14-hour light condition per day, 70% of Relative Humidity in PGR.

Statistics

One-way ANOVA and Tukey's HSD Calculator was used for calculation (https://www.icalcu.com/stat/anova-tukey-hsd-calculator.html) to calculate p values at 0.05% level of significance to see any significant difference. The MedCalc statistical software (https://www.medcalc.org/calc/comparison_of_means.php) was also explored to calculate the difference between the observed means in two independent samples.

Discussion

The cutting aid was enriched with IBA, NAA, PHB, H_3BO_3, Vitamin, Surfactant, Talc power. The direct power enriched with auxin was used for the study for evaluating effect on corm on early time point emergence growth. Yacón, *Smallanthus sonchifolius* was originated from the mountain regions of South America. This plant categorized as a perennial herb, attained height of 2 to 2.5 m tall with a root system composed of 4 to 20 edible fleshy tuberous storage roots (Zardini, 1991). In addition to enrichment of fructo-oligosaccharides, the tuber was an excellent source of low energy (Aybar et al., 2001). Aybar et al. (2001) demonstrated that the hypoglycemic effect of the aqueous extract of yacón leaves in diabetic rats evidenced an increase in the concentration of plasma insulin. Recently, analysis of the leaf and tuber extracts showed that both parts of the yacón plant represented a rich source of phenolic acids suggesting antioxidant proprieties (Valentova et al., 2005).

This is the first-time report that new plant emergence was recorded from 0.477±0.033g corm in the formulated artificial soil under controlled environment (**Fig. 1**). The auxin treated corm behaved differentially in the above ground growth in artificial soil under controlled environment. The growth snapshot was recorded at 14 days (**Fig. 1**). The cutting aid, enriched with auxin was used for treatment.

Figure 1

To evaluating the below ground characters, all corm was removed from aftificial soil at 14 days and snapshotted (**Fig. 2**). From the result, it was revealed that root development was recorded even

when no leaf initiation was evidenced (**Fig. 2**). Therefore, corm reacted differentially in the above ground characters only, not below ground characters in the artificial soil under controlled environment (**Fig. 2**).

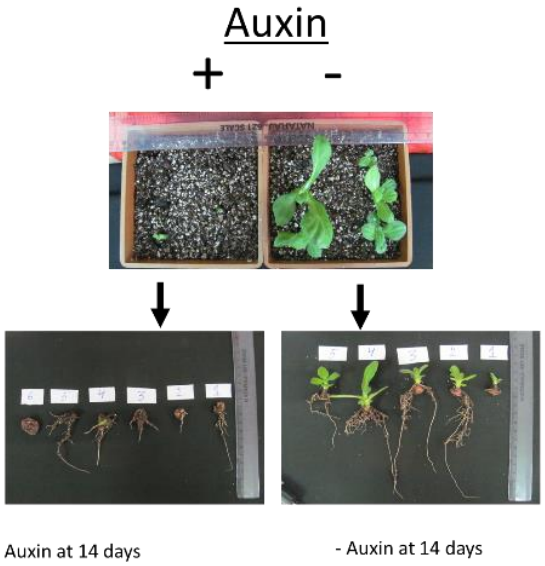
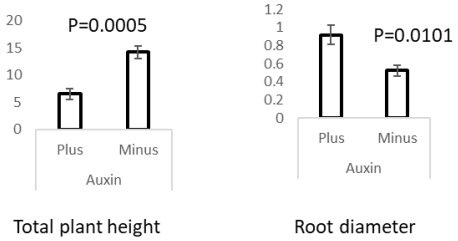


Figure 2

The above and below ground growth record at 14 days in auxin treated corm is recorded (**Fig. 3**). The result showed that significant difference was recorded in 'total plant height', and 'root diameter' (**Fig. 3**). As the new leaf was initiated in auxin untreated corm, the plant was higher as compared to auxin treated corm when no leaf initiation was recorded (**Fig. 3**). Hence, the leaf development was recorded in auxin untreated corm, the number of leaf emergence, leaf length and leaf diameter were higher in auxin untreated corm (**Fig. 3**). Curiously, the root diameter was higher in auxin treated corm (**Fig. 3**).



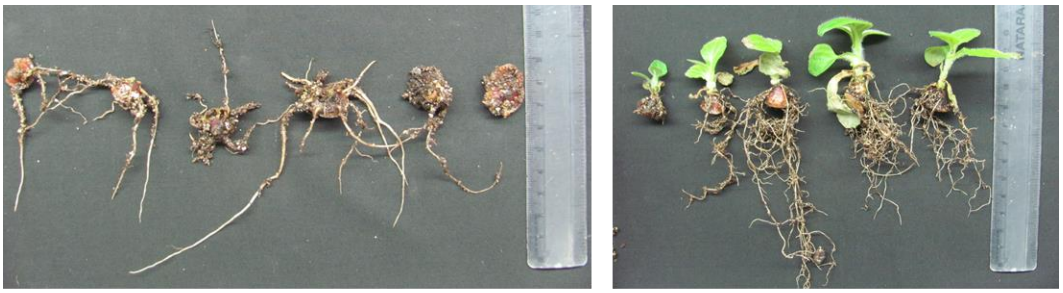
Total plant height

Root diameter

Significant difference at 14 days in
i) Total height
ii) Root diameter
iii) Number of leaf
iv) Leaf length
v) Leaf breadth

Non-significant difference at 14 days in
i) Total weight
ii) No. of root
iii) Highest root length

Figure 3



+ Auxin at 28 days - Auxin at 28 days

Figure 4

Corm mediated emergence was snapshotted at 28 days to evaluate above and below ground characters (**Fig. 4**). From the experiment, it was revealed that both have root initiation but auxin untreated corm showed only leaf emergence and development (**Fig. 4**).

The statistical analysis revealed that 'total weight', 'total plant height', 'number of roots', 'highest root length' and 'root diameter' were not significant (**Fig. 5**). Interestingly, there was no emergence in leaf initiation at 28 days (**Fig. 5**). Naturally, number of leaves, leaf length and leaf breadth were higher in auxin untreated corm (**Fig. 5**).

Significant difference in
i) Number of leaf
ii) Leaf length
iii) Leaf breadth

Non-significant difference in
i) Total weight
ii) Total plant height
iii) Number of root
iv) Highest root length
v) Root diameter

Figure 5

Character modulated from 14 days to 28 days in corm mediated emergence -

Significance difference in common
i) No. of leaf
ii) Leaf length
iii) Leaf breadth

Significance difference attenuated in
i) Total plant height
ii) Root diameter

+ Auxin at 28 days - Auxin at 28 days

Figure 6

In summary, it was found that no leaf emergence was developed at 28 days. Therefore, from 14 days to 28 days, only 'number of leaf', 'leaf length' and 'leaf breadth' were incresed (**Fig. 6**). Interestingly, the characters like 'total plant height' and 'root diameter' were significant at 14 days

time point but significance difference was attenuated in 28 days. Moreover, the characters like 'total weight', 'total plant height', 'number of roots', and 'highest root length' were not significantly different (**Fig. 6**). The summary of the result showed that auxin inhibited only in leaf emergence but not in the below ground characters (**Fig. 6**).

Author contribution statement

HAM conceptualized the idea, performed the experiment and wrote the manuscript. BP and MM performed experiments.

Acknowledgement

The communicating author (HAM) acknowledged sincerely to NMPB, Ministry of AYUSH for the financial support (Grand Number-Z.18017/187/CSS/R&D/WB-1/2016-17-NMPB-IVA, Dated: 05.08.2016) and DST, India for the financial support for DST-SERB project (Grand Number-ECR/2015/000184) as Early Career Research Award to HAM.

Compliance with ethical standards (e.g. Conflict of interest)

The communicating author (HAM) declared that there is no conflict of interest.

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[Article ID : 01/II/07/0221]

RADAR ENTOMOLOGY – NEW HORIZON IN ENTOMOLOGY

Devina Seram and Yendrembam K. Devi
Department of Entomology, School of Agriculture
Lovely Professional University, Phagwara, Punjab-144411, India

Introduction

Radar is a system for detecting the presence, direction, and speed of any object (Eg. aircrafts, ships, etc.) by sending out pulses of radio waves which are reflected back off the object. Radar has a more obvious connection with entomology than any of the remote sensing methods because it has been used effectively in direct observations of insects. The pioneering work in radar entomology that radar could be successfully used as a powerful entomological tool was initiated and performed by Schaefer in 1969. Following this pioneering demonstration, application of this technique has led to spectacular advances in the study of long-distance migration and other aspects of flight behavior in the field. Insects cannot perceive radar waves, at least at the power levels used in normal entomological studies, so the technique allows observations of undisturbed, natural behavior. Radar has also been used to investigate windfields affecting airborne insects.

Common Entomological Radars

Most of the radars used to date in entomological studies have been small, mobile, incoherent pulse systems using a wavelength of 3.2 cm and based on commercially available marine systems. These radars transmit from their antennae a narrow, conical beam of short pulses of electromagnetic waves. Any object illuminated by a pulse reflects or scatters some of the pulse energy, and a part of this scattered energy (the "echo") is returned in the direction of the radar. If the echo is strong enough, it is detected and amplified when it reaches the radar receiver, and the presence of a target is registered on a display device. Target direction can be deduced from the orientation and directive properties of the radar antenna, and target range from the time elapsing between transmission of the illuminating pulse and reception of the echo. Typical maximum detection of the received echo ranges between 1.5 - 2.5 km for individual medium-sized (100 mg) insects and up to several tens of kilometers for dense concentrations.

Stages of Operation in Radar Entomology

Two stages of target recognition are required in radar entomology.

1. First, it is vital to discriminate the echoes returned by insects from those of birds, bats, and precipitation;
2. Secondly, it is often necessary to identify the species of insect detected.

The first stage is usually accomplished easily, at least at close range, because the diffuse echo returns from precipitation are very different from discrete insect echoes and because the flying speeds and radar-derived wing beat frequencies of insects usually differ clearly from those of other animals. On the other hand, recognition of individual insect species from their radar returns is made difficult by intraspecies (within a species) spread and interspecies (between species) overlap of wing beat frequency. In most successful radar studies, identification has relied heavily on supplementary evidence of species composition acquired, for example, by aerial trapping or ground sampling in the takeoff area.

Other types of radar

In addition to the "**3.2-cm pulse radars**" that have been widely used for insect flight studies, a number of other types of radar have provided useful entomological observations from time to time:

1. Bistatic and Doppler radars for low-altitude studies
2. Millimetric-wavelength radars
3. Frequency-modulated continuous-wave (FMCW) radars
4. Tracking radars
5. Harmonic radars

Large radar installations : One of the first demonstrations that insects can be followed by radar was made with large, powerful tracking systems. Although large radars offer a substantial range advantage, in practice this tends to be offset by their lack of mobility, by the uncertainty about the degree to which the sensing beam is occupied by insect targets.

Conclusion

Entomological remote sensing using radar and specialized optical techniques is a very active field and has already made major contributions to the study of insect flight. There is considerable promise that techniques currently under development will greatly improve the identification capabilities of entomological radars, and this will facilitate the study of more species.

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[Article ID : 01/II/08/0221]

BACKYARD RECIRCULATORY AQUACULTURE SYSTEM

Anurag semwal, Avdhesh Kumar, Ujjwala upreti and Mahendra Kumar Yadav
College of Fisheries science,
G.B. Pant University of Agriculture and Technology,
Pantnagar, Uttarakhand

What is RAS

The Recirculatory Aquaculture System (RAS) is an aquaculture technique in which water is filtered and reused after suspended matter and metabolites are filtrated and separated. The system is used for the high-density farming of different fish species using a minimal land area.

Objectives

- To inspire small-scale farmers and women in household backyards to take up fish farming.
- To increase the production and consumption of fish on a regular diet.
- Promoting the production of income from small-scale fish farming and improving livelihoods.

What is required to set up an RAS unit

- Land of approx. 100 sq. m land
- Good water source
- Source of Seed and Feed

What fish to culture

- Most suitable for Monosex Tilapia and Pangasius
- Fingerling size (> 2gm)

Tilapia (*Oreochromis niloticus*)

Pangasius (*Pangasius pangasius*)

What & how to feed the fish

- Pellet feed with 28-30% protein
- 2-4 times a day
- Manual broadcasting

Who will construct and install the system ?

The National Centre for Aquatic Animal Health (NCAAH) will support farmers in the building of fish tanks and will produce and build the whole system, including cages, pumps, aerators, filters, etc.

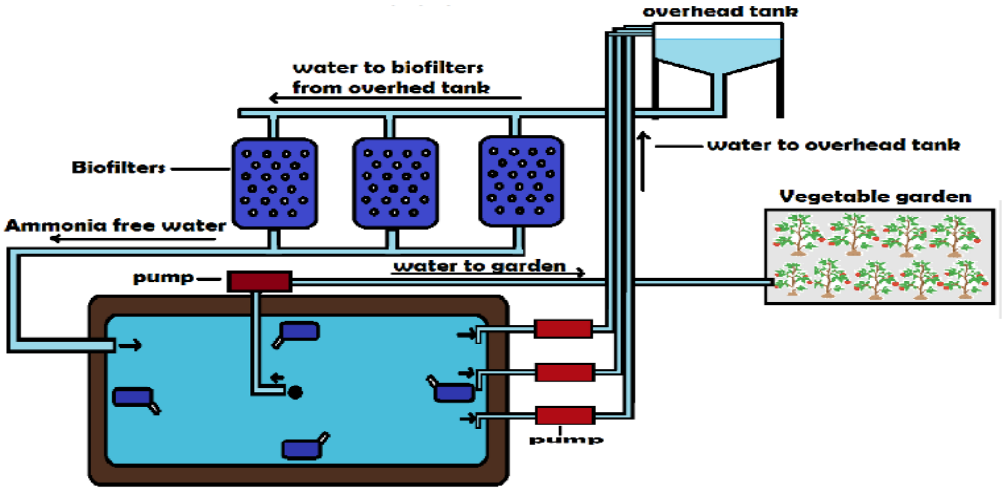
Desirable water quality to maintain

Temperature	:	26-30 ^{0}C
Dissolved Oxygen	:	4-6ppm
pH	:	7-8
Alkalinity	:	120-150ppm
Ammonia	:	<0.5ppm
Nitrite	:	<0.5ppm
Nitrate	:	<5ppm
Hydrogen Sulphide	:	Nil

What are the project Components?

- Awareness Workshop to applicants by AOC (Aqua- One Centre)
- Setting up by NCAAH
- Training for the farmers by AOC
- Input for culture by Farmer
- Advisory & Service delivery by AOC

Model Design



How much is the project Cost?

Setting up (Rs. 5.6 lakh) Tank Construction (excavation-1day)	:	Rs. 1.0 lakh
Procurement & installation of pumps, filters, cages, aerators, water-testing kit (9days)	:	Rs. 4.6 lakh

Details for setting up an RAS Unit		
Tank Dimension	:	6.7 m x 6.7 m x 2 m
Water Volume of the Tank	:	90,000 litres each
Nos. and Volume of cage	:	3 cages of 30,000 litres each
Pond Bottom with Central slurry pit	:	Conical with 18o slope
Water Depth at deepest point	:	3.3 m
Effective water depth	:	2 m
Pump	:	0.5 hp centrifugal pump
Aerators (Venturi system)	:	4 systems in a pond
Biofilter	:	Trickling, Nitrifying Bioreactor

How to calculate fish yield and Income		
Culture period	:	5-6 months
Stocking	:	1500 fish per cage; 4500fish per unit
Harvest size	:	450 gm
Expected survival	:	80%
Target harvest/ yield	:	1600 kg per unit/cycle
Crops per Year	:	2
Market Sale price	:	Rs.130/Kg
Gross income/yr.	:	Rs. 4.6 lakh
Gross profit/yr.	:	Rs. 1.36 lakh
Profit earnings/month	:	Rs. 11,300

Conclusion

Recirculating aquaculture system is the key to the future of aquaculture. Its merits outweigh its disadvantages. It allows sustainable use of water supplies, and in areas where high quality water is scarce. Although it has high costs for the establishment, the scale of the RAS is huge.

[Article ID : 01/II/09/0221]

ROLE OF BIOLOGICAL METHODS IN INTEGRATED DISEASE MANAGEMENT

Harish J[1], Sunaina B.[1] and Anita P.[1],
[1] Department of Plant Pathology,
Rani Lakshmi Bai Central Agricultural University, Jhansi, UP
Corresponding author's email id: anitapau6243@gmail.com

Abstract
Plant diseases cause the reduction in yield and income. Control measures should be taken to reduce the incidence. Integrated disease management (IDM) plays very important role in reduction of disease inoculum. In recent days, biological control has become one of the important strategy in IDM for control of plant diseases due to harmful effects of fungicide application and also their easy commercial multiplication and economically cheaper compare to other chemical fungicides. However, efficiency of biological methods varies with geographical area, soil texture, clay content, crops, and moisture content. Due to increasing consciousness among the people regarding the residual effects of the chemical used and the beneficial effects of the biological agents, used of biological con troll methods has been becoming very important.

Key words : Bio control agents, suppressive soils, pathogen, disease, antagonism, disease incidence, management,

Introduction
Plant diseases cause more devastation in crop production. All crops are susceptible to diseases caused by many pathogens. According to FAO, losses in production due to diseases are 12% annually. The losses are also increasing due to diversified agricultural practices. Diseases have to be controlled to increase the yield and productivity and ultimately to increase farmer's income. Management of these diseases is a significant component in crop production. Different conventional methods like cultural, physical, biological and chemical methods are important. In recent years, farmers follow chemical control widely rather than other methods due to their quick action provided by low concentration. However, their high cost, excessive use of agrochemicals and residual effects leads to environmental pollution. Knowing its harmful effects, it is high time to search for alternative methods. Among all alternative methods, biological control is gaining popularity due to eco-friendly and economical nature. Biological control refers to the purposeful utilization of introduced or resident living organisms, other than disease resistant host plants, to suppress the activities and populations of one or more plant pathogen. The use of microbial antagonists to reduce diseases as well as the use of host specific pathogen to control weed and insect populations is generally referred as biological control agents (BCA). The main advantage of using BCA is that they are pathogen specific and cause less harm to non-target species. The major biocontrol agents are *Gliocladium virens, Trichoderma harzianum, Trichoderma viridae, Purpureocillium lilacinum, Fusarium oxysporum, Agrobacterium radiobacter* K-84, *Bacillus subtilis, Pseudomonas fluorescens,* etc. Biological control also includes suppressive soils, trap crops (bhendi, marigold, mustard), antagonistic crops, botanicals etc.

