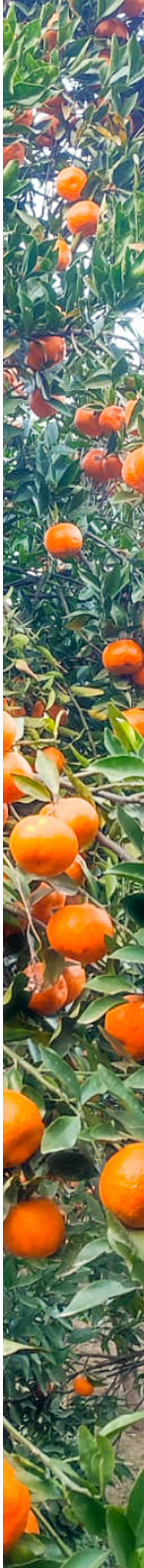
Proceedings of
Expert's Workshop on Management and reinforcement of Citrus Orchard

(10-11 OCTOBER, 2023)

Government of Gandaki Province
Ministry of Agriculture & Land Management
Directorate of Agriculture Development
Pokhara



कार्यक्रमका केही झलकहरू

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ABSTRACT

Citrus is one of the major fruits of Nepal in terms of income generation, area of cultivation and preference of consumers. Among the total citrus area cultivated, mandarin orange has dominated others species. The area of citrus cultivation has been expanding every year however the productivity has been fluctuating. Gandaki Province of Nepal has been dominating other provinces in terms of citrus cultivated area and production. Citrus fruit alone contributes around 1.52% of AGDP which is 29.58% against contribution of total fruit sector on AGDP. So citrus is a major income generating fruit crop of the farmers in this province. However, farmers are facing many obstacles for the area expansion, good harvest and the market management. In this scenario, Directorate of Agriculture Development under the Ministry of Agriculture and Land Management, has organized a workshop with the objective of formulating solid strategies for management and reinforcement of citrus orchard in the province. There were 8 scientific and strategic presentations from various research and extension institutions and rigorous discussion among the participants ranging from research, extension, universities and citrus farmers. The key findings from two days' workshop has been presented in this document which will be applied as a major guideline for the future program design and implementation.

ACKNOWLEDGEMENT

Citrus is one of the major fruits of Nepal in terms of area under cultivation, employment and income generation. Gandaki province has many production pockets of various citrus fruits and the area under citrus cultivation is expanding annually. Though the area under citrus cultivation is expanding, its productivity is not satisfactory due to various biotic and abiotic factors.

Realizing the need of formulating solid strategy for citrus fruit development in the province, Directorate of Agriculture Development, Gandaki province organized a workshop. The workshop attempted to extract the ideas and experiences from citrus experts working in teaching, research and extension services together with commercial citrus growers from the province. Altogether eight technical and scientific papers were presented in the workshop by various experts, following the rigorous discussion to formulate the solid strategy.

This publication includes all technical and scientific papers presented in the workshop with the aim to institutionalize the summary of the workshop. I hope this workshop proceeding will be the guiding document for citrus fruit development in the province, and I hope the issues raised in the workshop will be addressed through policy, program and budget in the coming days.

I would like to thank all the experts for sharing the valuable information in the forum. Further, I would like to deliver the special thanks to Salik Ram Adhikari, Bala Krishna Adhikari and Milan Acharya for their continuous effort to organize and manage the workshop as well as prepare the manuscript in this precious form.

Lastly, I would like to welcome all for the valuable feedbacks regarding the improvement of this publication.

Thank you!

Basu Dev Regmi
Director General

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BACKGROUND

Citrus is the major fruit of Nepal in terms of area, production and its contribution to AGDP. The commercial citrus cultivation in Nepal was started only after 1970, after the establishment of National Citrus Research Program (NCRP 2010). Now the share of citrus fruit is around 21.6% over the total fruit production in Nepal (MoALD, 2023). The area and production of citrus in Nepal is increasing whereas productivity has been fluctuating year by year. Total area under citrus cultivation during 2012/13 was 36975 ha whereas it was increased to 49306 ha during 2021/22. Consequently, the production has also been increased from 216188 mt in 2012/13 to 306149 mt in 2021/22. Ten years average productivity of citrus fruit since 2012/13 to 2021/22 was 9.27 mt/ha with the highest productivity of 10.03 mt/ha in 2019/20 and the lowest, 8.79 mt/ha in 2015/16. Mandarin is the most dominant fruit among citrus in terms of area and production. It alone covers around 56.75% and 60.54% of the citrus fruit area and production. Mandarin is followed by sweet orange, lime, lemon and other citrus fruits respectively (MoALD, 2023). Among 75 districts, citrus fruit is cultivated in 65 districts, and commercial citrus cultivation is found in 42 districts (MoALD, 2021). Gandaki Province occupies 19.8 and 27.43 percent of the total citrus and mandarin production respectively in the country (MoALD, 2023).

Citrus Diversity and Varieties in Nepal

Mid-hills of Nepal ranging from 800-1500 masl has an appropriate agro-climatic condition for citrus fruit cultivation (Paudyal, 2016). It has also favorable geography and edaphic condition for citrus cultivation. National Citrus Research Program, Paripatle (NCRP), Dhankuta and its command areas are the most diversity center of citrus species (Gautam, 2020). There are 120 citrus genotypes alone in NCRP collected from local and exotic sources during different times (NCRP, 2018). However old plantations are mostly dominated by single variety of Khoku mandarin and Dhankuta local of sweet orange (NCRP,2004).

The existing varieties of citrus species have low yield potential with short production period in Nepal. A great genetic diversity exists among citrus species across the country for the fruit characteristics. However, almost all varieties of mandarin, sweet orange and acid lime have the same harvesting period that the production of these species is limited to October to January. Therefore, appropriate varietal alternative to these varieties for expanding the production period is necessary in Nepal.

Lama and Kayastha, 1999, reported fourteen species of citrus from Gandaki Province. Twelve species of citrus are available in National Citrus Development program Kirtipur, Namely *Citrus reticulata*, *C.unshinu*, *C. sinensis*, *C. grandis, C. paradise*, *C.lemon*, *C. aurantifolia*, *Fortunella, Japonica, Poncirus trifoliate, Citrange* etc. Mandarin (*C.reticulata*), sweet orange (*C.sinensis*), acid lime (*C. aurantifolia*) and lemon (*C. lemon*) are cultivated commercially in Nepal. Mandarin orange grown in Nepal is excellent in terms of size and quality. Mandarin orange contributes as food, improvement of nutrition, generation of employment, income and in maintaining good environment (Shah, (1992), Gurung, 1998). Tomiyashu et al., (1998), has listed in priority to mandarin orange as cash generating source for mid hill farmers.

Major Diseases in Citrus

Similar to other crop the citrus crop also suffers from various type of biotic and abiotic causes. Among the biotic reasons various types of insect pests, fungi, bacteria, nematodes, viruses and plant parasites are major. Nutritional disorders due to the deficiency of many nutrients are the major abiotic causes. Some areas are also very prone to hailstone, high speed wind, prolonged drought etc. Various citrus species are prone to large number of diseases.