Integrated disease management (IDM) is defined as a decision based process involving coordinated use of multiple tactics for optimizing the control of pathogen in an ecologically and economically manner. IDM is majorly based on application of combined strategies and tactics. Biological control play very important role in IDM, in which BCA enhances the root zone microflora, reduce the

pathogen incidence. Even though fungicides are giving results but due to their residual effects, biological methods are used against certain pathogens, BCA is available in cheaper cost and it can easily be multiplied in FYM and soil. Besides, used of bio-control agent will reduce the amount of the use of chemical fungicides for managing the diseases, thereby reducing the residual effect.

Mycelium and resting spores of fungi such as *Pythium, Phytophthora, Rhizoctonia, Sclerotinia,* and *Sclerotium* have been parasitized by fungi which belong to some Chytridiomycetes and Hypomycetes families. The major beneficial microorganisms are *Trichoderma, Pseudomonas, Bacillus, Gliocladium*, etc. Biocontrol agents using antagonistic microorganisms help in practical and economical alternative for management of plant pathogens. The level of disease control by BCA's to the crop is nearly equivalent to fungicide action. These BCA have multiple mode of action with target specific, also control the seed borne diseases and enhance the plant growth. The efficiency and durability of BCA's depends on specific traits of the pathogen such as genetic diversity and ability to evolve in opposite to selection pressure. This was affected by mutation, population genetics, and recombination. Selection pressure clearly depends on extent use of biocontrol agents and also specific mode of action of BCA.

Mechanisms of Biocontrol agents

A proper understanding of concept of mechanism of action of BCA's will improve the consistency of management. There are two types of mechanisms are involved, direct antagonism and indirect antagonism.

Direct antagonism

Hyper parasitism

It is the most direct form antagonism. It involves huge tropical growth of biocontrol agents against pathogen. Mycoparasitism is under the control of enzymes. The two enzymes are chitinase and beta−1, 3 gluconase helps Trichoderma in biological control. A single pathogen can be attacked by multiple hypoparasites e.g. *Ampelomyces quisqualis* and *Gliocladium virens* that can parasitize powdery mildew pathogen. Many fungi show to antagonize and inhibit the numerous fungal pathogens of aerial plant parts. E.g. *Chaetomium* spp. And *Anthelia bombacina* suppress *venturia inaeqalis*. *Darluca filum* parasitizes several rusts, *Ampelomyces quisqualis* parasitize powdery mildew. *Gonatobotrys simplex* and *Nectria inventa* parasitize *Alternaria* species.

Competition

Both pathogens and biocontrol agents are compete for the nutrients and space to get establishment. Usually BCA's compete for nutrients is rare, but, for micronutrients such as iron and manganese in highly oxidized and arable soils. Biocontrol agents have more efficient in production of iron binding ligands called siderophores. This forms a complex called siderophore-fe-complex. This results in less availability of iron for the pathogen leads to less pathogen infection.

Antibiosis

Production of low molecular weight compounds or antibiotic compounds by microorganisms that are directly affect the pathogen. An efficient biocontrol agent produces sufficient qualities of antibiotics reduce the pathogen inoculum density. *Pseudomonas putida* WCS358r strains produce phenazine and 2, 4-diacetyl pholoroglucinol improves capacity to suppress plant diseases in the field. *Bacilluscereus* strain UW85 produces both zwittermycin and kanosamine.

Production of lytic enzymes

Microorganisms secrete and excrete other metabolites that interfere with pathogen metabolic activities. Lytic enzymes can hydrolyze chitin, proteins, cellulose, hemicellulose and DNA. E.g.

control of *Sclerotium rolfsi* by *serratia marcescens mediated* by chitinase expression. Hydrogen cyanide effectively blocks the cytochrome oxidase pathway is high toxic to all aerobic microorganisms.

Indirect antagonism

Induced systemic resistance

It is indirect form of antagonism. Many classes of compounds are released by the *Trichoderma* spp. into the zone of interaction and induce resistance. Induced resistance is one of the mechanism by which the resistance is obtained in the host against pathogens. The defense responses includes thickening of cell wall by lignification, production of phytoalexins, proteins, pathogen related proteins, enzymes stops the spread of disease to other parts of the plant.

Cross protection

An organism which first arrives at an infection site acts directly or indirectly against a pathogen that arrives later. E.g. Symptomless strains of the TMV are used to protect tomatoes from virulent strains of the same virus. Cross protection involves inoculation of young citrus trees and nursery with mild strain of Tristeza virus inoculated trees protected from virulent strain.

Suppressive soils

Many soil borne pathogens such as *Fusarium, Rhizoctonia*, Take-all disease, *Pythium* spp ciolonized well in soil and cause severe diseases and makes the soil conducive for diseases. The soil in which, these soil borne organisms develop less and cause mild disease due to some innate bio-chemical or biological property of the soil is termed as suppressive soils. A number of antagonistic microorganisms have been naturally found in suppressive soils such as *Trichoderma, Pencillium, Pseudomonas, Bacillus*, etc. These microorganisms produce antibiotics, lytic enzymes, competition for food and do not allow pathogen to reach high inoculum density. However, continuous monoculture of crops in conducive soils sometimes leads to suppressive soils after some years. Suppressive soil added to conducive soil also reduces the disease inoculum. The degree of supressiveness depends on soil physical and chemical characteristics like fertility level, biodiversity, soil pH, organic matter, clay content, and population of soil microflora and soil management. The mechanism of suppression is through antibiosis, competition, parasitism and predation. Suppressive soils can be divided to two broad types, natural and induced. Natural supressiveness is correlated with the physical properties of soils and relatively not depends on crop history. In induced supressiveness, it is majorly dependent on agricultural practices. Soils that naturally suppress the development of wilt diseases were identified in various cropping systems in the world. Soil suppressive to Take-all disease of wheat was identified under cropping conditions, that is, monoculture over the years. Avocado root rot caused by *Phytophthora cinnamomi* was controlled due to supressiveness created by highest number of microorganisms with higher nitrogen and calcium content. Suppression of inoculum densities of *Pythium ultimum* was found in finely textured soils.

Antagonistic Plants and botanicals

A few kinds of plant e.g. Asparagus and marigold, are the antagonistic to nematodes because they release substances in the soil that are toxic to several plant parasitic nematodes and fungi. When interplant with nematode susceptible crops, antagonistic plants decreases the number of nematodes in the soil and in the roots of the crops. E.g. sorghum secrets HCN that inhibit *Fusarium* population. Marigold roots secrets alpha-tertinyl which reduces root knot nematode. Mustard produces glucosinolates reduces the incidence of soil borne nematodes. Scales of red onion produces catechol and protocatechuic acid reduces the smudge incidence. A number of botanicals

are used against a number of fungal disease. Commercially used botanicals are neem, garlic, turmeric, eucalyptus, tobacco, lemon grass, etc. The leaf extracts of *Eucalyptus globosus* (5%) and *Azadirchta indica* (5%) exhibits greater antifungal against *Alternaria brassica*e and *Albugo candida*.

Conclusion

Integrated approach of preventive and corrective measures to keep the pathogen from causing significant problems. IDM is a disease control approach which uses all the management strategies to maintain disease pressures below an economic injury. It does not allow a regular application of chemicals, but promotes cultural, physical and biological methods in which regular application of fungicides effect the environment. Practical application of biocontrol agents in the field level are not showing effective results due to constraints such as soil type, soil texture, soil pH, convenience, efficacy, reliability, BCA's shows diversity in different field conditions. Some experiments resulted that biological control has the nearly same efficiency as fungicide application. The combined systematic using of all control methods such as cultural, physical, chemical method and biological methods would be economical and control these diseases effectively. Benefits of IDM in disease control are more than that achieved by individual method.

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[Article ID : 01/II/10/0221]

ECOLOGICAL NICHE MODELING FOR ASSESSING POTENTIAL DISTRIBUTION OF *DIPTEROCARPUS TURBINATUS* C.F. GAERTN IN MAHANADA WILDLIFE SANCTUARY OF DARJEELING DISTRICT, NORTH BENGAL

Lakra P. C.[1], Ehrar, O.[2] and Biswakarma S.[1]
[1] Environmental Research Station, Darjeeling
[2] Central Tasar Research & Training Institute, Nagri (Ranchi) Jharkhand

Abstract
The prospective application of ecological niche modeling can be seen in this study, which maps the potential distribution of *Dipterocarpus turbinatus*, one of the indigenous tree species in the Mahananda Wildlife Sanctuary. This study has also tested the efficiency of the MaxEnt model as it has given accurate and précised result about the species distribution. Different environmental variables comprising of annual mean temperature, temperature seasonality, maximum and minimum temperature of warmest month , precipitation seasonality, human influence index, elevation, slope and land use land cover were used to model the distribution of the species . In the study area of Mahananda Wildlife Sanctuary, we have collected multiple sample points at different location using GPS of the target species namely *Dipterocarpus turbinatus* (Garjan) over the entire Mahananda Wildlife Sanctuary area. The South-Western region of the study area has shown the higher potential, followed by the South-Eastern and Northern region. The prediction ranges from 0 to 1, 0 suggesting no potential for the occurrence and 1 shows high potential for the occurrence of the *Dipterocarpus turbinatus*. The North-Western region followed by Eastern region has shown the minimum support for the distribution of the *Dipterocarpus turbinatus* in the study area. The potential distribution of the *Dipterocarpus turbinatus* in the study area was predicted by MaxEnt model which involved multiple predictor variable like Bioclimatic variables, Elevation, Slope, Soil, LULC, and Human Influence Index, where the maximum contribution of Elevation is 39.1% followed by Human Influence Index with 14.2%, Soil with 12.7%.

Key words : MaxEnt model, human influence index, *Dipterocarpus turbinatus.*

Introduction
Ecological niche is defined as the position of a species within an ecosystem, describing how an organism responds to the distribution of resources and competitors (Khatibi and Sheikholeslami, 2016). A species' niche includes all of its interactions with the biotic and abiotic factors of its environment. Biotic factors are living things, while abiotic factors are non-living things. The concept of the ecological niche relates a set of environmental variables to the fitness of species, while habitat suitability models (HSMs) relate environmental variables to the likelihood of occurrence of the species (Khatibi and Sheikholeslami, 2016). The environment is in most cases represented by climate data (such as temperature, and precipitation), but other variables such as soil type, water depth, and land cover can also be used. Among various predictive factors, climate is expected to play a dominant role in determining the distribution of any species (Pearson and Dawson, 2003). It is tremendous for a species to occupy a unique niche in an ecosystem because it reduces the amount of opposition for resources that species will come upon. The environmental niche can be viewed as the set of environmental conditions that allow a given species in question to survive, reproduce and grow. However, a species can occupy only a part of its fundamental

environmental niche in a particular ecosystem - that is its realized niche. The concept of the ecological niche was used to understand and model anthropogenic impacts on species distribution (Peterson, 2003).

Ecological niche models (ENMs) are used for predicting species distribution, in which the primary assumption is that species distributions are always in equilibrium with current climate (Ray et al., 2015). ENMs combines known occurrence records with relevant environmental layers to estimate species' ecological requirements and potential geographic distributions (Menon et. al. 2010). This model is used to analyses a wide variety of biodiversity phenomena, including geographic distributions, future potential distributions under scenarios of climate change, species' invasions , agricultural crop damage by pest organisms, and priorities for biodiversity conservation (Ortega-Huerta and Peterson, 2008). ENMs are used to estimate the relative suitability of habitat known to be occupied by the species, to estimate the relative suitability of habitat in geographic areas not known to be occupied by the species, to estimate the changes in the suitability of habitat over time given a specific scenario for environmental change and as estimates of the species niche (Warren and Seifert, 2011). Environmental variables such as climatic, topographical and habitat data are used for predicting species distribution (Sillero, 2012). ENMs require either presence-absence data for the target species, or presence-only data for prediction (Ray et al., 2015). Presence only data is more accurate than presence-absence data for Ecological Niche Modelling (Pearce and Ferrier 2000). Ecological niche modelling predicts the suitable area of the species and therefore allow elaboration of conservation strategies (Silva et al., 2018).

Maxent is a program for species distributions modelling from presence-only species data (Elith et al., 2010). It is becoming one of the most common software for Ecological Niche Modelling because it is easy to use (Warren and Seifert, 2011) and it fits the problem of species distribution modelling cleanly and efficiently (Ortega-Huerta and Peterson, 2008). It requires only presence data together with environmental information for predicting species distribution (Fourcade et al., 2014). Maxent generates accurate model and provide an output which show the role of each environmental variables in prediction model (Ortega-Huerta and Peterson 2008). The prediction made by Maxent is continuous and it integrates fine topographic data to produce more detailed prediction (Phillips et al., 2005). Maxent gives high predictive accuracy and have many features that gives good model performance in minimum time (Phillips and Dulik, 2008).

It is the indigenous trees within the areas from India like Andra Pradesh, Assam, Manipur, Meghalaya, and Tripura. The trees of *Dipterocarpus turbinatus* are lofty, it can grow upto 30-45 meter tall. The bark is gray or dark brown, and is shallowly longitudinally fissured and flaky. Branchlets are glabrescent. The leaf buds are falcate, with both buds and young twigs densely gray and puberulous. The stipules are 2 to 6 centimeter, densely, shortly dark grayish or dark yellow puberulous; the petiole is 2–3 centimeter, densely gray puberulous or glabrescent; the leaf blade is ovate-oblong, 20-30 × 8–13 centimeter, leathery, glabrous or sparsely stellate pubescent, lateral veins are in 15-20 pairs conspicuously raised abaxially, base rounded or somewhat cordate, margin entire or sometimes sinuate, apex acuminate or acute. It is found in mixed deciduous, evergreen and semi-evergreen forests. The conservation status is based on the rate of habitat loss, the major threat for the species, though some subpopulations are protected in reserves.

Materials & Methods

Study areas : Mahananda Wildlife Sanctuary is located on the foothills of the Himalayas, between the Teesta rivers and Mahananda rivers. It is situated in the Darjeeling district of West Bengal,

India; it comes under Darjeeling Wildlife division .The sanctuary covers at area of 159 km^2 of reserve forest and was started as a game sanctuary in 1955. In 1959, it got the status of a sanctuary mainly to protect the Indian bison and Royal Bengal tiger, which were facing the threat of extinction. The forest type in Mahananda Wildlife Sanctuary varies from riverain forests like Khayer-Sisoo to dense mixed-wet forest in the higher elevation in Latpanchar area of Kurseong hills. The variation in altitude and forest types helps the existence of a large number of species of mammals, birds and reptiles. Varying altitude from 500 ft at the southern range of Sukna forest to the elevation up to 4,500 ft at Latkothi beat office covers varied vegetation and is home to superb biome restricted species. Latpanchar actually forms the highest part of the Sanctuary, with an average altitude of 4200 ft.

Satellite data

The Landsat ETM+ and DEM was used in this study area. Erdas Imagine 9.1 and Arc GIS 10.2 software was used for digital image processing and spatial database. Aster DEM data with forest area boundary was clipped. A digital elevation was developed from ASTER data of 30 meter resolution. GIS layers of areas of occurrence for *Dipterocarpus turbinatus* and elevation was created. This map along with Survey of India topographical sheet of 1:50,000 was used for ground truth verification as per GPS location.

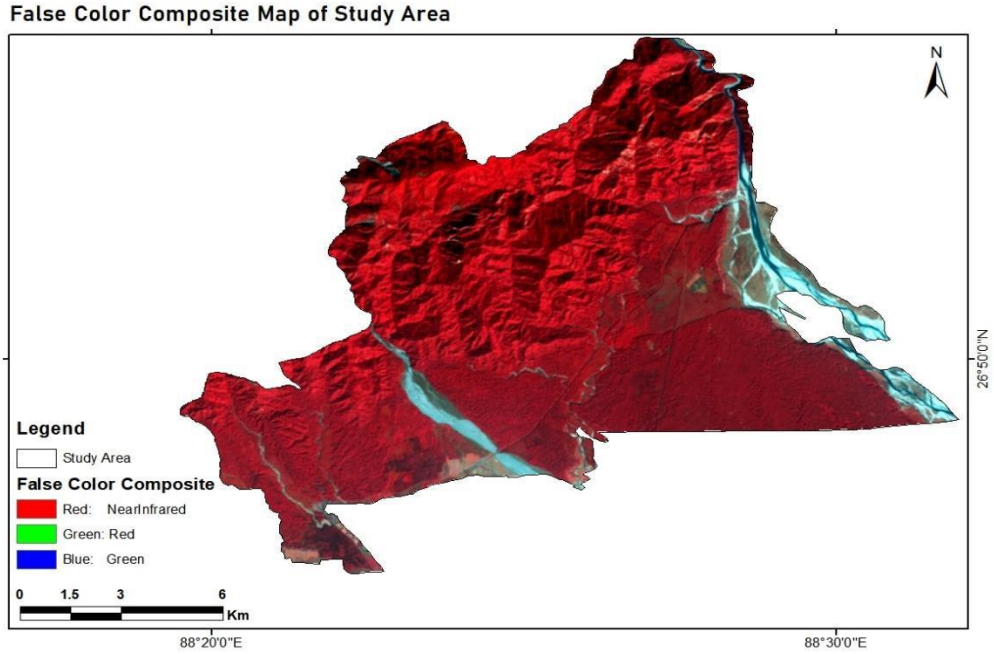

Figure 1 : Study areas map of Mahanada Wildlife Sanctuary

Maxent model

MaxEnt is a grid-based machine learning algorithm that follows the principle of maximum entropy. It takes species presence only data and predict the distribution of a species. It is based on maximum entropy algorithm and can be downloaded from the website: - http://www.cs.princeton.edu/schapire/maxnet/ (Phillips et al., 2006).

Modeling procedure

Dipterocarpus turbinatus occurrence point data was divided into training data (75 % of occurrence point data used for model prediction) and test data (25 % occurrence point data used for model validation). Fourteen replications of the model will be run and sub sample is used as replicated run

type. The regularization multiplier will retain as the default value of 1. The maximum iterations will be fixed at 1000 with a convergence threshold of 0.00001. Area under the receiver operating curve (AUC) used for accuracy assessment of the model outputs. It ranges between 0 and 1, with AUC value more than 0.8 considered as good prediction.

Data used

Table 1: Bioclimatic variables use in niche modelling

Code	Biometrics variable	Unit
Bio_01	Annual mean temperature	Celsius
Bio_04	Temperature Seasonality (Std. deviation*100)	Celsius
Bio_05	Maximum Temperature of Warmest Month	Celsius
Bio_06	Maximum Temperature of Warmest Month	Celsius
Bio_12	Annual Precipitation	mm
Bio_15	Precipitation Seasonality (Coefficient of variation)	mm
Bio_16	Precipitation of Wettest Quarter	mm
Bio_17	Precipitation of Driest Quarter	mm

Methodology

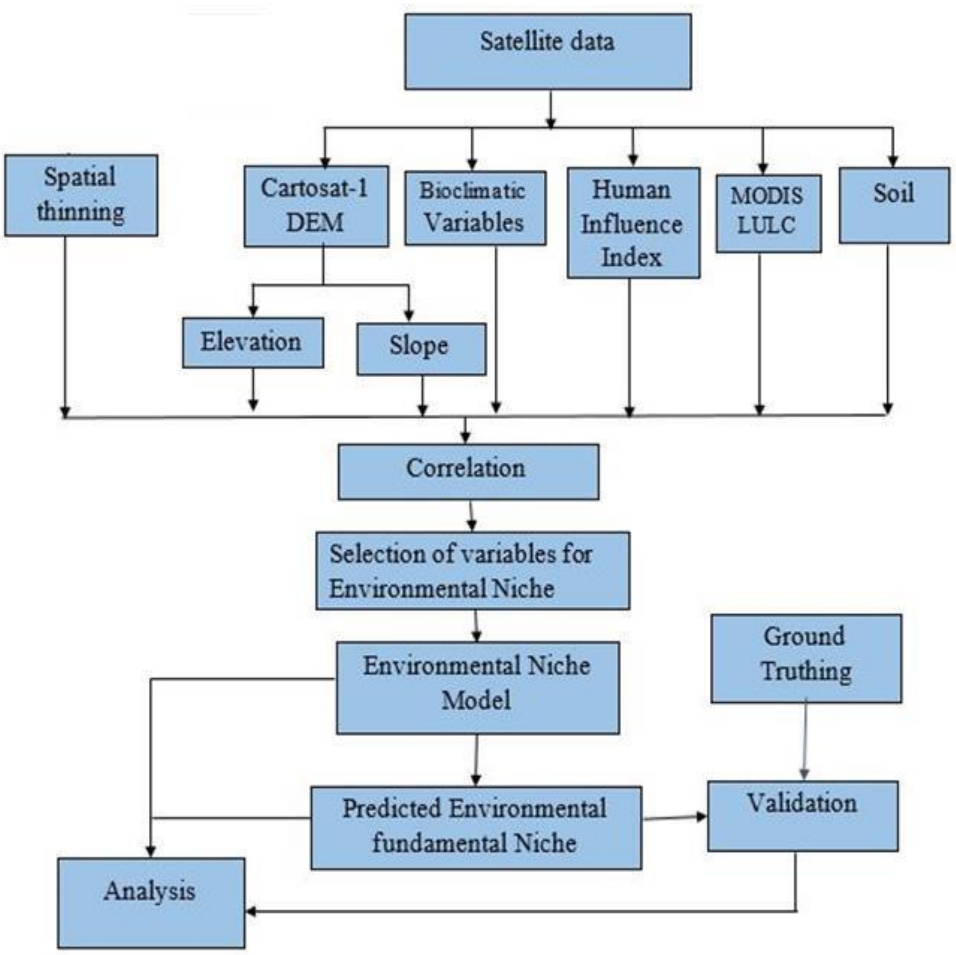

Figure 2 : Flowchart for assessing the present distribution of *Dipterocarpus turbinatus* in Mahananda Wildlife Sanctuary.

Result and discussion

Result

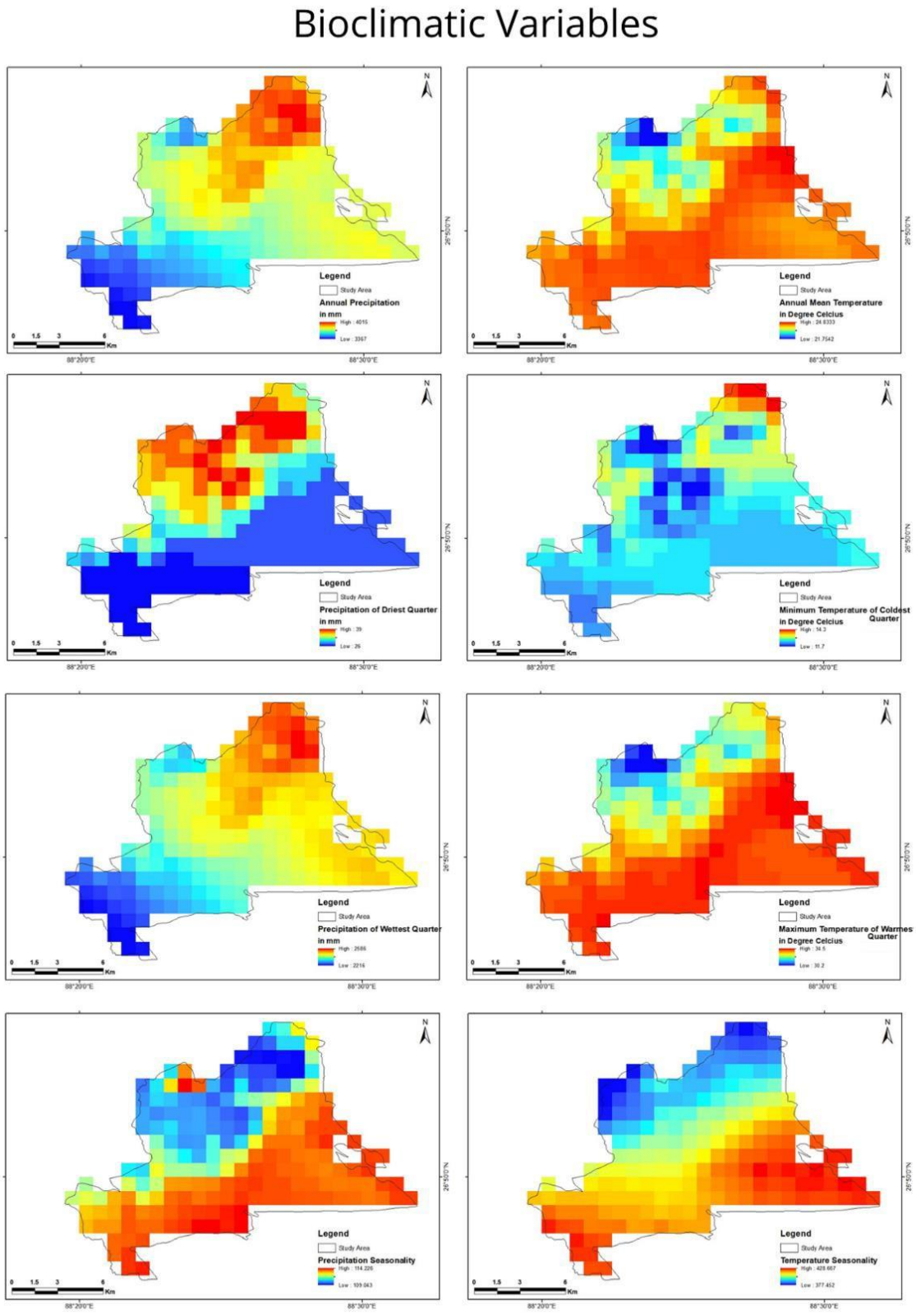

Figure 3 : Map showing different Bio-Climatic variables

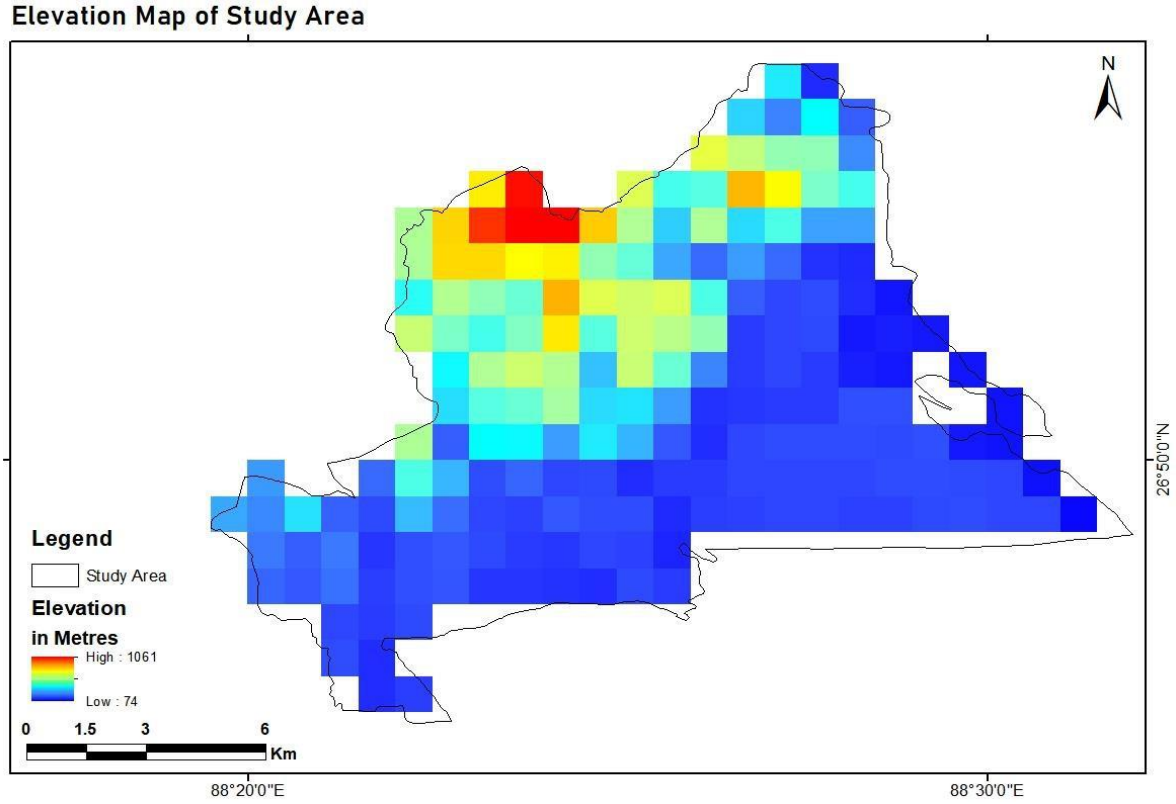

Figure 4 : Map showing Elevation map of the study areas.