Major Citrus diseases present in world are Huanglongbing (Citrus greening), Tresteza, Greasy spot, Alternaria brown spot, Phytophthora induced diseases, Melanose, Scab, Canker, and Post bloom fruit drop (Teixeria et al., 2004). Citrus tresteza virus (CTV) and Citrus greening (HLB) diseases are serious problems for citrus fruit production in many African and Asian countries including Nepal (Teixeria et al., 2004). Among these diseases, HLB has been considered as the most important disease for declining citrus industry in Nepal (FAO, 2011). Citrus trees infected with HLB have five times lower yields as compared to healthy ones (Regmi, 1982).

Major Fungal Diseases in Citrus

Major disease caused by fungi reported in Nepal are powdery mildew (*Oidium tingitaninum*) (Khadka et al., 1967), wither blight/Anthracnose (*Colletotrichum acutanum*) (Lama, 1979), damping-off (*Rhizoctonia spp*) (Lama, 1979), foot and root rot (*Phytopthora parasitica, P.citropthora, P.palmivora*) (Lama, 1980), gummosis (*Phytophthora* spp) (Lama, 1980), pink disease (*Erythricium salmonicolor*), Greasy spot (*Mycosphaerella citri*)

(Khadka et al., 1967), sooty mould (*Capnodium oleaginum*), blue mould (*Penicillium italicu*) (Lama, 1979), green mould (*Penicillium sp*), citrus scab (*Elsinoe fawcetti*) (Khadka et al., 1967), Styler-end rot of citrus/core rot of citrus (*Alternaria citri*) (Khadka et al., 1967).

Major Bacterial Diseases in Citrus

Most prevalent bacterial diseases reported in Nepal are Citrus canker (*Xanthomonas axonopodis* pv. *Citri*) and Citrus greening (HLB) (*Candidatus liberobacter asiaticus*) (Lama T.K, 1980).

Major Viral Diseases in Citrus

Citrus tristeza disease (*Citrus tristeza virus*) (CTV) (Lama T.K, 1980) and Citrus leprosis disease (*Citrus leprosis virus*) (CiLV) (Lama T.K, 1980) are the major virus diseases.

Major Nematode Diseases in Citrus

There is one nematode disease which has been reported as Citrus Root Nematode (*Tylenchus semipenetrans*) (Manandhar HK and P Amatya 1985).

Major Parasitic Plants in Citrus

There is one parasitic plant, which is locally called Ainjeru (एजेरु) of citrus (Parasitic angiosperm, *Loranthus* spp.) has been reported by Lama T.K in 1980 (NCDP, 2014).

Major Insects Pests in Citrus

Citrus Chinese Fly *Bactocera minax* (Diptera: Tephritidae), Oriental Fruit Fly, *Bactocera dorsalis* (Diptera: Tephritidae), Citrus Psylla ; *Diaphorina citri* (Hemiptera : psyllidae), Citrus Stink bug; *Rhynchocoris poseidon* (Hemiptera: Pentatomidae), Red scale; *Aonidiella aurantii* (Hemiptera; Pentatomidae), Citrus Aphid *Toxoptera citricidus* (Hemiptera : Aphididae), Orange Stem Borer, *Stomatimum barbatum* (Coleoptera: Cerambycidae), Citrus mealy bug, *Planococcus citri* (Hemiptera: Pseudococcidae), Citrus Leaf miner; *Phyllocnistis citrella* (Lepidoptera : Phyllocnistidae), Citrus Red mite; *Panonychus citri* are the major insect pests of citrus in Nepal. And Lemon butterflies, *Papillio demoleus* (Lepideoptera: Papilionidae), Leaf Mining Beetle, *Throscoryssa citri* (Coleoptera: Chrysomelidae), White Flies, *Dialeurodes citri* (Hemiptera: Aleyrodidae), Tree Hopper, *Oxyrachis* spp. (Hemiptera; Membracidae), Red Ant, *Oecophylla smaragdina* (Hemiptera:

Formicidae), Fruit Sucking Moth, *Othreis fullonia* (Lepidoptera: Noctuidae) are reported as the minor insect pest. However recently, Fruit Sucking Moth, *Othreis fullonia* has been witnessed to be a most damaging insect in Sindhuli district. In recent years, Citrus Chinese Fly *Bactocera minax* has been damaging around 20-30% of total citrus fruit in Gandaki Province.

THE WORKSHOP INAUGURATION SESSION

The workshop was organized on 10th and 11th of October, 2023. There were 8 different scientific as well as strategic papers altogether presented. The program schedule (Annex 1), list of participants (Annex 2), presentations and name of reviewers (Annex 3) has been attached in Annex. After a continuous discussion on the papers presented in one and half days, the whole group was divided into five sub-groups assigning for the formulation of future strategies. The thematic areas for discussion were given for each sub-group and key findings from each sub-group were discussed on the group and documented.

Inauguration of the workshop

The inaguration session was Chaired by Mr. Sahadev Prasad Humagain, Secretary of Ministry of Agriculture and Land Management (MoALM), Gandaki and the Chief Guest of the program was Honorable Minister Mahendra Dhoj GC, Minister for MoALM, Gandaki Province. Senior Horticulture Development Officer, Bala Krishna Adhikari was master of ceremony. The session was moderated by Mr. Milan Acharya (Crop Development Officer, ADD, Gandaki).

Honorable Minister inaugurated the program with watering a citrus plant in a mud-pot and highlighted for the maximum extraction of knowledge from the specialists presented on the workshop. Honorable minister also delivered vote of thanks to the citrus specialists and scientists presented on the workshop and DoAD for organizing the important program. He also committed for the policy support for the implementation of recommendations provided from the workshop.

Mr. Sahadev Prasad Humagain, Secretary, MoALM, highlighted the immediate actions to be taken by the stakeholders for maximizing the yield of citrus as soon as possible and wished for the successful completion of the program.

PRESENTATION SESSION

There were altogether 8 presentations in this session ranging from the existing policy for citrus development and various technical issues faced by farmers in Nepal. The first presentation was delivered by Mr. Bala Krishna Adhikari, Senior Horticulture Development Officer, ADD, Gandaki.

1. Citrus Farming in Gandaki Province: Status, Problems and Prospects

Presenter: Mr. Bala Krishna Adhikari, ADD, Gandaki
Name of Reviewer: Mr. Beni Bahadur Basnet, Mr. Bhairav Raj Kaini

Major Highlights of the Presentation

Brief introduction of Gandaki Province, contribution of Agriculture, Fruits and Citrus fruits in GDP and AGDP, status of citrus fruit import in different fiscal years in Nepal, cultivated area and production status in 2078/79 in Nepal, area and production status in Gandaki Province during recent five years, Citrus Super/Zones, Blocks operating Districts/Rural/Municipalities in Gandaki Province, NAFHA projects implementing local levels, various institutions for education, research and development, and extension involved in horticulture sector in Gandaki province, registered nurseries in Gandaki Province, problems identified for the citrus cultivation in Gandaki Province, prospects of citrus cultivation in Gandaki Province were focused in the presentation.

Introduction

Gandaki Province occupies 14.67% of total area of Nepal where 487823 Ha land is cultivable land out of which only 76% land has been used for cultivation and remaining 24% land has been left barren. There is only 19.1% of total cultivated land which has been covered by horticultural crops among which 26% has been for different types of fruits. Among the area covered by fruits, 54% of fruit area has been occupied by citrus fruit only. So citrus is the number one fruit crop amongst the fruits in Gandaki province. Government of Gandaki Province identified the citrus cultivation as the second most prioritized sector among the agriculture.

Status of Citrus farming in Gandaki Province

Citrus fruits have a major contribution in AGDP which alone contributes 1.52% which is 29.58% among the fruit's contribution in AGDP. The trend

of citrus fruit import is decreasing from 42559 MT in 2075/76 to 25411 MT in 2079/80. Total citrus area under cultivation in Gandaki Province is 9973 Ha out of which 6275 Ha is productive area with the productivity of 9.66 MT/Ha. Among the nine citrus producing districts, Syangja ranks first with the area of 2202 Ha. 80% of the total citrus fruit is occupied by Mandarin orange alone. There are one Super Zone, three Zones and sixteen Blocks programs operated for citrus fruits development in Gandaki Province by Prime Minister Agriculture Modernization Project (PMAMP). Ongoing NAFHA projects also prioritized the citrus fruit development by covering 27 local levels of 8 districts of Gandaki Province with the goal to increase the area of Mandarin cultivation by 800 Ha and lime cultivation by 750 Ha.

Institutional arrangement for teaching research and extension

There are only 21 specialized horticultural technicians under provincial government in Gandaki Province. Two higher education institution affiliated by T.U. and A.F.U., one middle level technicians producing institution, CTEVT, Agriculture Research Directorate, Lumle, Horticulture Research Center, Malepatan, Pokhara, Horticulture Resource Development Center, Plant Protection Laboratory, PMAMP, REED Project, AKCs at each district are the major stakeholders involved in citrus fruit development in Gandaki Province. Only 46 private nurseries are registered in Gandaki Province which is involved in producing citrus seedlings.

Problems of citrus farming

Production and availability of quality seedlings and their regulation, quality of infrastructure used for the production of seedlings, quality of screen house, Bud Wood Certification system, PCR test of seedlings and their regulation, farmers' ignorance and lack of technical human resources for the orchard management, lack of quality and trained human resources, increasing trend of diseases and insect pests, scattered orchards over the province, problems in using the existing machineries in the orchards, lack of long term research and education, lack of relevant data, lack of institutional coordination among research, education and extension as well as institutional infrastructure, various drawbacks for agriculture loan, insurance implementation, subsidies, lack of long term study on cold storage and its management, significant post-harvest loss, challenges of climate change etc., are the major problems faced by the farmers.

Prospects of citrus farming

Talking about the scope and prospects of citrus industries in Gandaki Province, there is a long list of opportunities in this sector. The existing climate and edaphic condition is very suitable for the citrus cultivation, almost all the wards of this province has been connected with the Road and Electricity networks, Citrus fruit is getting popularity with the increasing trend and becoming a major source of farmers income, there is still a gap for independence and import substitution of citrus fruit, there is a great opportunity of export of citrus fruit particularly mandarin orange with its peculiar taste and as a mountain product, nutritional contribution from citrus fruit is also high, high scope from the industrial development point of view with the aspect of value addition and processed products, environmental protection by citrus tree which is also the lower chemical inputs demanding crop and scope for carbon credit/Carbon finance, scope of utilization of bare land by citrus cultivation, there are different institutions involved in the development of citrus industries like NAFHA, PMAMP, second prioritized crop by the Province Government, Special Project on citrus fruit.

Thus, if the problem mentioned above solved by the strategic coordination among the institutions involved; obviously the opportunities could be on our hands with a significant contribution on GDP by this sector.

2. Existing Technologies for Citrus Cultivation in Nepal

Presenter: Dr. Umesh Kumar Acharya, NCRP, Dhankuta

Name of Reviewer: Mr. Bala Krishna Adhikari, Mr. Milan Acharya

Major Highlights of Presentation:

Climatic and edaphic condition, different developed varieties of acid lime and mandarin, early varieties mandarin, varietal selection of mandarin, varietal selection of orange, cultivation plan for acid lime, strategies for mandarin cultivation, strategies for sweet orange cultivation, varietal research, studies on decline management, biotechnology/molecular lab facility at NCRP Dhankuta, green and blue mold management on storage

Table 1 Climatic and edaphic condition for citrus cultivation

Particulars	Mandarin	Sweet Orange	Acid Lime
Altitude (Meter)	800-1400	1000-1400	200-1400
Temperature (0C)	5-35	5-35	5-35

Particulars	Mandarin	Sweet Orange	Acid Lime
Soil Depth (Meter)	1-1.5	1-1.5	1-1.5
PH	5.5-6.5	5.5-6.5	5.5-6.5

Different developed varieties of acid lime and mandarin

Characters /Variety	Sunkagati-1	Sunkagati-2	Terhathum Local (Mid-hills)	NCRP 53
Average weight of fruit (gram)	40-60	40-60	30-50	90-120
Productivity (ton/ha)	34.5	26.9		30.9
Quantity of juice (%)	49	48	45-50	44
T.A. (%)	7-10	7-10	7-10	6.5
Period of maturity (Terai)	Ashad – Poush	Ashad – Poush	Kartik – Poush	Jestha – Saun
Period of maturity (Tallo Madhya Pahad)	Bhadra - Mangshir	Bhadra- Mangshir		Saun – Ashoj
Altitude (masl)			1000-1600	150-1600

Mandarin varieties developed for Koshi Province

Characters/Variety	Khoku local (Registered)	Banshkharka local (registered)
Average weight of fruit (gram)	123	101
Productivity (ton/ha)		29.18

Characters/Variety	Khoku local (Registered)	Banshkharka local (registered)
Thickness of peel (mm)		2.17
Average number of keshra		10
Average diameter of fruit (mm)	57	58
Quantity of juice (%)	48	38.17
TSS (%)	12.5	12
Acidity (%)	1.25	1.11
Maturity	Mangshir – Poush	
Altitude (masl)	1000-1600	

Early Varieties of Mandarin

Characters/Variety	Paripatle Early Mandarin -1 (Okitsuwaase)
Average weight of fruit (gram)	120
Average diameter of fruit (mm)	57
Quantity of juice (%)	64
TSS (%)	8
Acidity (%)	0.9
Productivity (ton/ha)	29.18
Maturity	Bhadra – Kartik
Altitude (masl)	800-1400

Varietal selection

Characters /Variety	Miyaga-wase	Dhankuta Local	Washing-ton Navel	Valencia Late
Average weight of fruit (gram)	128	153	168	141