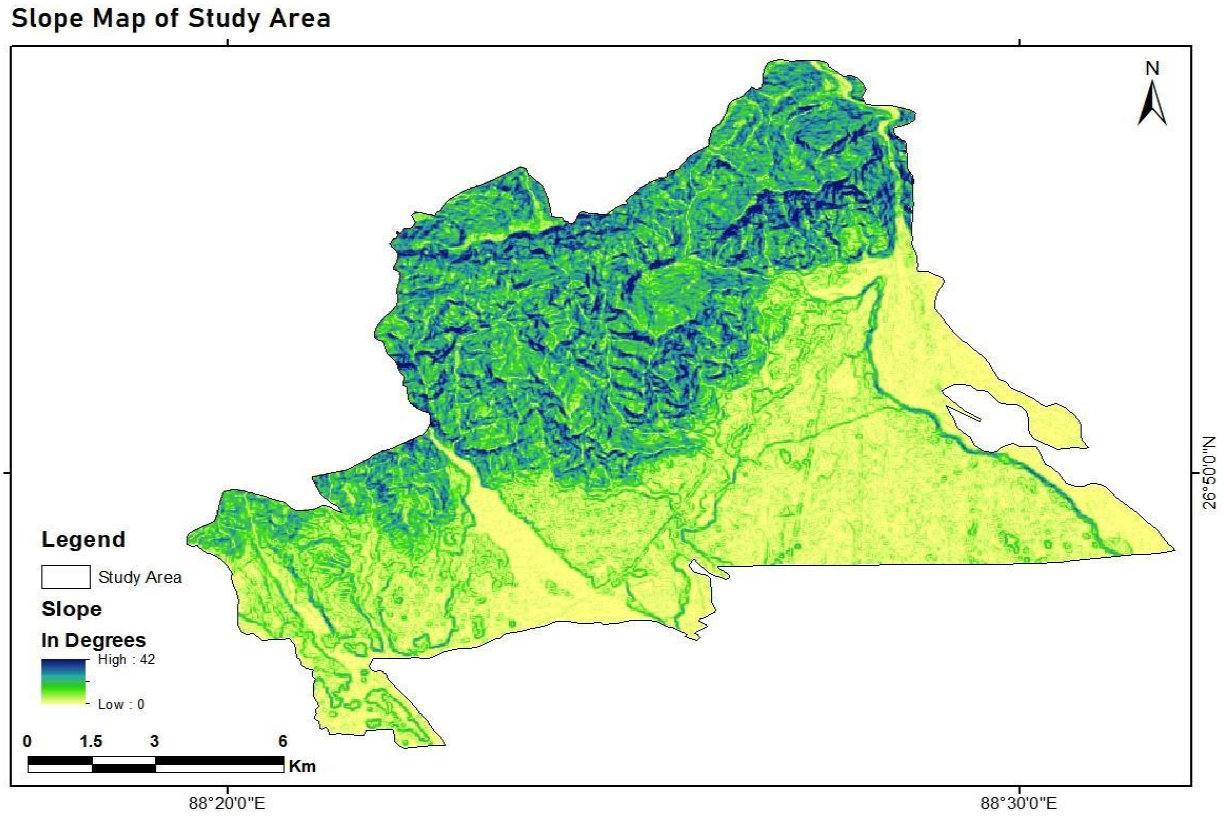

Figure 5: Map showing Slope map of the study areas

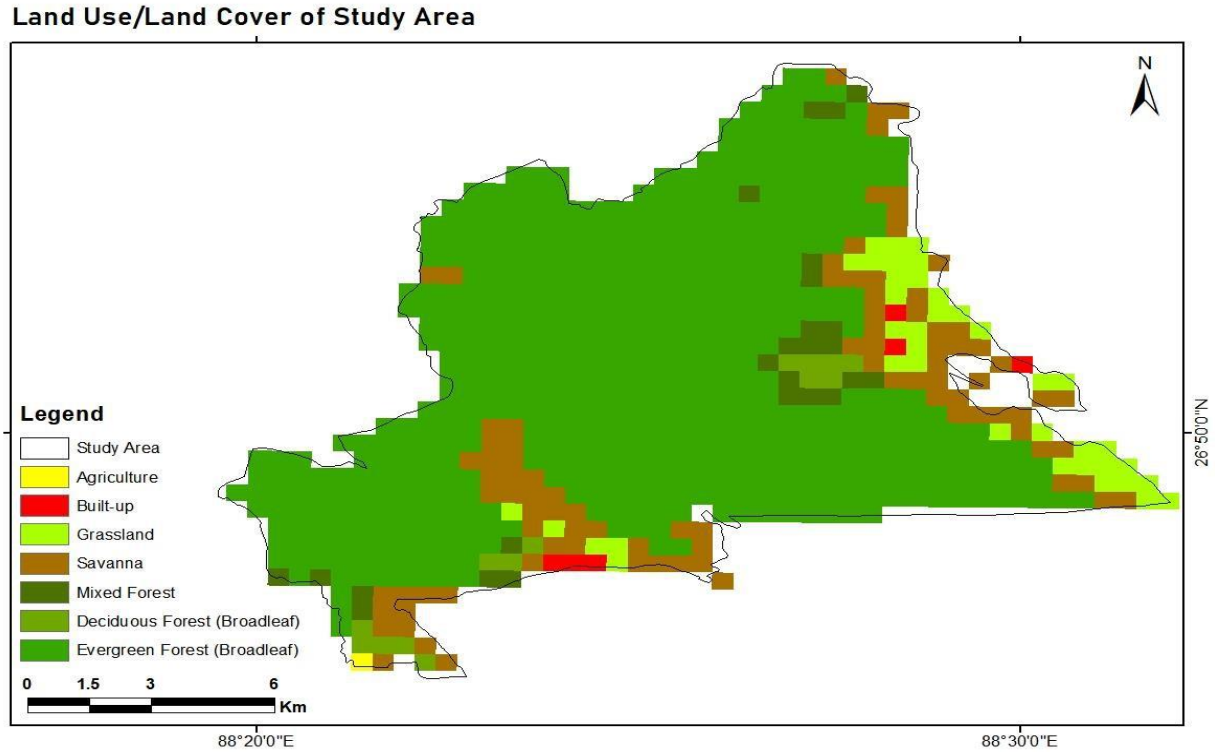

Figure 6 : Map showing Land Use & Land Cover map of the study areas

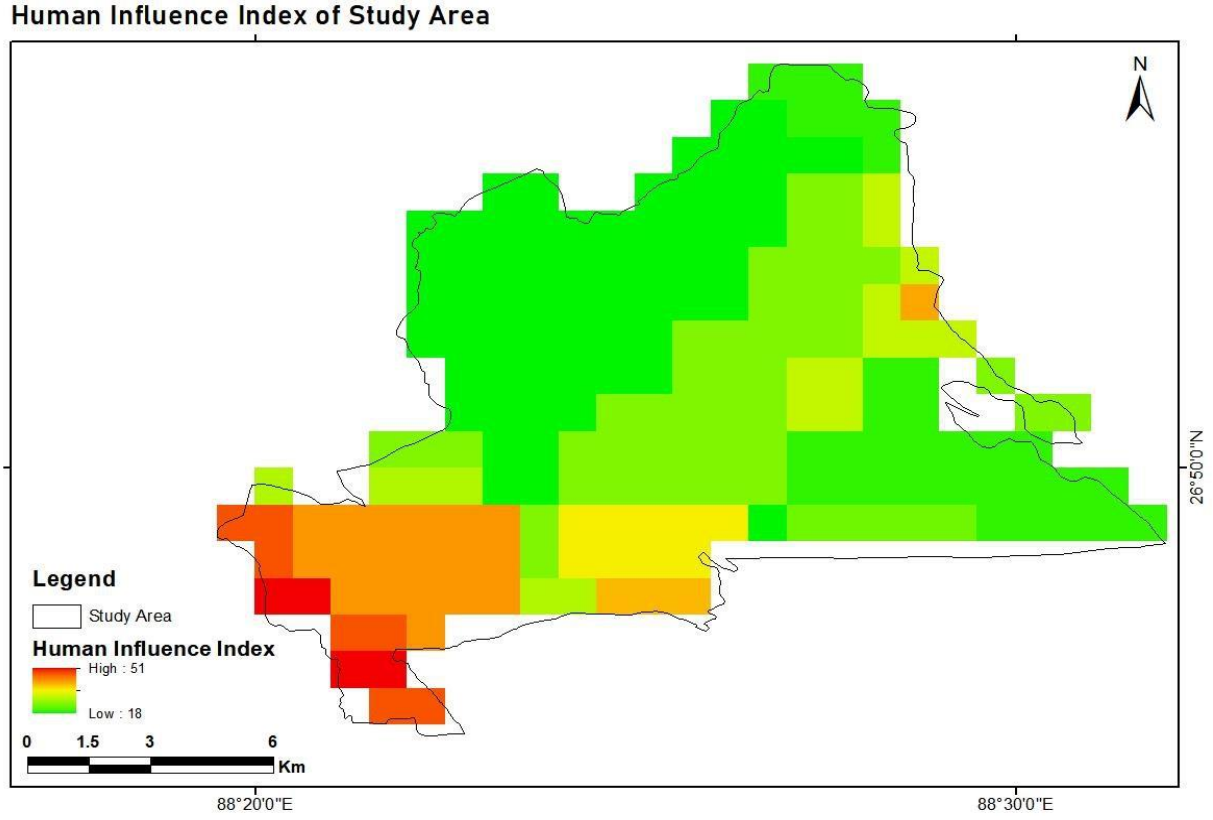

Figure 7 : Map showing Human Influence Index map of the study areas

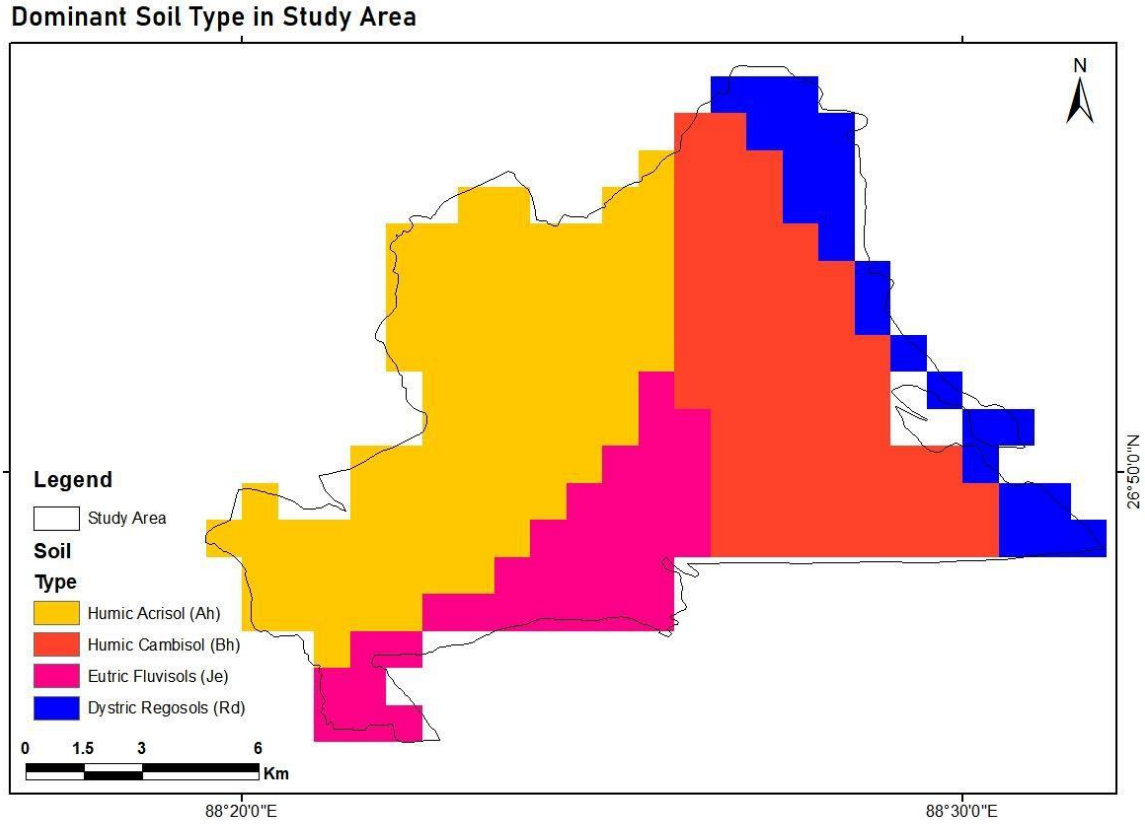

Figure 8 : Map showing Dominant soil types map of the study areas

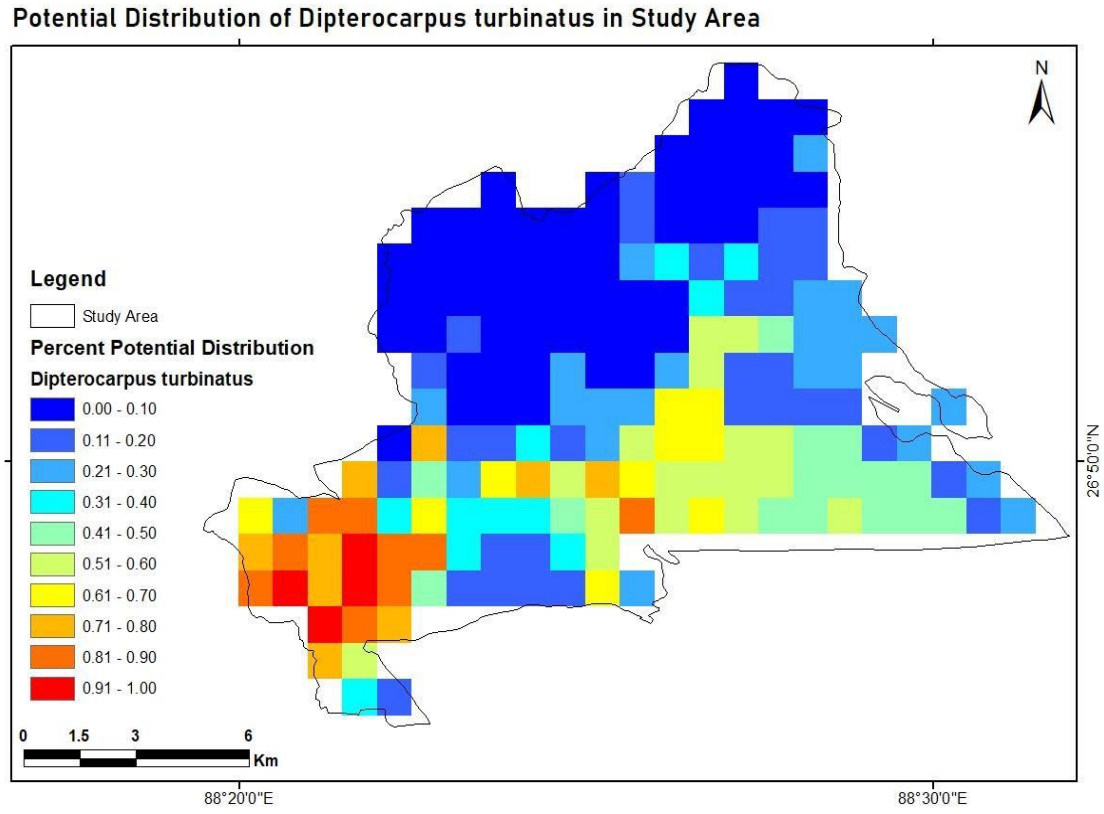

Figure 9 : Map showing Potential Distribution of *Dipterocarpus turbinatus* in the Study area

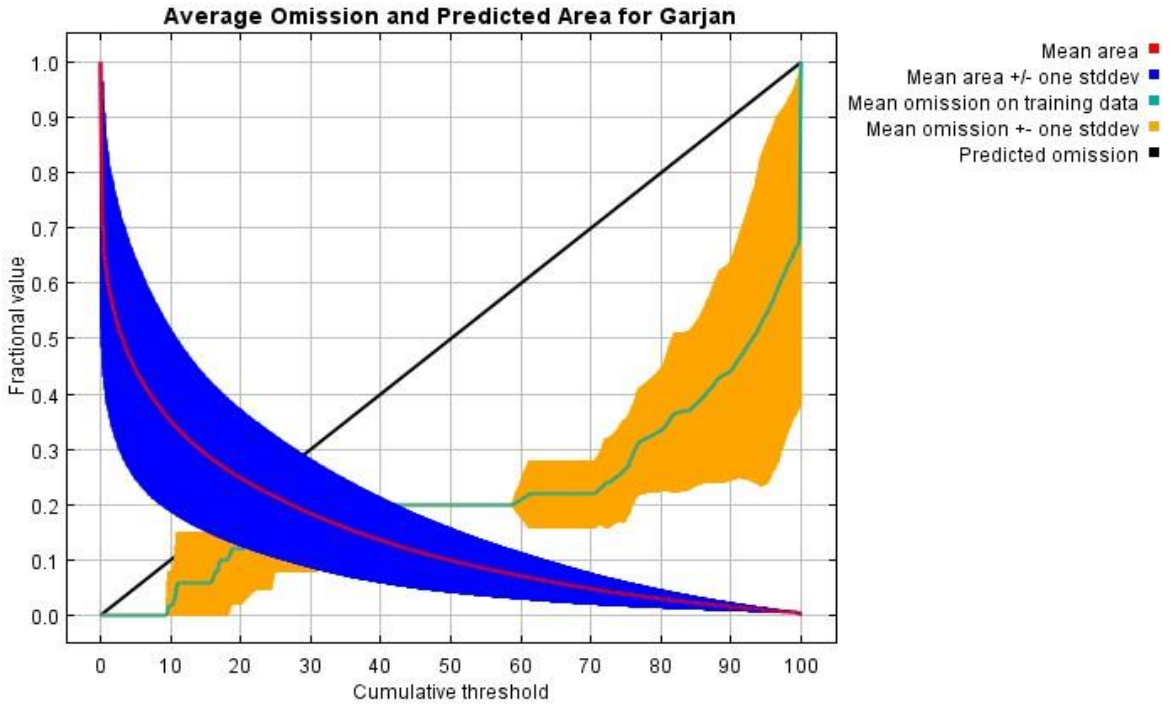

Figure 10 : Average omission and prediction area for *Dipterocarpus turbinatus*

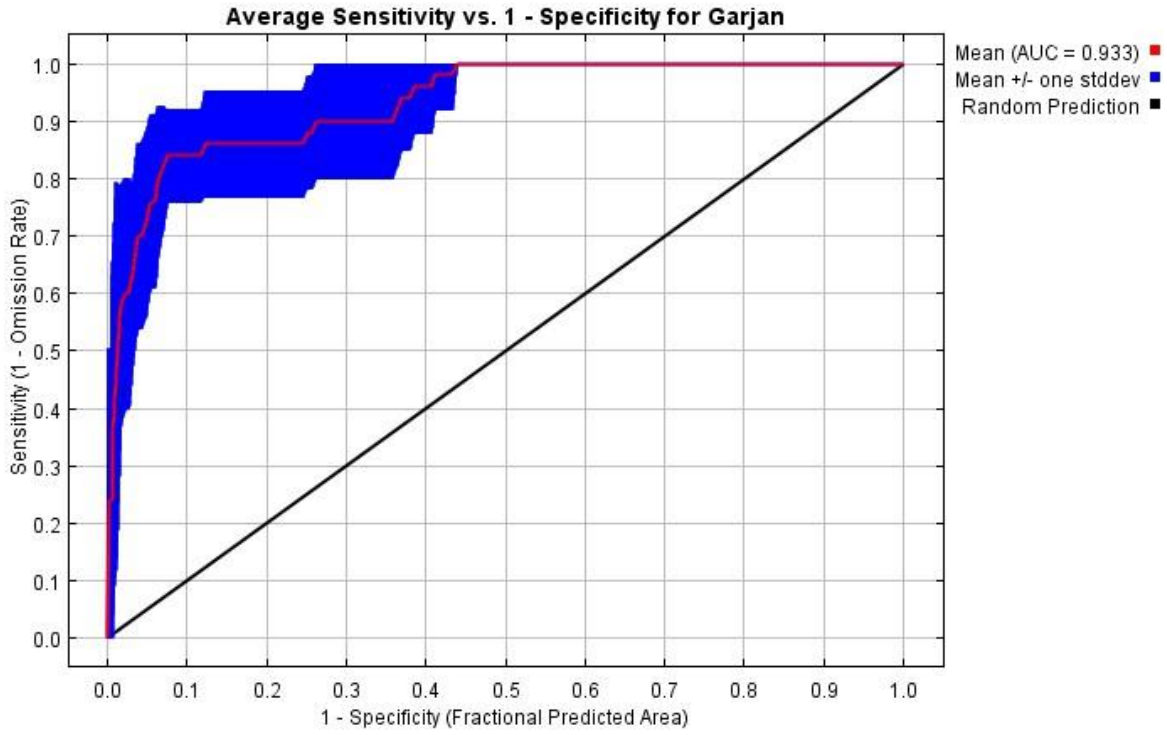

Figure 11 : Sensitivity Vs Specificity of prediction for *Dipterocarpus turbinatus*

Variable	Percent contribution	Permutation importance
dem_res_img	39.1	34.4
hii_asia	14.2	0.2
soil_img	12.7	7.8
bio__16__asc	11.9	17.2
lulc_rec_clip_img	10.4	13.2
bio__17__asc	6.4	6.2
slope_clip_img	1.8	7.1
bio__1__asc	1.2	8.3
bio__15__asc	0.8	0
bio__5__asc	0.7	4.3
bio__12__asc	0.5	0
bio__6__asc	0.3	1.2
bio__4__asc	0	0

Figure 12 : Percent contribution and permutation importance of respective variables for the distribution of *Dipterocarpus turbinatus*

The potential distribution of the *Dipterocarpus turbinatus* is done using Ecological Niche modelling, basically by the help of MaxEnt model which depicts the occurrence pattern of the target species over the region. In the study area of Mahananda Wildlife Sanctuary, we have collected multiple sample points using GPS of the target species namely *Dipterocarpus turbinatus* (Garjan) over the entire Mahananda Wildlife Sanctuary area. All the sample points were derived from different sample plots of 500x500m plots dimension. The potential distribution of the *Dipterocarpus turbinatus* in the study area was predicted by MaxEnt model which involved multiple predictor variable like bioclimatic variables, elevation, slope, soil, land use land cover , and human influence index. The AUC was above 0.933 for all variables indicating very high accuracy **(Swets et al. 1988)**. The prediction ranges from 0 to 1, 0 suggesting no potential for the occurrence and 1 shows high potential for the occurrence of the *Dipterocarpus turbinatus*. The red color showed the maximum potential, the blue showed the minimum potential whereas all the in between colors showed the varying potential distribution of the target species. The South-Western region of the study area has shown the higher potential, followed by the South-Eastern and Northern region. The North-Western region followed by Eastern region has shown the minimum support for the distribution of the *Dipterocarpus turbinatus* in the study area. The MaxEnt model also allows to perform an internal jack-knife test to quantify the importance of the variables on influencing the distribution of *Dipterocarpus turbinatus*. The distribution shows that the elevation contributed the most that is 39.1% followed by Human Influence Index with 14.2%, soil with 12.7%, Precipitation of Wettest Quarter (Bio_16) with 11.9% and LULC with 10.4% rest of the variables contributed less than 10.

Conclusion

The prospective application of ecological niche modelling can be seen in this study, which maps the potential distribution of *Dipterocarpus turbinatus* in the Mahananda Wildlife Sanctuary. This study has made an attempt to understand the relationship between the predictor variables including bioclimatic variables, elevation, slope, soil, land use land cover, and human influence

index and target species. This study has also tested the efficiency of the MaxEnt model as it has given accurate and précised result about the species distribution. MaxEnt has provided a number of outputs, such as the contribution of each predictor variables. Elevation contributed the most that is 39.1% followed by Human Influence Index with 14.2%, Soil with 12.7%, were the variable with maximum contribution, for mapping the potential distribution of the *Dipterocarpus turbinatus*.

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[Article ID : 01/II/11/0221]

THE EVOLUTION OF HONEYBEES COMMUNICATION

Sourav Singh[1*] and Monika Sharma[2*]
[1*]Department of Entomology, School of Agriculture
[2*]Department of Agronomy, School of Agriculture
Lovely Professional University, Jalandhar, Punjab, India, 144411
[1]Email: souravsinghrajoria@gmail.com
[2]Email: ms9375033@gmail.com

Abstract
Honey bee dance has been intensively studied as a communication system, and yet we still know very little about the neurobiological mechanisms supporting how dances are produced and interpreted. Here, we discuss how new information on the functions of the central complex (CX) of the insect brain might shed some light on possible neural mechanisms of dance behaviour. We summarise the features of dance communication across the species of the genus Apis. We then propose that neural mechanisms of orientation and spatial processing found to be supported by the CX may function in dance communication also, and that this mechanistic link could explain some specific features of the dance form. This is purely a hypothesis, but in proposing this hypothesis, and how it might be investigated, we hope to stimulate new mechanistic analyses of dance communication.

Introduction
Honeybees play a crucial ecological role as pollinators of the many plant species, and their products are the idea for a multi-million-dollar commercial industry round the world. they're major agricultural pollinators round the world and are keystone pollinators in tropical ecosystems. Many of the foremost important pollinating insect species are social, adding more complexity between pollination systems and ecosystem dynamics, because it has been well recognized that those species have mostly contain methods of methods communication. for a few floral species, pollination might not occur without an evolved communication system some pollinators possess. Communication among insects is extremely important for his or her survival, especially for social insects that sleep in complex colonies. Various societal creatures depend on chemical indication, or else pheromone to express through solitary alternatives for supervisory nestmates to food source, caution them of hazard, and design region. Pheromones are chemical signals secreted by a private that are transmitted and understood only within one species. In contrast, other sorts of chemical signals are often perceived by and elicit a response in another species, as in interspecific mutualisms or interceptive eavesdropping (Nieh, 1998). Eavesdroppers might sense the chemical indication of alternatives species &contest for an inadequate source. Bees particularly usage pheromone and chemical indication to detect or perceive sources. Honeybees, for instance, mark nectar-depleted flowers using submaxillary gland pheromones. Honeybees foragers that detect this pheromone are ready to recognize which flowers to avoid, thereby increasing colony foraging efficiency. Honeybees also are famous for his or her remarkable dance language, which is employed by workers to recruit nestmates to resources like food, water, resin and nest cavities. The waggle dance notifies nestmates of the way and distance of anew exposed food resources. Olfactory communication also plays a crucial role in recruitment additionally to several other aspects of colony life (Frisch, 1967). for instance, honeybees can navigate to food sources by detection of nectar

scent and should deposit cuticular hydrocarbon footprints or submaxillary gland pheromone to mark nectar-depleted flowers and thereby increase colony foraging efficiency. Honeybee complex social behaviour is a crucial and rich source for behavioural genetics, like forage marking pheromone releasing by foragers while they're foraging, and including the genetics of aggression. Marking by forage marking pheromone produced by the submaxillary gland of honeybee workers is vital in basic research studies of bee learning and memory also in applied studies examining how honeybee foraging behaviour are often mitigated.

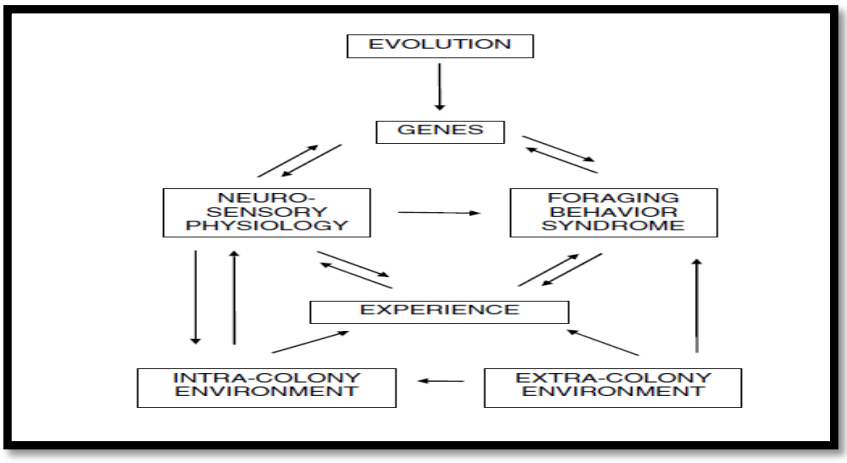
Honeybees communication

Foragers impart their flower discoveries in place with initiate different forager bees of the hive should rummage in the same range. The elements that focus recruiting prosperity would not totally known Yet most likely incorporate assessments of the nature of nectar or pollen brought on of the hive. Honeybees impart with one another eventually perusing two ways: those physical correspondence and chemical correspondence toward method for pheromone or smell that transmit imperative data to parts of the bee's province. Pheromones assume a paramount part done recruitment correspondence (Free, 1987). They utilization pheromones with aide nestmates for nourishment sources, caution them for peril signal, Stamp region territory (Leal, 2010). Honey bee could emanation or recognizes smell alternately compound signa for example, such that pheromone, bloom odour, nectar by tangible receptor found on the flagellum for their antennae (Suwannapong *et al*, 2010).

Foraging behaviour using forage – Marking pheromone

It has been also noted that *A. Mellifera* foragers utilize 2-heptanone will mark already visited flowers, thereby indicating nectar exhaustion should other bees (Engels *et al*., 1997; Giurfa, 1991). However, the four local Thai *Apis species* don't show up to utilize aversive pheromone denoting throughout scrounging (Suwannapong, 2000; Suwannapong *et al*., 2010c). To example, they might return to those same bloom briefly after the principal visit Furthermore proceed with should rummage on the same bloom all the while for a few bees of their own species or other species. Suwannapong (2000) watched *A. florea*, two on three bees of *A. cerana*, particular case on two bees of *A. dorsata* Also one should two bees of *A. andreniformis* going by the same bloom (Suwannapong, 2000). It is likewise workable that honeybees, like bumblebees, could take in should connect flower exhaustion alternately flower reward utilizing olfactory cues such as cuticular hydrocarbon "footprints," which need aid kept same time strolling on the nourishment sourball (Leadbeater & Chittka, 2007). However, this remains with be investigated.

Fig.2: An integrative scheme of the honey bee foraging behaviour syndrome.



Source: Based on Review literature

The mandibular gland of *A. mellifera*, the hotspot for this putative food-marking pheromone is fundamentally 2-heptanone. However, the elementary part from mandibular gland secretions to Thai honeybees is (Z)-11–eicosanol. To general, those ten greater part abundant segments in the mandibular organs about all these species would 80% comparable (Suwannapong, 2000).

Chemical communication

A) Interactions between queens and worker bees

Slessor *et al*. (2005) accounted numerous parts for pheromone correspondence in the bees. Those creators explained those parts of the queen retinue pheromone (QRP) that is attract with forager bees. It will be referred to that QRP entices forager bees should lick and antennae those queens on assemble a little example from claiming this attractive blend. Those essential part from this blend is 9-oxo-(E)-2-dece¬noic acid (ODA). Different segments incorporate two enantiomers for ODA's biosynthetic precursor, (R)- Also (S)-9-hydroxy-(E)-2-decenoic acid (HDA), Furthermore two fragrant segments methyl p-hydroxybenzoate (HOB) Furthermore 4-hydroxy-3-methyoxyphenylethanol (HVA). Know these exacerbates are results of the mandibula organs and the mix may be known as the queen mandibular pheromone (QMP). Individual segments perusing themselves engaging. Just when all five parts would join together does the mix inspire the full entourage reaction. It need get to be obvious that some strains from claiming honeybees don't figure engineered QMP in the least attractive; hence there exist additional substances included in the entourage response. Methyl oleate, coniferyl alcohol, palmityl alcohol, & linoleic acid have been distinguished Likewise further synergistic substances. Three new fatty-acid-derived constituents need aid not for mandibular gland origin, and in this way the wording shift will QRP might have been essential. The finish personality of the QRP will be even now not completely characterized. But for methyl oleate (a synergistic part from QRP) different queen esters (the palmitates, oleates, ethyl stearate, ethyl Also methyl palmitoleate) need been found. These queen esters would convey likewise latent chemical travellers in the queen bunch in light of they need aid not attract. They work Likewise primer pheromones, which influence the physiology of the worker bees. For example, ethyl palmitate is clearly a dynamic operator helping of the queen's capability will restrain specialist ovarian improvement (Slessor *et al*., 2005). Primer pheromones need aid productive intends to looking after social agreement in the colony and more their impacts would essential. These pheromones enactment Toward influencing those physiology of the beneficiaries for a resulting movement for their conduct (Le Conte & Hefetz, 2008). Large portions primer pheromones also need a releaser impact. For example, queen retinue pheromone (QRP) acts Likewise a releaser pheromone toward attracting forager bees of the queen also likewise a primer pheromone perusing physiologically hindering forager ovary improvement (Wanner *et al*., 2007). Primer capacities are connected with brood also queen retinue pheromones (Pankiw, 2004a). The more abundant queen mandibular gland pheromone component, 9-keto-2-(E)-decenoic acid (9-ODA) and two fragrant components, 4-hydroxy-3-hy¬droxyphenylethanol (HVA) & methyl p-hydro-xybenzoate (HOB) are comparatively transmitted (Naumann *et al*., 1991, 1992). Thus, the queen mandibular organ pheromone unpredictable is exchanged through the as a unit. After being discharged onto those figure surface of the queen it may be uprooted toward specialist bees in the queen's retinue, particularly the individuals who come into contact for the queen through their mouthparts. Other forager bees acquire pheromones by means of immediate contact for entourage bees or for different labour bees that need at that point obtained those queen pheromones. Grooming behaviour also contributes of the exchange for pheromone. Naumann (1991) demonstrated clinched alongside as much investigation that self-grooming brings about those translocations from claiming manufactured queen mandibular gland pheromone starting with the mouthparts Furthermore

mind of the abdomen also limbs of bee forager. Those queen mandibular gland pheromone could additionally arrive at forager bees through queen or forager "footprints" onto brush wax. Fischer & Grozinger (2008) tried the impacts of queen mandibular pheromone (QMP) presentation on starvation resistance, lipid storage, & gene expression in the fat figures for foragers bees.

B) Interactions between queens and drones:

A complicated system of chemical verbal exchange in honeybees has evolved often in the context of social behaviour and mating. Single components (or a aggregate of additives) of the queen mandibular gland secretion may also have different features. For instance, the virgin queen uses the mandibular gland secretions to attract drones on her mating flights, whereas the mated queen makes use of mandibular gland secretions to signal her presence to forager bees inside the hive (Brockmann *et al*., 2006). In the 1970s, 9-oxo-2-decenoic acid (nine-ODA), the major thing of the mandibular gland secretions, changed into shown to feature as a intercourse pheromone. 9-ODA is considered as the foremost lengthy-distance intercourse attractant. Drones and virgin queens leave their colonies for mating flights. Drones gather at the drone congregation areas (estimated sizes variety from 50 to two 100 meter in diameter) and right here look ahead to virgin queens. Upon detection of the pheromone, drones provoke looking and chasing of the queen with only some rapid ones being successful (Brockmann *et al*., 2006). Wanner *et al*. (2007) diagnosed an odorant receptor (Or) for the queen's 9-ODA in drone antennae. They assayed the pheromone responsiveness of 4 candidate receptors (AmOr10, -11, -18, and -170) by means of the use of Xenopus oocytes and electrophysiology. AmOr11 answered mainly to 9-ODA (EC50 = 280 ± 31 nM) and now not to any of the opposite seven QRP additives (nine-hydroxy-2-decenoic acid, methyl p-hydroxybenzoate, 4-hydroxy-3-methyoxyphenylethanol, methyl oleate, coniferyl alcohol, 1-hexadecanol, and linolenic acid). Nine-ODA is probably the handiest QRP aspect that acts as a protracted-distance sex pheromone (Wanner *et al*., 2007). Brockmann *et al*. (2006) recommended that different components of the queen's secretion play a role in the verbal exchange among sexes. (2E)-9-hydroxyde¬cenoic acid (9-HDA) and (2E)-10-hydroxydecenoic acid (10-HDA) apparently act over a brief range. These two compounds aren't attractive to drones from a distance, but added to 9-ODA they accelerated the drone's contacts with a queen dummy. A similar increase within the variety of drones making touch with the baited dummy changed into also discovered while tergite gland extracts had been added to 9-ODA (Brockmann *et al*., 2006). The tergal gland secretion is composed of lengthy chain fatty acids (most important compound is (Z)-9-octadecenoic acid), long-chain esters (essential decyl decanoate was detected in virgin queens) and a linear series of unsaturated hydrocarbons (Wossler and Crewe, 1999). Tergal gland alkenes possibly do now not characteristic as intercourse pheromones. The production of queen tergal gland alkenes begins after mating. Smith *et al*. (1993) established in their experiments that the manufacturing of tergal gland alkenes is inspired by using herbal mating and no longer via experimental insemination. It has long been recognized in the beekeeping industry that instrumentally inseminated queens are not as seasoned productive as evidently mated queens. Problems are located with preliminary introduction and recognition of the inseminated queens, rapid replacement of the added inseminated queen by using a queen raised from her eggs and decreased brood production by using inseminated queens. The tergal gland alkenes may also play a key role inside the care and popularity of the queen and her eggs by way of worker bees in the hive (Smith *et al*., 1993). Rhodes *et al*. (2007) recorded modifications in constituent degrees from head extracts of queen with increasing age. Non-mated 7day old queens had better common degrees of 9-HDA and 9-ODA and 10-HDA than mated seven-day old queens.

C. Interactions between worker bees

One key benefit of eusociality is shared defence of the nest, brood, and stored food (Breed *et al*., 2004). Defence of the nest performs a critical role inside the biology of honeybees. Defensive behaviour is partially prompted and modulated by using pheromones. These alarm pheromones are produced in the mandibular gland and sting equipment of forager bees (Pankiw, 2004a). Most honeybee alarm pheromone additives are produced within the Koschewnikow gland and sting gland (Breed *et al*., 2004). Over 40 compounds (along with precursor, intermediate and very last biosynthetic merchandise) were identified from extracts of the worker sting equipment (sting gland and Koschewnikow gland) (Pankiw, 2004a). About 15 additives launch one or greater alarm behaviours (flying from the nest to locate the source of disturbance, pursuing, biting and stinging) (Pankiw, 2004a). Isopentyl acetate (isoamyl acetate, or IPA) changed into first recognized as a defensive compound (Boch *et al*., 1962). IPA elicits greater stinging pastime than any of the alternative defensive compounds and it additionally acts as a goal-marking pheromone, guiding different defenders to the sting side (Pankiw, 2004a). Pickett *et al*. (1982) recognized a much less risky component, (Z)-eleven-eicosenol, as some other effective alarm pheromone thing for inducing stinging behaviour. (Z)-eleven-eicosenol prolongs the hobby of the extra risky IPA presumably with the aid of gradualing down the evaporation of IPA. The combo of IPA and (Z)-11-eicosenol is lively for a longer time than IPA by myself (Pickett *et al*., 1982). Hunt *et al*. (2003) analyzed the alarm pheromone additives from colonies of Africanized honeybees and that they discovered an unsaturated derivative of IPA (3-methyl-2-buten-1-yl acetate, 3M2BA). This compound turned into gift at levels of 0–38% the quantity of IPA. Behavioural assays showed that 3M2BA recruited worker bees from hives as a minimum as efficaciously as IPA (Hunt *et al*., 2003). IPA and 3M2BA are synergistic of their natural ratios and a aggregate of those two compounds recruited bees more successfully than both of the compounds on my own (Hunt *et al*., 2003). 3M2BA may be specific to sure populations of Africanized honeybees (Breed *et al*., 2004). The mandibular glands of employee bees also produce the alarm substance, 2-heptanone (2HPT; Pankiw, 2004a). This compound indicates a far lower potential to attract guards from colony entrances and sting than IPA does (Breed *et al*., 2004). With growing age of employee bees, the size of the mandibular gland and the quantity of 2HPT step by step will increase (Vallet *et al*., 1991). This method that the level of 2HPT is higher in foragers than in protect bees. It is therefore feasible that 2HPT has other functions associated in particular with foraging behaviour. 2HPT confirmed a repulsive effect when added to sucrose solution which was visited by means of foragers and it can act as a repellent forage-marking fragrance (Vallet *et al*., 1991; Giurfa, 1993). Repellent scents are used to keep away from the probing of flowers which have these days been depleted of nectar or pollen (Stout and Goulson, 2001). Worker bees strongly reject all vegetation they've these days visited (Giurfa, 1993). Flowers just abandoned by means of another forager also are rejected, in a decrease although vast share (Giurfa, 1993). Differences within the reaction degree of bees to their own marks or to accomplice's marks advocate that repellent scent-marks are in the main self-use signals (Giurfa, 1993). However, Stout and Goulson (2001) also observed interspecific interactions. Bumblebees (Bom-bus lapidarius, Apidae) averted plants these days visited via honeybees and vice versa. Honeybees rejected flowers that had previously been visited by bumblebees even greater than those formerly been visited by way of honeybees. The repellent forage-marking scents of bumblebees are tarsal secretions (long-chain alkanes and alkenes), which are much less unstable than 2HPT (Goulson *et al*., 2000; Stout and Goulson, 2001). The molecular weight of 2HPT is 114, whereas bumblebee tarsal hydrocarbons have a molecular weight of ca. 300–400 (Stout and Goulson, 2001). Stout and

Goulson (2001) also observed that repellent forage-marking scents can be active for forty– sixty minutes.