Characters /Variety	Miyaga-wase	Dhankuta Local	Washing-ton Navel	Valencia Late
Average diameter of fruit (mm)	58	65	66	66
Quantity of juice (%)	68	44	34	38
TSS (%)	8	12	14	12-14
Acidity (%)	0.9	1.5	1.4	1.5
Productivity (ton/ha)	29.18			
Maturity	Ashoj – Kartik	Mangshir-Poush	Kartik-Mangshir	Falgun – Chaitra
Altitude (masl)	800-1400	800-1400	800-1200	800-1400

Plan for Cultivation of different citrus fruits

Table 2 Plan for Acid Lime Cultivation

Varieties/ Months	Baisakh	Jestha	Ashad	Srawan	Bhadra	Ashoj	Kartik	Magshir	Poush	Magh	Falgun	Chaitra
Tarai Thulo (NCRP 53)		■	■	■	■	■	■	■				
Tarai and inner terai (Sunkagati 1 & 2)			■	■	■	■	■	■	■	■	■	■
Mid Hill (NCRP 53)				■	■	■						
Lower Hill (Sunkagati 1 & 2)				■	■	■	■	■				
Hill (Local varieties)							■	■	■			
Storage in Mid Hill										■	■	■

Table 3 Plan for Mandarin Cultivation

Varieties/ Months	Baisakh	Jestha	Ashad	Srawan	Bhadra	Ashoj	Kartik	Magshir	Poush	Magh	Falgun	Chaitra
Local Varieties (Khoku)												
Early Variety (Unshu)												
Late Variety (Kinnow and Markat)												
Storage												

Table 4 Plan for Orange Cultivation

Varieties/ Months	Baisakh	Jestha	Ashad	Srawan	Bhadra	Ashoj	Kartik	Magshir	Poush	Magh	Falgun	Chaitra
Local Varieties (Wasington Navel)												
Late Variety (Valencia Late)												
Storage												

Studies on decline management

Integrated Plant Nutrient Management recommended for citrus decline management:

Nitrogen 500 gram + Phosphorus 250 gram + Potassium 500 gram + Boric Acid 20 gram + Zinc Sulphate 150 gram + Copper Sulphate 75 gram + Manganese Sulphate 75 gram per plant per year

LAMP Hydroxy reaction Napthol Blue (HNB based) for HLB detection

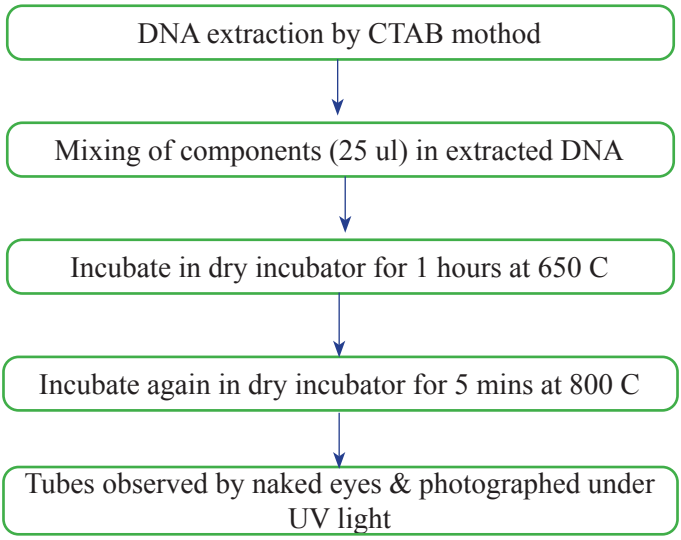


Figure 1 Flow chart of LAMP-HNB based for HLB detection

Mutation breeding

- Searching for seedless local mandarin
- Local variety mandarin seed treated with EMS.
- Grown on coco-peat media
- Seedling transferred to speed breeding chamber
- Later tissue cultured sapling will be produced.
- Checked for mutation using molecular marker.

3. An Insight of Nursery Management Directive Enforced by Gandaki Province Government

Presenter: Mr. Basu Dev Regmi, ADD Gandaki

Name of Reviewer: Mr. Bala Krishna Adhikari, Mr. Gobinda Raj Koirala

Major Highlights of Presentation

Background of the nursery directive endorsed by Gandaki province government, major points included in the directives, institutional provisions for the implementation of the directive, Province level nursery management committee, role; responsibilities and authorities of committee, role; responsibilities and authorities of the Agriculture Development Directorate,

role; responsibilities and authorities of Horticulture Development Resource Center, role; responsibilities and authorities of Agriculture Knowledge Center, roles of local level, provision on nursery inspector, role; responsibilities and authorities of nursery inspectors, responsibilities of nursery owners, process of Budwood Certification for citrus, process during seedlings transportation and distribution, management of under-standard seedlings, restriction on sales of under-standard seedlings, quality standards of seedlings were the major points discussed in the presentation.

Background

Most of the nursery owners have been producing seedlings with very minimum standards so the quality of seedling and their supply is very poor. Seedlings supplied from other places, especially from the terai have very poor quality. Gandaki province government endorsed this directive to ensure the quality supply by discouraging the supply of poor-quality seedlings in the province. The directive was based on the Agri-Business Promotion Act, 2077.

Province level nursery management committee

Chairman – Director of Agriculture Development Directorate (ADD, Gandaki)

Member – Chief of Agriculture Development Division of Ministry (MoALM, Gandaki)

Member – Chief of Plant Protection Laboratory (PPL, Gandaki)

Member – Chief of Soil and Fertilizer Testing Laboratory (SFTL, Gandaki)

Member – Chief of Seed Testing Laboratory (STL, Gandaki)

Member – Chief of Horticulture Research Center (HRC, Pokhara)

Member-Secretary – Chief of Horticulture Development Resource Center (HDRC, Gandaki)

Committee can invite in the committee meeting the subject matter specialists, and representatives of Farm Center and owner of nursery on the basis of need.

Role and responsibilities of committee

Provide the necessary suggestions to the Ministry,

Provide the necessary directions and suggestions to the relevant stakeholders,

Facilitation for the ultimate solution of any disputes and complaints

Role and responsibilities of Agriculture Development Directorate

- Coordination between the relevant stakeholders
- Preparation of seedling balance sheet for the demand and supply of seedlings in province
- Provide the direction to the relevant institutions for the quality maintenance of seedling
- Recommendation of price of the seedlings produced in the government farms to the Ministry
- Recommendation to the Ministry regarding the import and distribution of seedlings inside the province to restrict the harmful diseases and insect pests
- Update of fruit seedlings details

Role and responsibilities of Horticulture Development Resource Center

- Quality regulation and control of the government and private nurseries
- Identification of danger and restricted diseases, insect pests with coordination with Plant Protection Laboratory and Agriculture Knowledge Center and inform to the Agriculture Knowledge Center
- Control and restriction of the sales and distribution of seedlings produced by unregistered nurseries in coordination with relevant institutions
- Operation of trainings about the fruit nursery establishment and management as well as seedling quality standards
- Necessary coordination for the management of source seed and seedlings
- Operation of necessary training for nursery inspectors
- Operation of other relevant works as the secretariat of committee

Role and responsibilities of Agriculture Knowledge Center

- Technical coordination for the registration of private nursery
- Documentation of registered nurseries
- Take the necessary actions for the maintenance of quality standards of the seedlings
- Documentation of the produced and sales/distributed seedlings by nursery owners
- Regular submission of the report about the details of seedlings of

demand and produced saleable seedlings
- Provide the technical service and training for nursery owners
- Spot monitoring of nurseries before sales and distribution of seedlings for the disease-free seedlings and quality certification to support the nursery inspectors
- Restriction of the sales and distribution of seedlings from unregistered nurseries

Quality of seedling and scion

- Genetically true to the type
- Pedigree recorded
- Free from insect pests and diseases
- Tagging by differentiating the varieties
- Approved certification of citrus greening and tresteza virus free seedling for citrus seedlings
- Regular PCR for greening and ELISA test for citrus tresteza virus of mother plant used for scion in each two years and certification of free of these diseases

Quality of Mother Plants

- Genetically true to the type
- Pedigree recorded
- Free from insect pests and diseases
- Tagging by differentiating the varieties
- Approved certification of citrus greening and tresteza virus free seedling for citrus seedlings

Regular PCR for greening and ELISA test for citrus tresteza virus of mother plant used for scion in each two years and certification of free of these diseases

4. Existing policies, organizational set-up and human resources (is it sufficient ? Or need more alternatives – suggested options) for the Citrus industry.

Presenter: Bhairab Raj Kaini, National Citrus Expert
Name of Reviewer: Mr. Bala Krishna Adhikari, Mr. Milan Acharya

Major Highlights of Presentation:

Brief introduction, Policies, priorities and programs, Institutional setup,

Strategic programs, Human resources were the major issues discussed in that presentation.

Brief introduction

According to Tanaka, 1994, citrus might have appeared on the globe about 30 million years ago. Chinese literature has referred citrus cultivation as early as 2200 B.C. Chinese travelers have mentioned Nepal as "the country of golden fruits" in about 2000 years ago when they saw the yellow color of mandarin fruits at ripening (Lohar and Lama, 1997). 'Suntala' is probably the abbreviation of 'Suntara' which means golden star in Nepali. Many species of citrus are believed to be native to the tropical and sub-tropical parts of the Himalayan region. Nepal is situated in the eastern Himalayan region and many species of citrus are indigenous to Nepal. Bonavia (1890) reported that mandarin oranges were found in semi-wild condition at Butwal area of Nepal, that finding was also supported by Tanaka. In fact, Nepal is one of the centers of citrus diversity and many species of citrus are found grown in this country. Citrus fruits having commercial potential in Nepal are mandarins (Citrus reticulata Blanco), sweet orange particularly Junar (Citrus sinensis Osbeck), lime (Citrus aurantifolia Swing), lemon (Citrus lemon Lin) and hill-lemon (Citrus pseudolemon). In the past, Nepalese people used to grow citrus fruits in the kitchen gardens for social dignity and offering of fruits to relatives and neighbors were used to consider as a kind of hospitality.

Although there are many citrus species grown in Nepal, mandarin (Citrus reticulata Blanco), sweet orange (Citrus sinensis Osbeck) and acid lime (Citrus aurantifolia Swingle) are cultivated in commercial scale. Hill lemon (Nibuwa in Nepali) is also a popular species in Gandaki province but its cultivation is limited in the home garden. Mandarin and citron are considered indigenous crops of Nepal.

Institutional setup for citrus R and D in Nepal

Citrus R and D was initiated by establishing Citrus Research Station in Dhankuta and Sub Station in Pokhara in 1961 (BS 2018) with the support of the Indian Aid Mission (IAM).

In BS 2020, the first horticulture seminar was held at Horticulture Research Station, Kirtipur. Junar fruits from Dhankuta were exhibited in the seminar. Junar cultivation in Sindhuli particularly at Ratanchura area was specially discussed first time at the seminar and regarded as an important commodity for Nepal.

National Citrus Development Program (NCDP) was established in 2029 BS (1972) in Pokhara and moved to Dhankuta in 2031 giving full responsibility for citrus R and D of the country. In 1977 (2034) Horticulture Research Station, Dailekh was established in Midwestern region with major mandate on citrus. Thus, Dhankuta, Pokhara and Dailekh Stations were identified as major centers for citrus R and D. Later Sindhuli, Papa and Dhunibesi Horticulture Farms were also attached with Citrus Development Programs.

Dhankuta Agriculture Research station was handed over to Nepal Agricultural Research Council (NARC) after the establishment of NARC in 2048 and named as Agriculture Research Station (Horticulture) Dhankuta. From July 2000 (Shrawan 2057 BS) the station was officially recognized as National Citrus Research Program (NCRP). In 2050, NCDP was moved to Kirtipur from Dhankuta under Department of Agriculture. In 2060 (2003) Horticulture Centre, Palpa was recognized as Citrus Development Centre, Palpa.

Other major projects/programs involved in citrus development are/were Horticulture Development Project (HDP) from 1985 to 1997, Hill Fruit Development Project in 11 hill and mountain districts of Eastern Development Region from 1985 to 1995 and Prime Minister Agriculture Modernization Project (PMAMP) from BS 2073 under the Ministry of Agriculture and Livestock Development.

At present, National Citrus Research Program (NCRP) under NARC and National Fruit Development Center (NFDC) under Department of Agriculture (DOA) are the two government institutions solely involved on citrus research and development respectively.

Policies, priorities and programs

With the objective to increase the production of mandarin and sweet orange, the government launched citrus priority program in Dhankuta, Sindhuli, Ramechhap, Kaski and Dailekh districts in 1985 focusing on to increase citrus area, establish nurseries, training to farmers and demonstrate integrated orchard management approach.

Citrus was prioritized fruit crop and so the government launched citrus priority program in Dhankuta, Sindhuli, Ramechhap, Kaski and Dailekh districts in BS 2035 focusing on mandarin and sweet orange. The APP also accorded national priority to these crops. A Special Junar Development Program was launched in Ramechhap and Sindhuli in BS 2037.

Lime Mission Program was implemented from 2064/65 in ten districts of the country. In first phase (2064/65), Bhojpur, Terathum and Dhabkuta district were included. Makawanpur was added in the second phase (2067/68) and another six districts namely Nuwakot, Nawalparasi, Palpa, Gulmi, Surkhet and Jajarkot were included in the third phase (2070/71). Major activities of the mission program were (i) screen house construction for mother plants at DOA farms (Kirtipur and Palpa) (ii) area expansion of lime (iii) lime sapling production (iv) nursery establishment at government and private sector (v) construction of irrigation water collection pond (vi) drip irrigation demonstration and (vii) training, workshop, interaction, visit, audio-visual production.