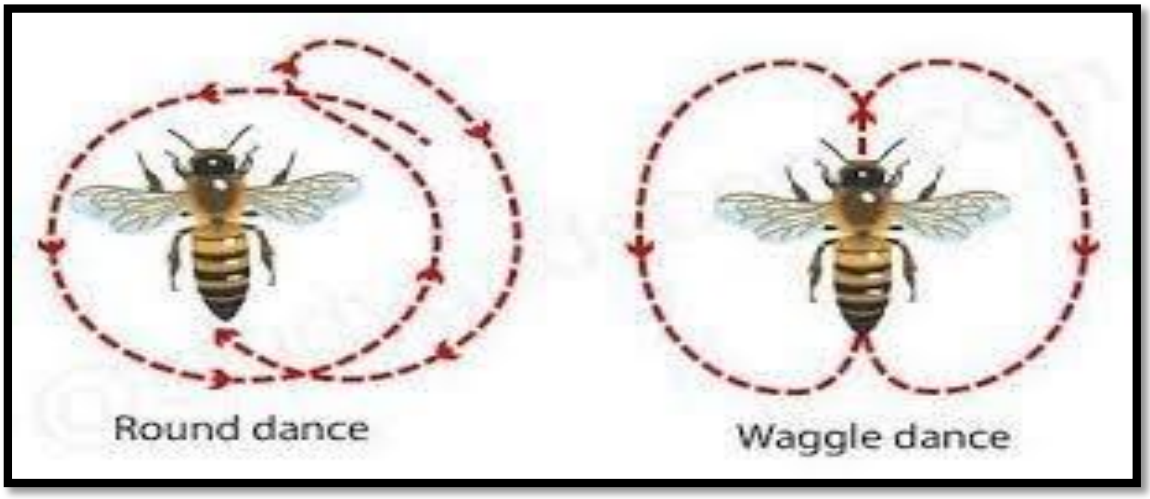
D) Interactions between adults and brood

In the conversation among brood and forager bees a chemical cue at the surface of larvae known as brood pheromone (BP) is important (Le Conte *et al*., 1995; Pankiw *et al*., 2008). BP is a blend of ten fatty-acid esters (methyl palmitate, methyl oleate, methyl stearate, methyl linoleate, methyl linolenate, ethyl palmitate, ethyl oleate, ethyl stearate, ethyl linoleate and ethyl linolenate; Le Conte *et al*., 1990; Le Conte *et al*., 2001). Some components are extra lively than others, however all ten pheromone compounds show a few releaser pheromones effects on grown- up bees (Le Conte *et al*., 2001). The esters are found in distinct amounts and proportions as a characteristic of caste and larval age (Le Conte *et al*., 1994/1995). Thus, nurses can understand the various needs of larvae and provide them with optima care (Le Conte *et al*., 2006). Four esters, methyl linolenate, methyl linoleate, methyl oleate, and methyl palmitate, induce the worker bees to cap the cell with a thin cover of wax (Le Conte *et al*., 1994). They are produced in massive portions by the larvae at some stage in the capping (Le Conte *et al*., 1994, 1994/1995). Le Conte *et al*. (1995) tested BP as a further chemical stimulus in the artificial rearing of the queens. They discovered that methyl stearate increases the popularity of the queen cells, methyl linoleate enhances the quantity of royal jelly deposited by way of the worker, and methyl palmitate will increase the weight of the larvae. In addition to releaser results on various factors of brood care, BP additionally has primer effects (Le Conte *et al*., 2001, 2006). Methyl palmitate and ethyl oleate growth activity of the hypopharyngeal glands, which produce proteinaceous material that is fed through nurse bees to larvae (Mohammedi *et al*., 1996; Le Conte *et al*., 2001). Brood pheromone also inhibits ovary improvement in employee bees further to the queen's pheromone (Mohammedi *et al*., 1998; Le Conte *et al*., 2001). It even appears that the presence of the unsealed brood affords an inhibitory sign more potent than the queen's pheromone (Kropacova & Haslbachova, 1971; Mohammedi *et al*., 1998). Mohammedi *et al*. (1998) showed that a number of the ten esters, ethyl palmitate and methyl linolenate are the compounds which are concerned inside the prevention of ovary development of bees. All of the 10 esters (boiling factor round 200 °C) typically referred to as brood pheromone are non-unstable and their movement is probably facilitated with the aid of employee to employee contact (Pankiw, 2004a; Maisonnasse *et al*., 2010). Very lately, a brand new surprisingly unstable molecule, E-β-ocimene, has been recognized in larvae (Maisonnasse *et al*., 2009). This brood pheromone element additionally acts as a primer pheromone with moves on worker bee body structure: inhibition of worker ovaries (Maisonnasse *et al*., 2009) and acceleration of employee bee behavioural maturation (Maisonnasse *et al*., 2010). E-β-ocimene (boiling factor 73 °C), which belongs to the terpene family, is unstable so and therefore has an aerial transmission and is easily dispersed inside the colony (Maisonnasse *et al*., 2010). All worker bees within the nest may be in direct touch through this sign, together with the nurse (younger bee), however also middle-elderly bees, from ages 12–21 days, specializing in nectar processing and nest renovation but do no longer engage inside the brood care (Johnson, 2010; Maisonnasse *et al*., 2010). E-β-ocimene will be the signal for the transition of center-aged bees to foragers (Maisonnasse *et al*., 2010). Brood ester pheromone (the blend of 10 methyl and ethyl esters) additionally modulates the behavioural maturation of worker bees and its outcomes range with dose (Le Conte *et al*., 2001; Maisonnasse *et al*., 2010). Low doses of brood ester pheromone boost up foraging ontogeny, whereas excessive doses of this pheromone have the alternative impact (it slows down the progression of younger bees closer to the tasks typical of older bees; Le Conte *et al*. 2001; Maisonnasse *et al*., 2010). Young and vintage larvae emit one-of-a-kind portions of pheromones. E-

β-ocimene is emitted principally by using the young instars (L1, L2–three) whilst brood ester pheromone reaches a maximum fee at some stage in the capping stage (L4–five; Maisonnasse *et al*., 2010). The young larvae (low want in nurses) promote foraging through emitting a low amount of brood ester pheromone and a big amount of E-β-ocimene. In evaluation, antique larvae (excessive want in nurses), with the aid of producing a high quantity of brood ester pheromone, sell tending (keeping nurses in contact with them for an extended time; Maisonnasse *et al*., 2010).

Physical communication

Fig.-1: Types of communication



Source: Internet

Honeybees additionally speak for the food resources through physical conversation referred to as bee dances or dancing action. When a forager reveals a food supply, it must speak the vicinity of the found food source to her nestmates. Extensive studies indicate that honeybees dance inside the nest after a successful foraging ride and communicates to her nestmates with records approximately the useful resource. In some social insects, pheromone trails are used to communicate similar messages. What is exquisite about honeybees is that foragers do no longer observe the scout (the scout may continue to be in the hive for hours). It conveys to its fellows the path and distance. Shortly after its go back, many foragers depart the hive and fly without delay to the meals **(Wenner, 1964)**. The superb aspect about that is that the foragers do now not comply with the scouts again (the scouts may additionally continue to be within the hive for hours). It turns out that the scouts can carry to the forager's records about the food of scent, the distance and the course from the hive. So, the scout bees have communicated to the foragers the vital information for them to locate the meals on their own. Honeybees guide their nest mate for the gap and course. The dance basically encodes the statistics her nestmates want to realize so that you can effectively revisit the equal resource patch. Variations of the dance exist, relying on the distance of the communicated supply from the colony. The round dance is carried out whilst the useful resource is within 50 meters from the hive. This dance includes a scout bee, or returning forager, acting a chain of slim round movements that may be repeated. Resources which might be perceived as rewarding will have higher dance circuits performed. Similar behaviours occur for sources which are greater than a hundred meters from the hive. These dances are greater commonly called the "waggle dance," and encodes the path and distance of the meals source to her nestmates. Scout bees fly from the colony looking for pollen and nectar. If successful in finding excellent substances of meals, the scouts return to the hive and "dances" at the honeycomb. When the dance going on, the

honeybee first walks straight in advance, vigorously shaking its stomach and producing a buzzing sound with the beat of its wings. The distance and pace of this motion communicates the space of the foraging website to the others. Communicating course becomes extra complicated, as the dancing bee aligns her body within the route of the food, relative to the sun. The entire dance sample is a figure-eight, with the bee repeating the directly portion of the movement each time it circles to the centre once more. Honeybees also use two variations of the waggle dance to direct others to meals assets toward domestic. The round dance, a sequence of narrow circular actions, signals colony individuals to the presence of food inside 50 meters of the hive. This dance only communicates the direction of the supply, no longer the gap. The sickle dance, a crescent-shaped sample of movements, indicators workers to food resources within 50-one hundred fifty meters from the hive. However, such dances ought to be notion as a continuum of one form of dance – the waggle dance and now not a couple of forms of dances (Kirchner *et al*., 1988). There isn't any evidence that this form of verbal exchange depends on man or woman getting to know. The orientation of the dance correlates to the relative function of the sun to the food supply, and the length of the waggle portion of the run is correlated to the space from the hive. Also, the extra energetic the show, the higher the food. There is no evidence that this form of conversation relies upon on character mastering. Von Frisch executed a sequence of experiments to validate his concept. Other honeybee species have a comparable approach of communicating resources to their nestmates. For example, in *A. florea* and *A. andreniformis* (the "dwarf honey bees"), the dance is completed at the dorsal, horizontal portion of an uncovered nest. The runs and dances point immediately closer to the useful resource in these species, as opposed to relative to the solar. Although specific species of honeybees have waggle dances, the period of the waggle dance and the gap being communicated to her nestmates are particular. Such species-specific conduct shows that this shape of conversation does not rely on learning but is rather decided genetically. Each honeybee species has a typically specific correlation of "waggling" to distance, as nicely. Such species precise action suggests that this form of communique does not rely on gaining knowledge of but is instead decided genetically. Honeybees would possibly use each dance and pheromone to manual the nestmates to locate the food source. Various experimental consequences exhibit that the dance does convey facts, however the use of this facts can be context-based, and this will give an explanation for why the outcomes of earlier research have been inconsistent (Nieh, 1998). In essence, each aspects of the "controversy" agree that odour is used in recruitment to resources, however they fluctuate strongly in opinion as to the facts content of the dance. Honeybees additionally have potential on a cognitive map of seen landmarks for his or her meals resources. In addition to the waggle dance, honeybees use scent cues from meals assets to transmit records to other bees. Some researchers trust the scout bees convey the unique smells of flowers they visit on our bodies, and that those odors must be present for the waggle dance to work. Using a robot honeybee programmed to carry out the waggle dance, scientists observed the fans ought to fly the right distance and route, but were unable to perceive the precise food source present there. When the floral scent became added to the robotic honeybee, different people may want to find the flora. After acting the waggle dance, the scout bees may additionally share some of the foraged meals with the subsequent workers, to communicate the exceptional of the meals deliver to be had at the location. Honeybees may use each dance and pheromones to manual their nestmates to find a food supply. Various experimental consequences exhibit that the dance does deliver records, but the use of this facts can be context-structured, and this could provide an explanation for why the results of earlier research were inconsistent. In essence, each facets of the "controversy" agree that scent is used in recruitment to assets, but they vary strongly in opinion as to the data content of the dance.

Honeybees also have the cognitive capability to seen recognize and study landmarks for his or her food sources (Vladusich *et al*., 2005).

Conclusion

The waggle dance might be a "symbolic replay" of a foraging fligh. We suspect that the whole waggle dance is an act of conditioning: A recruit "learns" the location of a feeding site during attendance of a symbolic replay of a foraging flight inside the hive. A food sample delivered by the dancer through trophallaxis serves as a reward. We know that bees can perform most of the behaviour that are required for this task'. Although there has been enormous success in dissecting the phenomenon of dance behaviour, thus far there has been little progress in studying the neural mechanisms involved. This is because it is an extremely hard task. Bees only dance in a hive, and no one has yet persuaded any bees to execute dances in a laboratory setting, making the dance a very difficult phenotype to investigate experimentally. Learning more about the neurobiology of the bee brain has allowed us to flesh out this hypothesis. If indeed dance evolved by exaptation of orientation and learning systems, then while dance can still be described as a functionally referential signal, the form of the dance is far from arbitrary and reflects a hive-bound replay of a foraging flight.

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[Article ID : 01/II/12/0221]

USE OF MULTILINE CULTIVARS AND CULTIVAR MIXTURE FOR DISEASE MANAGEMENT

Sanjay H B[1]., Anita P[1].*, and Sunaina B.[1]
RLBCAU, Jhansi, Uttar Pradesh
*Corresponding author email id: anitapau6243@gmail.com

Abstract
Multilines and cultivar mixture can provide functional genetic diversity that limits pathogen expansion. The most important mechanism of cultivar mixture and multilines for disease control are induced resistance, barrier and frequency effects. Differential adoption may prevent the rapid evolution of complex pathotypes in mixture. Mixture can have ability to stabilize yield and yield losses due to diseases, abiotic stresses are also buffered. When mixture components are put together product quality can be enhanced. Pathogen evolution can be managed by preventing extensive cultivation of single mixture in either time or space.

Key words : Multilines, genetic diversity, cultivar mixture, diseases, pathogen evolution.

Introduction
About 26% of crop yield is lost annually due to different diseases incidences. To prevent these losses, many management practices are adopted, and out of which some practices are not eco-friendly. Indiscriminate use of pesticides leads to evolution of pesticides resistance pathogen, adverse health effects and leaves environmental reduce. And extensive use of these pesticides causes increasing cost of cultivation and decrease the interaction between beneficial microorganisms with crops and cause degradation of soil. Many eco-friendly methods of disease management are not quick in action. At the time of their action huge crop getting infected by pathogen. To elude from these problems many breeding methods are identified to release biotic stress resistant varieties. Out of which multilines and varietal mixture plays an important role to release many disease resistant varieties.

Monoculture of high yielding, genetically similar plant causes the susceptibility to the various environmental stresses, as they have low genetic diversity and lack genetic flexibility. The use of multiline cultivars and cultivar mixture will introduce genetic diversity in the cropping ecosystem and plays a vital role to prevent the breakdown of resistance. Multiline oat cultivars developed at Iowa State University contain 12 resistance genes for crown rust disease caused by *Puccinia* coronata. Multiline cultivar is constructed by combining several resistance genes separately into a well adopted cultivar by backcrossing to the adopted parent. Then combine a group of cultivar that are agronomically similar and contain different resistance gene. Similar to the multiline approach cultivar mixture are also adapted for increasing genetic diversity, but in cultivar mixture no attempts are made to ensure that the components of the mixture are agronomically similar. This cultivar mixture approach is better suited for pasture, forage or tree crops that are harvested by hands. Uniformity of growth and harvesting is not concern in these crops.

Development of multiline varieties
A multiline variety is usually created by mixing the seeds of several lines that are phenotypically similar, but different genes for resistance to a given diseases. So that vertical resistance for the disease can be achieved. There are two main steps in the development of multiline as follows:

1) Development of component line: The resistance genes are incorporated in an elite variety to produce many near isogenic lines as there are different R genes. This is done through 5-6 generation of backcrossing and evaluation for resistance. And a limited backcross of 2-3 generation followed by Pedigree selection or by making double or multiple crosses. The lines obtained from these two approaches may not be similar for agronomic traits.
2) Grouping of components: There should be large (15-20) number of component line for getting durability of resistance. If reduced level of disease is the objective, a rather small number of component (6) lines should be adequate.

Effect of resistance level and the proportion of resistance on disease in a mixture

The disease level in the mixture was reduced most when the mean resistance of the pure stands was intermediate. This translated into a linear relationship between the effects of mixing on disease and the mean resistance level. In a mixture composed of components resistant to only part of pathogen population, other mechanisms like induced resistance may give disease reduction. In a mixtures composed of more than two components with varying resistance, differ level of mixing effects of resistance can be expected. Here the performance of a mixture with respect to disease reduction can be calculated by having knowledge of resistance level of the components in pure stand. And performance of the mixture depends on the main level of resistance of all components that determine the resistance level and not the number of component in a mixture.

Correlation between disease severity and grain yield in multi-lines

While releasing a multiline varieties there should be yield advantages higher than the present varieties. Yield comparison is done between area grown in in multi-lines with diseases and without diseases. With increase in disease severity, relative yield losses were reduced in mixture when compared with pure stand. The increase in relative advantage of mixture with increasing disease severity in the pure stand points to the great benefits in terms of yield stability and buffering from unexpected calamities those growers could reap by adopting within crop diversification.

Mechanism of reduction of diseases

Functional and special diversification of resistance gene reduces disease severity. It reduces special density of plants susceptible to pathotype. This results in decreasing the amount of susceptible tissue in an area. Hence, much of primary inoculum landing on the crop falls on an inhospitable host leading to a decrease in the amount of effective initial inoculum so the start of an epidemic is delayed. And probability of secondary inoculum produced on a parent plant reaching and infecting neighboring plant is reduced due to lower density of susceptible plant. Many spores are lost because they fall out of the air before they reach a susceptible host. Resistant plant in a mixture imposes a physical barrier to the spread of inoculum to susceptible plant. Inoculum that landed on resistant components of the mix is also lost from the population leading to reduction in secondary inoculum, so that role of epidemics development gets reduced. Finally the effectiveness of resistance gene might be influenced by induced resistance interaction between host and pathogen.

Pathogen evolution in a mixture

Vertical resistance caused by major genes may break down quickly and become susceptible, but resistance breakdown in mixture is slow because, resistance gene will have less exposure to the pathogen and it reduces collection pressure and increases durability of the gene. Mixture support more diverse pathogen population than monoculture and the degree of diversity maintained within mixture appears to be positively related to the degree of disease control provided. Due to continuous effort of pathogen for infection causes natural selection in the pathogen, so that fit pathogen is survived and gets evolved to newer prototype, so that resistance can be breakdown.

Pathogen evolution can be managed some extent by ensuring that no single mixture grown extensively in either time or space.

Disadvantages of multiline cultivars

A disadvantage of multiline cultivars is the massive breeding effort and huge time is required to develop them. Agronomic ally similar characters are conserved difficultly. By the time of multiline cultivar is released conventional breeding is likely to have produce cultivar that out yield the multiline varieties. Huge efforts are directed at only one disease management and contribute little to the control of other diseases of that crop. Here all resistant genes are introduced to field and may have risk of breakdown of resistance.

Achievements

Multiline varieties appear to be a useful approach to control diseases which are airborne and where new races are continuously produced. In India, multiline varieties have been released in wheat. Kalyan Sona and Sonalika are the most popular variety used as recurrent parent to produce these varieties. Variety KSML3 and MLKS11 consists of 8 lines having rust resistance gene. And KML7406 has 9 lines deriving rust resistance from different source. Sonalika multiline 1 was released for cultivation in Punjab state contain 6 component lines.

Conclusion

Use of disease resistant multiline and cultivar mixture for crop production is a cheapest method of disease management. And here along with yield advantage diseases will also be managed. Without affecting the ecological balance, use of multiline and cultivar mixture create diversity in the crop ecosystem. Hence, that different resistant gene of the crop produces incompatible reaction with the different pathotype of the pathogen. So that during host pathogen interaction it leads to the production of resistance response. Multilines are especially effective for airborne diseases, it lowers the density of susceptible plant per unit area and prevent the further spread of the diseases. So, that secondary inoculum can be effectively managed. Finally, productivity of the crop can be increased by proper management of the diseases.

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[Article ID : 01/II/13/0221]

NEW FARM BILL-2020: AGITATION OF INDIAN FARMERS AGAINST THREE FARM ACTS

Kumar T.
Assistant Professor, School of Agriculture-GEHU-Dehradun
(teshukumar@gmail.com)

Introduction

In 2017, the central government had released model farming acts. The Standing Committee on Agriculture (2018-19), however, noted that several reforms suggested in the model acts had not been implemented by the states. In particular, the Committee found that the laws that regulated Indian agricultural markets (such as those related to agricultural produce market committees or APMCs) were not being implemented fairly and honestly or serving their purpose. Centralization was thought to be reducing competition and (accordingly) participation, with undue commissions, market fees, and monopoly of associations damaging the agricultural sector.

A committee consisting of seven Chief Ministers was set up in July 2019 to discuss implementation. The committee is yet to submit its report. The center promulgated three ordinances in the first week of June 2020. In September 2020, President Ram Nath Kovind gave his assent to the three 'Agriculture Bills' that were earlier passed by the Indian Parliament. These Farm Acts are as follows with short information to understand the all acts:

1. The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020

It permits intra and inter-state trade of farmers' produce beyond the physical premises of Agricultural Produce Market Committee (APMC) markets and other markets notified under the state APMC Acts.

(a) Trade of Farmers' Produce: The Act allows the farmers to trade in outside trade area such as farm gates, factory premises, cold storages, and so on. Previously, it could only be done in the APMC yards or Mandis.

(b) Alternative Trading Channels: It facilitates lucrative prices for the farmers via alternative trading channels to promote barrier-free intra-state and inter-state trade of agriculture produce.

(c) Electronic Trading: Additionally, it allows the electronic trading of scheduled farmers' produce (agricultural produce regulated under any state APMC Act) in the specified trade area. It will also facilitate direct and online buying and selling of the agricultural produce via electronic devices and the internet.

(d) Market Fee Abolished: As per the Act, the State Governments are prohibited from levying any market fee or cess on farmers, traders and electronic trading platforms for trading farmers' produce in an 'outside trade area'.

Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020

It creates a national framework for contract farming through an agreement between a farmer and a buyer before the production or rearing of any farm produces**.**

(a) Farming Agreement: The Act provides for a farming agreement between a farmer and a buyer prior to the production or rearing of any farm produce.

(b) Minimum Period of Farming Agreement: The minimum period of the farming agreement shall be for one crop season or one production cycle of livestock.

(c) Maximum Period of Farming Agreement: The maximum period of the farming agreement shall be five years. It also states that if the production cycle of any farming produce is longer and may go beyond five years, the maximum period of farming agreement may be mutually decided by the farmer and the buyer and explicitly mentioned in the farming agreement.

(d) Pricing of Farming Produce: The pricing of farming produce and the process of price determination should be mentioned in the agreement. For prices subjected to variation, a guaranteed price for the produce and a clear reference for any additional amount above the guaranteed price must be specified in the agreement.

(e) Settlement of Dispute: The Act provides for a three-level dispute settlement mechanism-- Conciliation Board, Sub-Divisional Magistrate and Appellate Authority.

Essential Commodities (Amendment) Act, 2020

It is an act of Indian Parliament which was enacted in 1955 to ensure the delivery of certain commodities or products, the supply of which if obstructed owing to hoarding or black-marketing would affect the normal life of the people. This includes foodstuff, drugs, fuel (petroleum products) etc.

- Removes foodstuff such as cereals, pulses, potato, onions, edible oilseeds, and oils, from the list of essential commodities, removing stockholding limits on such items except under "extraordinary circumstances"
- Requires that imposition of any stock limit on agricultural produce be based on price rise.

Powers of Central Government

(a) The Government of India regulates the production, supply, and distribution of a whole host of commodities it declares 'essential' in order to make them available to consumers at fair prices.

(b) The Government can also fix the MRP of any packaged product that it declares an 'essential commodity'.

(c) The Centre can add commodities in this list when the need arises and can take them off the list once the situation improves.

(d) If a certain commodity is in short supply and its price is spiking, the Government can notify stock-holding limits on it for a specified period.

4- Powers of State Government: The respective State Governments can choose not to impose any restrictions as notified by the Centre. However, if the restrictions are imposed, traders have to immediately sell any stocks held beyond the mandated quantity into the market. This is done to improve supplies and brings down prices.

5- Amendment: With the amendment in the Act, the Government of India will list certain commodities as essential to regulate their supply and prices only in cases of war, famine, extraordinary price rises, or natural calamities. The commodities that have been deregulated are food items, including cereals, pulses, potato, onion, edible oilseeds, and oils.

6- Stock Limit: As per the amendment, the imposition of any stock limit on agricultural produce will be based on price rise and can only be imposed if there's-- a 100% increase in the retail price of horticultural produce and 50% increase in the retail price of non-perishable agricultural food items.

7- Calculation: The increase will be calculated over the price prevailing immediately preceding twelve months, or the average retail price of the last five years, whichever is lower.

Result and discussion on farm bill

On 20 September 2020, Prime Minister Narendra Modi referred to the bills as a watershed moment in the history of Indian agriculture and stated the bills will "ensure a complete transformation of the agriculture sector" and empower tens of millions of farmers. In the Prime Minister's *Mann ki Baat* radio address on 29 November 2020, he said that "all political parties had been making promises to the farmers but now these promises had been fulfilled." Modi cited the example of a farmer from Maharashtra "whose payments for his corn crop were kept pending by traders for four months." "In this situation, the new farm laws that were passed in September came to his aid. Under this law, it was decided that all dues of the farmers should be cleared within three days of procurement, failing which, the farmer can complain."

The Chief Economist of the International Monetary Fund (IMF) *Gita Gopinath,* said the "farm bills and labour bills are very important steps in the right direction. They have the potential to have more labour market flexibility, providing greater social security to workers and more formalisation of the labour market. In the case of agriculture, having a much more integrated market, creating competition, having farmers getting a greater share of the price that finally the retail price that's paid. So that helps with rural incomes". She also stressed that the implementation of it must be right.

Several Union Ministers urged farmers not to have "misconceptions" about the reforms. On 30 November, the Prime Minister said that the farmers are being "lied" to: "the farmers are being deceived on these historic agriculture reform laws by the same people who have misled them for decades." Modi added that the old system was not being replaced, rather new options were being put forward for the farmers. Rejecting demands for the inclusion of Minimum Support Price (MSP) as a mandatory provision in the Farm Bills, Minister of Agriculture & Farmers' Welfare Narendra Singh Tomar said that, while the government was committed to MSP, it was "not a part of the law" earlier and "is not" today.

On 31 December 2020, the *Kerala legislative assembly* passed a resolution against the farm reforms and seek their withdrawal. On 1 January 2021, 866 academics from several educational institutes signed an open letter, expressing their support for the three farm laws. The open letter states that the three acts "wouldn't do away with the MSP, but rather free the farm trade from all illicit market restrictions, open the market beyond 'mandis' and further assists the small and marginal farmers to sell their produce at market and competitive prices. The new laws also provide full autonomy for farmers to sell their produce". Also, they "strongly believe in the government's assurance to the farmers to protect the farmers' livelihoods". The signatories are academicians from "DU, JNU, Gorakhpur University, Rajasthan University, Gujarat University and many more".

2. Reason behind the farmers protest against farm bill-2020

Indian farmers are fearing that they might lose more than they could gain after the new Farms Laws 2020 thereby taking the protest to the streets. Indian farmers and different farmers organization/unions/association are worried due to some reason not clearly mention in the farm bill. Some statement were mention from different kissan sanghthan leaders i.e.

As quoted by ANI, **Bhartiya Kisan Union leader Rakesh Tikait** stated, *" They (Central Government) want amendment in them (Farm Laws 2020) but we want these laws to be repealed. We don't want changes. We will end our protest only when these laws are withdrawn. Like the government brought the three bills, they should also bring a bill on the MSP."* ANI further quoted BKU leader Rakesh Tikait stating that they are ready to have future talks on Farm Laws 2020 with the Government. **Yogendra**

Yadav stated, *"We have decided that on January 7, we will take out a tractor march at four borders of Delhi including Eastern and Western peripheral. This will be a trailer for what lies ahead on January 26."*

As Farmers' agitation against three contentious Farm Laws entered third month, the Farmer's Union on 29 December 2020 has accepted Centre's proposal to hold sixth round of talks. After agitating farmers accepted Centre's proposal to hold sixth round of talks, Centre sent an invitation for talks on 30 December 2020 to 40 farmer representatives which have been accepted by the farmers.

As per a letter by **Union Agriculture Secretary Sanjay Agarwal,** *all the issues related to farmers, including the three farm laws, MSP-based procurement, the Commission for the Air Quality Management in National Capital Region and Adjoining Areas Ordinance, 2020, and the Electricity Amendment Bill 2020 will be discussed in detail with the 40 representatives of farm unions.* **The talks scheduled on 30 December 2020 at 2 p.m. between the Centre and 40 farmer representatives took place at Vigyan Bhawan, New Delhi.** The **sixth rounds of talks between the Central Government and the farmer unions** reached to **conclusions on the issues related to the environment and Electricity Acts**, however, their demand of **repealing the three Farm Laws 2020 and legal guarantee for MSP (Minimum Support Price) remained inconclusive.** The **seventh round of talks between the Centre and the farmers took place on 4 January 2021 at Vigyan Bhawan and failed to reach a breakthrough.** The eighth round of talks between the Centre and the farmers is scheduled on 8 January 2021 at 2 p.m.

It is to be noted that 7 rounds of talks have taken place so far between the Government and the Farmers' representatives. However, no solution has been found to date. As reported by ANI, ***Sukhwinder S Sabra, Joint Secy,*** Kisan Mazdoor Sangharsh Committee **stated that** *if their demands aren't met on 4 January 2021, then, they'll hold tractor march on January 6 and 26, 2021.*

The 11th round of talks between the protesting farmers and the central government over the three farm laws hit yet another roadblock Friday, as the farmers refused to settle for anything less than a full repeal of the legislations while the Centre asked them to reconsider its **proposal to put the Acts on hold** for 12-18 months.

Why are protests vociferous in some States

More than half of all government procurement of wheat and paddy in the last five years has taken place in Punjab and Haryana, according to Agriculture Ministry data. More than 85% of wheat and paddy grown in Punjab, and 75% in Haryana, is bought by the government at MSP rates. Farmers in these States fear that without MSPs, market prices will fall. These States are also most invested in the APMC system, with a strong mandi network, a well-oiled system of arthiyas or commission agents facilitating procurement, and link roads connecting most villages to the notified markets and allowing farmers to easily bring their produce for procurement. The Punjab government charges a 6% mandi tax (along with a 2.5% fee for handling central procurement) and earns an annual revenue of about ₹3,500 crore from these charges.

Minimum support price will be implemented.

Most of the slogans at the farmers' protests revolve around the need to protect MSPs, or minimum support prices, which they feel are threatened by the new laws. These are the pre-set rates at which the Central government purchases produce from farmers, regardless of market rates, and are declared for 23 crops at the beginning of each sowing season. However, the Centre only purchases paddy, wheat and select pulses in large quantities, and only 6% of farmers actually sell their crops at MSP rates, according to the 2015 Shanta Kumar Committee's report using National Sample

Survey data. None of the laws directly impinges upon the MSP regime. However, most government procurement centres in Punjab, Haryana and a few other States are located within the notified APMC mandis. Farmers fear that encouraging tax-free private trade outside the APMC mandis will make these notified markets unviable, which could lead to a reduction in government procurement itself. Farmers are also demanding that MSPs be made universal, within mandis and outside, so that all buyers — government or private — will have to use these rates as a floor price below which sales cannot be made.

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[Article ID : 01/II/14/0221]

SPICES FROM FLOWER AND FLORAL PARTS

Laishram Hemanta*, Mutum Preema Devi[1], M Jangyukala[2], Rocky Thokchom[3] and S. Romen Singh[4]

*& [2]Department of Horticulture,
School of Agricultural Sciences and Rural Development,
Nagaland University, Medziphema, Nagaland-797106.
[1]Department of Pomology and Post-Harvest Technology,
UBKV, Pundibari, Cooch Behar, West Bengal, India
[3]Pandit Deen Dayal Upadhyay Institute of Agricultural Sciences,
Bishnupur, Manipur-795134
[4]College of Horticulture & Forestry, Central Agricultural University,
Pasighat, Arunachal Pradesh -791 102.
*Corresponding author's email: hemanta.horti@gmail.com

Abstract

There are a large number of plants used as spices and classification or grouping can be done according to different systems. One system of classification is based on plant parts used which may be a fruit, berry, seed, rhizome, root, leaves, bark, bulb, kernel, aril, pulp / rind, latex and also from flower and floral parts. Spices from flower and floral parts include common spices like clove, saffron, caper, cassia bud, savory, mint etc. It also includes ornamental plants like rose, viola, lavender, jasmine etc. There are also lesser known or underutilized herbs and plants found in the north eastern region of the country like *Ocimum basilicum* Linn., *Ocimum canum* Sims, *Anisochilus carnosus* Wall etc. where the flower or floral parts or inflorescence are used as spices. They are traded and consumed locally some of which have high potential for commercialization as they are rich source of vitamins, minerals and phytochemicals apart from their medicinal values.

Introduction

Spices have been an important part of seasoning in foods throughout the world. Spices, herbs and essential oils have been the foundation for flavorings that defines the foods of the wide range of cultures and their cuisines throughout the world. Unless we have been exposed to these flavorings and smells, they may be "exotic" or "foreign" or "stinky." In today's world, we have more opportunities to experience cuisines that are new and different. Sometimes flavors have to be experienced several times to appreciate them and then we enjoy the new seasonings and find them delicious. This is often the case of spices from India. Many of these spices, herbs, and oils have been used not only for flavoring, but also for health and medicinal purposes. Some of these are being examined more carefully by researchers and western medical practitioners. With changing times, people are looking out for food flavoured or coloured with spices which are unconventional and uncommon out of curiosity or experimentation by foodies who delve in different dishes and cuisines. Such spices are lesser known and unpopular which are from ornamentals, trees, wild plants etc. Few points to remember about using spices from flower and floral parts is that firstly, some flowers and floral parts may not be consumable. Secondly, it may cause allergic reaction or impart unpleasant taste or smell. So sufficient research is required for ensuring the safety and from health point of view before using them. Nevertheless, we can always consume which are already used as safe or we can stick to only a few lists. It will be a fun and way to add colour and flavor to

all sort of dishes. Using some of them may enhance the aesthetic appeal of the dish or cuisine apart from the flavor.

Ornamental plants as spices

Lavender (*Lavendula* angustifolia) : This fragrant flower is used to flavour ice-creams and yogurts. **Rose (*Rosa species*) -** The food-safe and edible rose petals are suitable for use as an ingredient, a garnish or as a bed for food that needs to be extra special. Yet, its essential oil is added to many food items for flavouring purposes at least. Concentrated flavorings that are used to flavor Mughal-style dishes (a style of cooking in North India, Pakistan and Bangladesh). Rose water - a diluted form of rose essence is used to flavor desserts, biryanis, and yogurt drinks (lassi).

Jasmine (*Jasminum spp*.) : A fragrant flower, it is usually blended with green tea or added to rice dishes and salads. Both fresh buds and dried flowers are used (Allonsy, n.d).

Violets (*Viola odorata*) : These pretty flowers have a sweet flavour and heavenly aroma. They can be added to salads or in stuffings of poultry or fish. Soufflés, cream and similar desserts are flavoured with the essence of viola flowers. Mild pea flavour of *Viola tricolor* is used with sweet or savory foods like grilled meats and steamed vegetables.

Rhododendron (*Rhododendron arboreum* Sm.) : *Rhododendron arboreum* is one of the most stately and impressive rhododendron species. It is extremely variable in stature, hardness, flower color and leaf characteristics. It species name arboreum means tree like (Orwa *et al.,* 2009). In Nepal, Uttarakhand, North Bengal, Sikkim and North Eastern India, its fresh flowers are added to meat preparations as spice. It is believed that it helps in quick cooking of meat and gives unique taste and flavor.

In hilly areas, commercially the flowers of Rhododendron arboretum with sweet & sour taste are used in the preparation of squash, jams, jellies and local brew. It is a very common and pleasant drink, drunk once daily as refreshing appetizer & also to prevent highaltitude sickness. Fresh petals are used to prepare chutney known as barah ki chutney (Srivastava, 2012).

Common flower type spices

Saffron (*Crocus sativus* L) : It consists of the dried red stigmas of the plant cultivated for its large, scented, blue or lavender flowers. Saffron is well known all over the world which is added to various food items for colouring, flavouring and for taste. Saffron is one of the oldest and certainly among the world's most expensive spice. Saffron is mainly used as a spice highly valued for its coloring power, bitter taste and unique aroma attributed primarily to crocins, picrocrocin and safranal, respectively.

Capers : *Capparis spinosa,* the caper bush, also called Flinders rose, is a perennial plant that bears rounded, fleshy leaves and large white to pinkish-white flowers. The plant is best known for the edible flower buds (capers), often used as a seasoning, and the fruit (caper berries), both of which are usually consumed pickled. Other species of *Capparis* are also picked along with *C. spinosa* for their buds or fruits. The parts used are flower and flower buds. They have a very pungent taste and are used as condiments in sauces and pickles. The flower buds are eaten with salmon. Caper buds are used as a kind of pickles, particularly in the European countries. Caper pickles are used in preparing salads and sauces, particularly red meat and fish sauces, where the sauces is made from non-blooming buds that have been pickled in salt or vinegar and processed with other additives (Babili, 2015).