A survey was conducted in 128 citrus pockets of 32 districts by FAO under a TCP project in 2013. Field data were collected from 30 trees of three different orchards selected randomly from each citrus pocket of surveyed districts. Out of 128 pockets thus surveyed in 32 districts,

- 62 pockets were categorized as initial stage of decline;
- 40 pockets as moderately declined; and
- 26 as severely decline

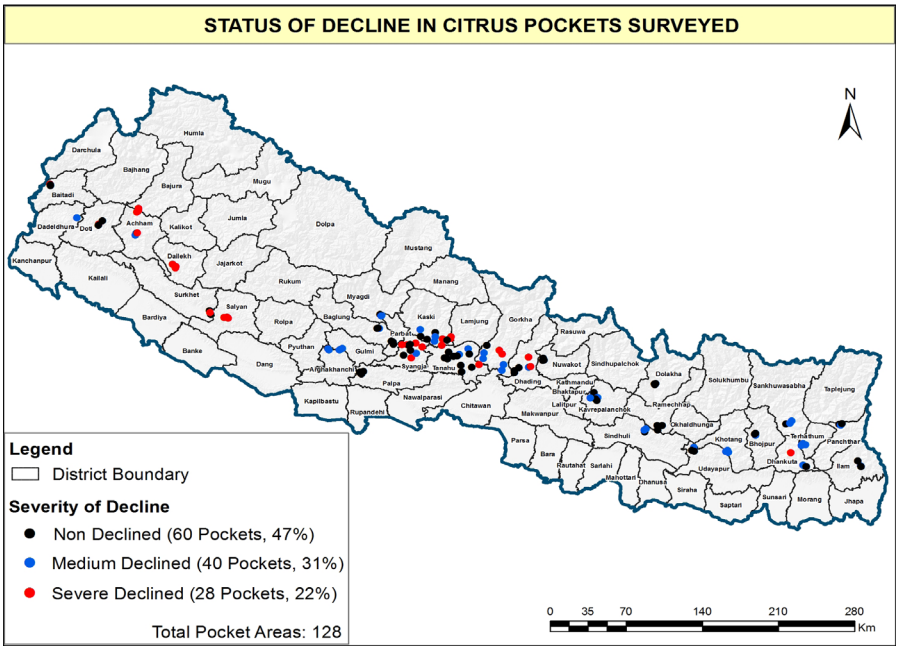


Figure 2 Status of decline in citrus pockets surveyed (Source: FAO, 2013)

Based on this study, a Citrus Orchard Improvement Program was developed. In FY 2070/71, this program was executed in Dhading, Gorkha, Lamjung, Tanahu, Kaski, Syanja, Parbat and Myagdi districts.

The major causes of citrus decline in Nepal are attributed to the presence and spread of various diseases, incidence of insect pests and nutritional and water deficiencies. The occurrence of some of the deadly diseases like 'Greening' and Phytophthora rot and widespread moisture and nutritional deficiencies, including micro nutrient deficiency, have aggravated the decline problem. There are two main factors causing citrus decline throughout the citrus growing areas of the country. These two factors are: (1) general negligence in orchard management and (2) spread of Phytophthora induced diseases due to intercropping close to the tree trunk. Although greening disease has been reported to spread throughout Nepal, it is more severe in the Western Development Region (NARDF, 2010). Furthermore, the intensity of greening infection is higher in lower belts (up to 900 m altitude) as compared to the higher belts (above 1200 m altitude). Scale insects and other sucking pests of citrus are also causing citrus decline throughout the country but their effects are moderate.

Strategic programs for citrus decline are listed below:

1. Mapping severely declined, moderately declined, low declined, and healthy areas
2. Removing severely declined trees by providing compensation to the farmers through detailed field surveys of the citrus growing areas.
3. Rejuvenating moderately declined, and low declined trees through practicing rejuvenation techniques.
4. Introducing bud wood certification system and establishing disease free nursery system
5. Practicing integrated Nursery & Orchard Management Techniques for production.
6. Developing technologies for prolonging harvesting season, increasing productivity and improving fruit quality

Human resources

During 1980s and 1990s, the ministry of agriculture was well known for having adequate qualified manpower. But the present scenario of human resources is different. There is limited human resources to serve large farming population in one side and on the other, the available human resources are

inadequately trained to provide technical services as per demand of the farmers. This situation along with major structural changes in the context of federal political system, has resulted in poor quality of service delivery and inability to meet service demand of commercial farmers and agribusiness entrepreneurs.

As horticulture including citrus is commercializing, farmers and entrepreneurs are demanding high level of R & D. In order to meet such demands, a complementary package of measures to improve quality and increase quantity of human resources is needed. Employment of adequate number of B.Sc. (Ag.) graduates in the field with necessary in-service training equipment has become an urgent need in commercial citrus pockets.

The skill of extension workers/technicians seems to be very general, their technical knowhow on nursery and orchard management practices including disease and pest management is very poor. Hence, training on assessment skill as well as nursery and orchard management practices with special reference to decline management have to be regularly provided to field technicians.

Each Agriculture Knowledge Centers of commercially citrus growing districts should have one citrus expert.

Each large or potential to be large citrus pocket should have an agriculture graduate with special long-term training in citrus.

Officer level manpower in citrus farms should have specialization trainings in citrus.

There should be synergies among research, education and extension to develop and retain experts.

5. Ecology of Chinese Citrus Fly, Its Management in Nepal

Presenter: Dr. Deb Raj Adhikari, PQPMC, Hariharbhawan

Name of Reviewer: Dr. Sunil Aryal, Mr. Shalik Ram Adhikari

Major Highlights of Presentation

Introduction of Fruit flies, Fruit fly species reported from Nepal, Fruit fly species *B. minax* and *B. tsuneosis.*

Introduction

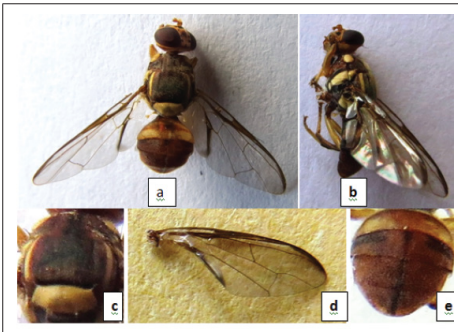
For a long time, citrus fruit has been cultivated. Mandarin orange and sweet orange are the most important citrus fruits, mostly grown as a cash crop to provide employment, income, and a market for local farmers (Adhikari and GC, 2020). Despite these advantages, citrus fruit is prone to severe damage

by fruit flies, and loss of income to citrus growers. The importance of fruit flies as pests has been noticed since the commercialization of agriculture. Tephritidae represent one of the largest families of dipterans with about 5000 species reported across the world in six subfamilies, 500 genera, 40 tribes and subtribes (Norrbom et al., 1999; Freidberg, 2006). In India, nearly 284 species are recorded in 84 genera and five subfamilies namely Dacinae, Phytalmiinae, Tachiniscinae, Tephritinae and Trypetinae.