Kewra (*Pandanus odoraratissimus* L) : Kewra is an extract distilled from the flower of the pandanus plant. It is primarily used to flavour South Asian cuisine. Pandanus is native to tropical South Asia, Southeast Asia, Australasia and is used as flavoring agent through out much of these regions. The male pandanus flower is almost exclusively used for kewra distillation. Kewra flowers have a sweet, perfumed odour with a pleasant quality similar to rose flowers, but kewra is fruitier. The kewra water or syrup can be sprinkled over a pulao or any rice dish to give it a hint of sweet or to balance out the spice. Kewra syrup has its use in sweet dishes like Gulab Jamun.

Clove (*Syzygium aromaticum* L) : Cloves are the aromatic dried buds of a tree used as a spice in virtually all the world's cuisine. The clove tree is an evergreen tree, which grows to a height ranging from 8-12 m, having large square leaves and sanguine flowers in numerous groups of terminal clusters. The flower buds are at first pale of a colour and gradually become green, after which they develop into a bright red when they are ready for collecting. Cloves are harvested when 1.5-2 cm long and consist of a long calyx, terminating in four spreading sepals and four unopened petals, which form a small ball in the center. It is one of the most ancient and valuable flower type spices in the entire world, known as far back as the 1st Century B.C. The dried flower buds are used in cooking either whole or in a ground form, but as they are extremely strong, they are used sparingly. In North Indian cuisine, it is used in almost all rich or spicy dishes as an ingredient of a mix named garam masala, along with other spices, although it is not an everyday ingredient for home cuisine, nor is it used in summer very often. Cloves are commonly used in biryanis, pickles, salads and garam masala. Clove buds possess intense fragrance and burning taste. They have deep brown colour, powerful fragrant odour which is warm, pungent, strongly sweet and slightly astringent (Milind and Deepa, 2011).

Cassia buds (*Cinnamomum cassia* L) : Also called Chinese cinnamon / Chinese cassia, cassia buds resembling cloves are picked just before blooming and dried in the sun. They have an earthy, floral, cinnamon taste that's often called for in pickling recipes, mulling spice blends and some traditional German baking. They are used in the East for pickles, curries, candies and spicy meat dishes (Filippone, 2019).

Savory (*Satureja hortensis* L.) : It is native to the Mediterranean region but is now grown worldwide. Its principal use is in sauces, pâtés and pickles. It is rarely used for meats, but mostly for vegetables. Savory is very often employed for legumes, especially dishes prepared from dried lentils or beans, where it aids digestion significantly. Furthermore, it is very well suited for mushrooms also (Katzer, "n.d").

Lesser known flower type spices in Manipur

Meitei, the valley inhabitants of Manipur have the tradition of using young inflorescences and raw leaves of *Ocimum canum* Sims, *Miriandra bengalensis* Benth. (commonly called Bengal sage), *Elsholtzia griffithii* and *Zanthoxylum acanthopodium* DC. (Pricky winged leaf) as spice in their indigenous sauce *Ametpa* or indigenous dish *Eromba* or as an ingredient of indigenous salad *Singju* (Yumnam and Tripathi, 2012). The inflorescence of these plants are used as spice. The leaves and inflorescence of *Ocimum canum* Sims is used in making pakora. Leaf or shoot and inflorescence of pricky winged leaf is cooked with fresh water snail & eaten in manipur.

Conclusion

Flowers and floral parts can be used as an essential ingredient in a recipe, seasoning for a dish or simply as a garnish. Even though some of the mentioned spices are popular, the uses and popularity of ornamental flowers and underutilized herbs as spices is location specific and limited and the

consumers are unaware of it but it has the potential for commercialization considering the changing food habit and the desire for the consumers to try new cuisines. Some of the flowers are high in antioxidants and minerals and have many medicinal properties like those used in chinese herbal medicine. The value added products and marketing of these flowers and flower parts as spices can be promoted to increase the income of the farmers through the diversified use of these plants.

Jasmine

Violets

Rose

Lavender

Rhododendron

***Ocimum canum* Sims**

***Miriandra bengalensis* Benth.**

Elsholtzia griffithii

***Zanthoxylum acanthopodium* DC.**

Clove

Kewra

Capers

Mint

Saffron

Savory

Cassia buds

Fig.1 Flower, Floral Parts and Inflorescence used as spice from different plants

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[Article ID : 01/II/15/0221]

IMPORTANCE OF POTASSIUM IN PLANT GROWTH AND ITS FORMS IN SOIL

Palsande V. N.
Assistant Professor, College of Horticulture,
Mulde, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli (MS)

Abstract
Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen. For optimal growth, potassium levels in plants should be between 2% and 3% of the dry weight. When potassium is limited, essential plant life processes from photosynthesis to moisture regulation are affected. Potassium availability to plants in general is governed by different forms of K *viz* water soluble K, exchangeable K, fixed K and mineral K. Plants utilize not only the readily available K but also the non-exchangeable and mineral K during the crop growth.

Introduction
Potassium (K) is one of sixteen essential nutrients required for plant growth and reproduction. It is classified as a macronutrient, as are nitrogen (N) and phosphorus (P). It is taken up by plants in its ionic form (K^+). Considering its role in crop production potassium is regarded as major element. Nutrient K is less mobile in soils because of the strong affinity with some exchange sites of clays. Large rates of K uptake can be attributed to its high mobility due to the large permeability of cell membranes to K-ions, which arise from the occurrence of a range of highly K selective, low and high affinity ion channels and transporters. The large K uptake rates achieved by roots result in a steep depletion of solution K in the rhizosphere. It has been well established that a significant proportion of plant needs of K is met from non-exchangeable fraction of soil K.

Table 1. Fertilizer consumption in India (Naidu *et al.,* 2011)

Sr. No.	Year	Fertilizer consumption (kg/ha)			Ratio of N: P: K
		N	P_2O_5	K_2O	
1	1960-61	1.39	0.35	0.19	7.3: 1.8: 1.0
2	1970-71	8.92	3.26	1.43	6.3: 2.2: 1.0
3	1980-81	21.22	7.00	3.60	5.9: 1.9: 1.0
4	1990-91	43.1	17.3	7.20	6.0: 2.4: 1.0
5	2000-01	58.7	22.8	8.70	6.8: 2.6: 1.0
6	2005-06	66.6	27.3	12.60	5.3: 2.2: 1.0
7	2008-09	77.9	33.6	17.10	4.6: 2.0: 1.0

Functions of Potassium in Plants
While potassium is not a constituent of any plant structures or compounds, it plays a part in many important regulatory roles in the plant. It is essential in nearly all processes needed to sustain plant growth and reproduction. Potassium plays a vital role in:

1. Enzyme Activation: Enzymes serve as catalysts for chemical reactions, being utilized but not consumed in the process. They bring together other molecules in such a way that the chemical reaction can take place. Potassium "activates" at least 60 different enzymes involved in plant growth. The K changes the physical shape of the enzyme molecule, exposing the appropriate chemically active sites for reaction. Potassium also neutralizes various organic anions and other

compounds within the plant, helping to stabilize pH between 7 and 8 optimum for most enzyme reactions. The amount of K present in the cell determines how many of the enzymes can be activated and the rates at which chemical reactions can proceed. Thus, the rate of a given reaction is controlled by the rate at which K enters the cell.

2. Stomatal Activity: Plants depend upon K to regulate the opening and closing of stomata the pores through which leaves exchange carbon dioxide (CO_2), water vapor, and oxygen (O_2) with the atmosphere. Proper functioning of stomata are essential for photosynthesis, water and nutrient transport, and plant cooling. When K moves into the guard cells around the stomata, the cells accumulate water and swell, causing the pores to open and allowing gases to move freely in and out. When water supply is short, K is pumped out of the guard cells. The pores close tightly to prevent loss of water and minimize drought stress to the plant. If K supply is inadequate, the stomata become sluggish – slow to respond – and water vapor is lost. Closure may take hours rather than minutes and is incomplete.

3. Transport of Sugars: Sugars produced in photosynthesis must be transported through the phloem to other parts of the plant for utilization and storage. The plant's transport system uses energy in the form of ATP. If K is inadequate, less ATP is available, and the transport system breaks down. This causes photosynthates to build up in the leaves, and the rate of photosynthesis is reduced.

4. Water and Nutrient Transport: Potassium also plays a major role in the transport of water and nutrients throughout the plant in the xylem. When K supply is reduced, translocation of nitrates, phosphates, calcium (Ca), magnesium (Mg), and amino acids is depressed. As with phloem transport systems, the role of K in xylem transport is often in conjunction with specific enzymes and plant growth hormones.

5. Protein Synthesis: Potassium is required for every major step of protein synthesis. The "reading" of the genetic code in plant cells to produce proteins and enzymes that regulate all growth processes would be impossible without adequate K. When plants are deficient in K, proteins are not synthesized despite an abundance of available nitrogen (N). Instead, protein "raw materials" (precursors) such as amino acids, amides and nitrate accumulate.

6. Starch Synthesis: The enzyme responsible for synthesis of starch (starch synthetase) is activated by K. Thus, with inadequate K, the level of starch declines while soluble carbohydrates and N compounds accumulate. Photosynthetic activity also affects the rate of sugar formation for ultimate starch production. Under high K levels, starch is efficiently moved from sites of production to storage organs.

7. Crop Quality: Potassium plays significant roles in enhancing crop quality. High levels of available K improve the physical quality, disease resistance, and shelf life of fruits and vegetables used for human consumption and the feeding value of grain and forage crops. Fiber quality of cotton is improved. Quality can also be affected in the field before harvesting such as when K reduces lodging of grains or enhances winter hardiness of many crops.

8. Photosynthesis: The role of K in photosynthesis is complex. The activation of enzymes by K and its involvement in adenosine triphosphate (ATP) production is probably more important in regulating the rate of photosynthesis than is the role of K in stomatal activity. When the sun's energy is used to combine CO_2 and water to form sugars, the initial high-energy product is ATP. The ATP is then used as the energy source for many other chemical reactions. The electrical charge

balance at the site of ATP production is maintained with K ions. When plants are K deficient, the rate of photosynthesis and the rate of ATP production are reduced, and all of the processes dependent on ATP are slowed down. Conversely, plant respiration increases which also contributes to slower growth and development.

Potassium deficiency symptoms in plant

Typical symptoms of potassium deficiency in plants include brown scorching and curling of leaf tips as well as chlorosis (yellowing) between leaf veins. Purple spots may also appear on the leaf undersides. Plant growth, root development, and seed and fruit development are usually reduced in potassium-deficient plants. Often, potassium deficiency symptoms first appear on older (lower) leaves because potassium is a mobile nutrient, meaning that a plant can allocate potassium to younger leaves when it is K deficient.

Table 2: Various potassium fertilizer materials and their percent nutrient content

Sr. No.	Material	Chemical Formula	N	P_2O_5	K_2O
1.	Potassium chloride	KCl	-	-	60-62
2.	Potassium sulfate	K_2SO_4	-	-	50-52
3.	Potassium nitrate	KNO_3	13	-	44
4.	Potassium sodium nitrate	$KNa(N0_3)_2$	15	-	14
5.	Potassium hydroxide	KOH	-	-	83
6.	Potassium polyphosphates	$K_4P_2O_7$	--	40-60	22-48
7.	Potassium metaphosphate	KPO_3	-	55-57	38

'Potash' and 'Potassium'

Fertilizers and organic manures release potassium into soil solution as the potassium ion, K^+ and plants take up potassium in this same form. However the potassium content of fertilizers is usually referred to and measured as 'potash' or K_2O. This is just a convention and 'potassium', 'potash', 'K' and 'K_2O' are often used interchangeably when referring to fertilizers or application rates. Soil analysis results are given as mg/litre (or ppm) of K (potassium) which relates to an Index, not to an amount of fertilizer, and should not be confused. If it is necessary to convert K to the K_2O value should be multiplied by 1.20. Similarly K values can be converted to K_2O by dividing by 0.83.

Table 3: All India consumption of N, P_2O_5 & K_2O (000 tonnes)

Year	N	P_2O_5	K_2O
1950-51	55.0	8.8	6.0
1960-61	211.7	53.1	29.0
1970-71	1479.3	541.0	236.3
1980-81	3678.1	1213.6	623.9
1990-91	7997.2	3221.0	1328.0
2000-01	10920.2	4214.6	1567.5
2010-11	16558.2	8049.7	3514.3
2018-19	17637.8	6910.2	2680.3

(Faidelhi.org)

Soils of India were considered to be relatively rich in available potassium, but intensive cropping with high yielding varieties has led to increased demand on soil potassium and the application of K fertilizers became necessary even in soils where K deficiency was not a problem of the major and secondary nutrient elements. The lithosphere contains an average of 2.6% K and in the earth's crust

K is the seventh most abundant element. The bulk of the soil potassium occurs in the K bearing primary minerals, such as micas and feldspars. The orthoclase and its polymorphs makeup 16% of the total potassium, biotite and closely associated micas constitute 3-8 % and muscovite contributes another 1.4%.

Forms of potassium in soil

Intensive cropping, however may deplete soil potassium reserves. Soil potassium is present in four forms: Potassium exists mainly in four farms viz., water soluble, exchangeable, non- exchangeable (fixed) and mineral K.

1. Water soluble K: Potassium present in soil solution as soluble cation is termed as water soluble K which is readily absorbed by the plants and relatively unbound by cation exchange forces and invariably subject to leaching losses in relation to soil properties. Appreciable quantities of potassium is likely to occur when applying water soluble K fertilizers and from irrigation water of high K content or soils contain high mixed soluble salts.

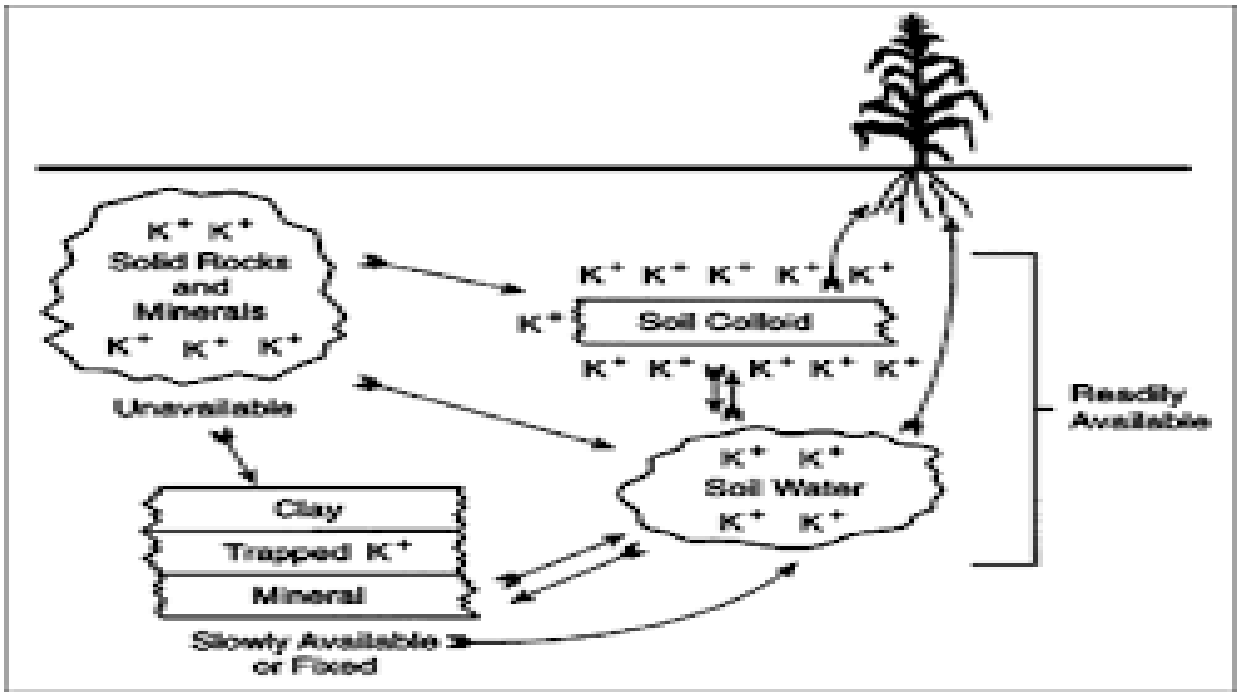

Fig. 1: Relationship of potassium in the soil-plant system

2. Exchangeable K : Exchangeable K is the portion of the soil K that is electrostatically bound as an outer-sphere complex to the surfaces of clay minerals and humic substances. It is readily exchanged with other cations and also is readily available to plants. The exchangeable K is the form of K present in the soil matrix and can be replaced by cations of neutral salts present in the soil solution. Exchangeable K constitutes approximately 90 per cent of the available K.

3. Nonexchangeable (Fixed) K: Nonexchangeable or fixed K differs from mineral K in that it is not bonded within the crystal structures of soil mineral particles. It is held between adjacent tetrahedral layers of dioctahedral and trioctahedral micas, vermiculites, and intergrade clay minerals such as chloritized vermiculite. Potassium becomes fixed because the binding forces between K and the clay surfaces are greater than the hydration forces between individual K+ ions. This results in a partial collapse of the crystal structures and the K^+ ions are physically trapped to varying degrees, making K release a slow, diffusion controlled process.

4. Lattice K : It is fraction of K that gets fixed in lattice space of the 2:1 clay minerals. This form of K is distinct from mineral K in that, it is not bonded co- valently within the crystal structure of soil mineral particle but held between adjacent tetrahedral layers of dioctahedral and trioctahedral wedge zones of weathered micas and vermiculite.

5. Mineral K :

Major portion of soil K exists as part of mineral structure and in a fixed or non-exchangeable form. In general more than 90 per cent of the total K in the soils is found in mineral form as structural K. As noted earlier, most of the total K in soils is in the mineral form, mainly as K-bearing primary minerals such as muscovite, biotite, and feldspars.

Conclusions

In summary, potassium does not work alone; rather, it functions with other essential nutrients and crop management inputs to produce the final product. The importance of balanced nutrition and efficient use of all plant nutrients must be recognized. The special role of potassium in crop quality is of particular importance for overall production.

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Official Address :
Peshok Tea Estate
P.O.- Peshok, Dist.- Darjeeling
West Bengal, India
PIN-734312

Contact No : +91 7501389678
email : agriindiatoday@gmail.com