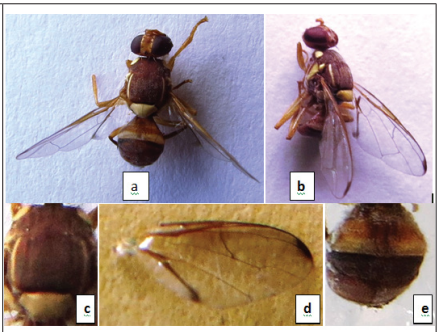
Fruit fly species reported in Nepal

1. *Bactrocera dorsalis* (Hendel, 1912)
2. *Bactrocera zonata* (Saunders, 1842)
3. *Bactrocera correcta* (Bezzi, 1916)
4. *Zeugodacus cucurbitae* (Coquillett, 1899)
5. *Zeugodacus tau* (Walker, 1849)
6. *Zeugodacus scutellaris* (Bezzi, 1913)
7. *Zeugodacus diversus* (Coquillett, 1904)
8. *Zeugodacus caudatus* (Fabricius, 1805)
9. *Bactrocera minax* (Enderlein, 1920)
10. *Zeugodacus yoshimotoi* (Hardy, 1973)
11. *Bactrocera tsuneonis* (Miyake, 1919)
12. *Dacus longicornis* (Wiedemann, 1830)
13. *Bactrocera nigrofemoralis* (White & Tsuruta, 2001)
14. *Bactrocera latifrorns* (Hendel, 1915)
15. *Zeugodacus artifacies* (Perkins, 1938)
16. *Bactrocera tuberculata* (Bezzi, 1916)
17. *Dacus ciliatus (*Loew, 1862)
18. *Bactrocera abbreviata* (Hardy, 1974)
19. *Bactrocera aethriobasis* (Hardy, 1973)
20. *Bactrocera digressa* (Radhakrishnan*,* 1999*)*
21. *Dacus feijeni* (White, 1998)
22. *Bactrocera nigrifacia* (Zhang, Ji & Chen, 2011)
23. *Bactrocera rubigina* (Wang & Zhao, 1989)
24. *Bactrocera syzygii* (White & Tsuruta, 2001)
25. *Zeugodacus duplicatus* (Bezzi, 1916)
26. *Dacus maculipterus* (Drew & Hancock, 1998)
27. *Dacus trimacula* (Wang, 1990)

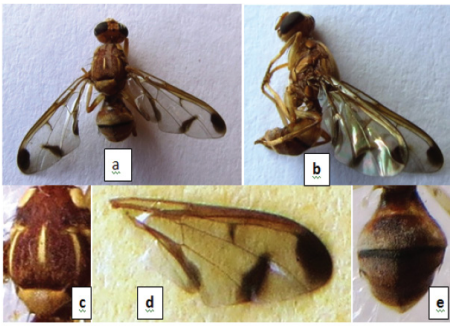
Field identities of different species of fruit flies in sweet orange (*citrus sinensis*) orchard in Sindhuli, Nepal (Adhikari and Joshi, 2018) are as:



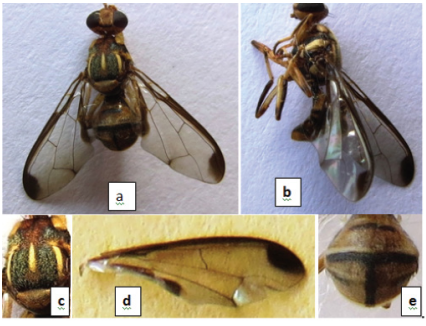
Bactrocera dorsalis



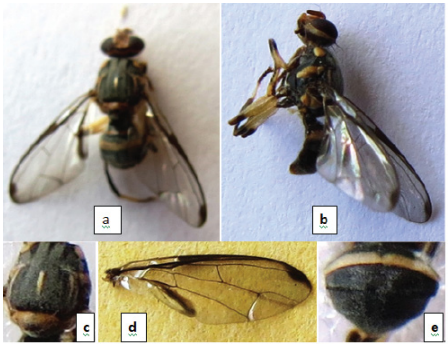
B. zonata



B. cucurbitae

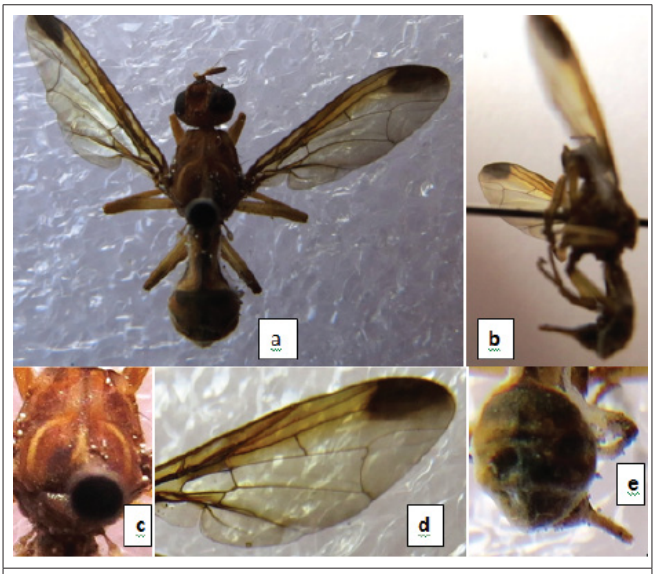


B. tau



B. scutellaris

B. longicornis



B. minax

Figure 3 Field identifiable morphological structure of different species of fruit flies; (a) Holistic view, (b) Lateral view, (c) Dorsal thorax, (d) Wing (e) Dorsal abdomen

The Chinese citrus fly (*B. minax*) resembles to the Japanese fruit fly (*B. tsuneonis*) in morphology (Drew & Romig, 2013); however, it lacks anterior supra-alar setae (EPPO, 2021).

Bactrocera minax | *Bactrocera tsuneonis*

Figure 4 Different species of Bactrocera

Molecular identification of *B. minax*

SEQUENCE FASTA:

>ON619567.1 *Bactrocera minax* isolate
CCF1/INPL/NPL cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

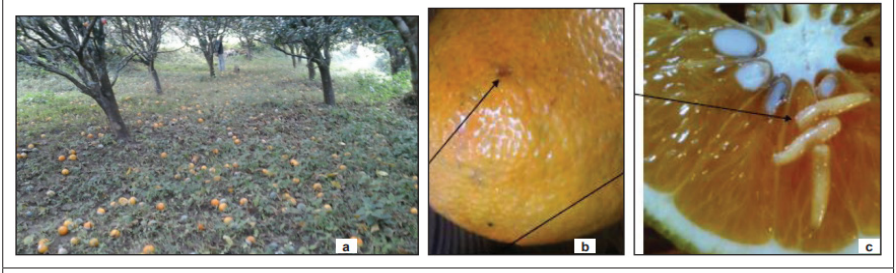
AAGAAGGAGGTATTCAGGTTTCGGTCTGTTAAAAG-
TATCGTGATAGCTCCGGCTAGGACTGGGAGAGA-
TAATAAAAGGAGTAGGGCTGTTAGTACTACAGCTC
ACACAAAGAGGGGCATTCGGTCAAATGTAATTCCTGTTGAGC-
GTATATTAATTACTGTCGTAATAAAGTTTACTGCCCCTAGAATT-
GATGAGATTCCTGCTAGGTGTAGGGAGAAAATGGCCAGGTC-
GACTGAGGCTCCTCCGTGGGCAATAATAGATGATAGCGGAG-
GGTAAACAGTTCAACCTGTGCCCGCCCCGTTTTCCACCAT
GCTGCTGACTAACAATAAGGTAAGAGATGGTGGCAGTAAT-
CAGAATCTTATGTTATTTATTCGTGGGAAAGCTATGTCGGGGG-
CCCCTAGTATTAGGGGTACTAATCAGTTTCCGAATCCCCCAAT-
TATAATAGGTATAACTATGAAGAAGATTATTACAAAGGCGTG-
GGCAGTAACGATTACATTATAAATTTGATCATCTCCGATTAA
GGCTCCTGGGTGTCCCAGTTCTGCTCGAACAAGGATTCTGAG-
GGAAGTCCCCACTATTCCTGCTCAAGCCCCGAAAATAAAG-
TATAGGGTTCCAATATC

Figure 5 DNA Barcode of *B. minax* generated by BOLD System v4 BOLD: ADI0635.

Management of fruit fly

- Sanitation of maggot infested orchard
- Male annihilation technique: parapheromone (ME, CL)
- Application of protein bait (food lure) fruits

- Crop/orchard management practices
- Tillage
- Quarantine measure
- Exclusion measure
- Botanical spray
- Soil treatment
- Chemical measures



Damage by fruit fly in the Sweet orange orchard of Mr. Puna Mashrangi at Toshramkhola-2, Sindhuli during Nov 2015

Collection and burrring dropped fruit is good sanitation operation

Figure 6 Sweet Orange Losses from Chinese Citrus fly, *Bactrocera minax* (Enderlein) in Sindhuli, Nepal (Adhikari and Joshi, 2018)

Life-cycle of Chinese citrus fly, *Bactrocera minax* (Enderlein) in Sindhuli, Nepal

Chinese citrus fly (*B. minax*) is a univoltine fruit fly species. Knowing the life-cycle stages and behavior of this pest are important aspects to develop its management strategy. As per its problem observed in the sweet orange (*Citrus sinensis*) orchards at Sindhuli district from 2014 to till date, the chart below represents the life-cycle stages based on observations made in orchards in different months during cropping season followed to adult emergence from soil. Similar life-cycle stages and development time period are mentioned in China (Xia et al., 2018). CCF adults emerged from soil during April to May and remained actively ovipositing after feeding proteinous foods in May to July. Female adult laid eggs below the skin of the immature sweet orange. Eggs developed into maggots (larvae) and fed in pulp that ruined the quality of fruit & left it non-marketable. Maggots remained actively developing inside fruit from July to October based on the time of infestation. An infested fruit found to be lighter in weight comparing to healthy fruit. Matured maggots made noticeable exit holes in the skin and escaped fruit to soil down. Any immature maggots inside the fallen fruit to soil remained inside until maturing that may take up to a fortnight period. The mature maggots entered into soil and transformed to pupae that remained inside for about 6 months, October to April. Adhikari et al. (2020b) illustrated the life cycle stages in the different months of the year as per its problem observed in the sweet orange (*C. sinensis*) orchards in Sindhuli district from 2014. Similar life cycle stages and time period was mentioned in China (Xia et al., 2018).

Country	Life Stage of *B. minax*	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
China (Hunan)	Adult				■	■	■						
	Egg						■	■					
	Maggot								■	■	■		
	Pupa	■	■	■	■	■					■	■	■
China (Shaanxi)	Adult				■	■	■						
	Egg						■	■					
	Maggot								■	■	■		
	Pupa	■	■	■	■	■						■	■

Country	Life Stage of *B. minax*	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
China (Hubei)	Adult												
	Egg												
	Maggot												
	Pupa												
Nepal (Sindhuli)	Adult												
	Egg												
	Maggot												
	Pupa												

Source: Xia et al. (2018), Adhikari et al. (2020b)

Figure 7 Life stages of *B. minax* in different countries

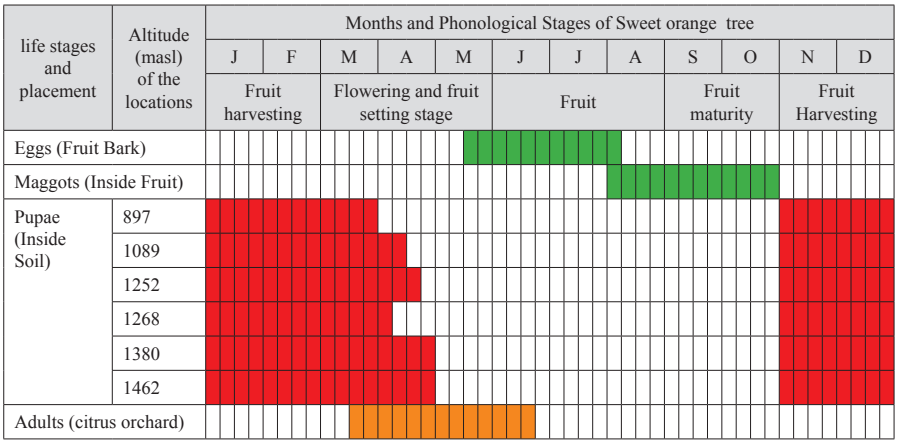


Figure 8 Seasonal phenology of *B. minax*

Nature of Damage

Eggs are laid just beneath the skin of the fruits. The oviposition spots can be observed. The maggots feed on the juice and pulps develops inside the maturing fruits. As a result of their feeding activity, the fruits turn prematurely yellow around the feeding site and eventually drop. When the maggots are mature, they leave the fruit by making an exit hole, and enter into the soil to pupate (Ecoman Biotech, 2014).

Means of movement and dispersal

According to the Fletcher (1989) adult flight and the transport of infested

fruits are the main means of movement and dispersal from one place to other places. Many *Bactrocera* spp. can fly 50-100 km.

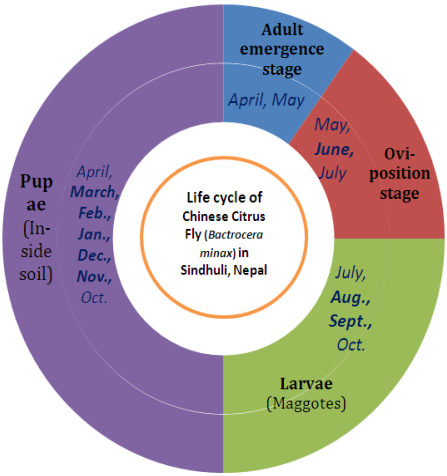


Figure 9 Life-cycle of Chinese citrus fly, *Bactrocera minax* (Enderlein)

Area Wide Control Program

The concept of Area Wide Control Program (AWCP) involved developing and integrating biologically-based pest control technologies into a comprehensive management package that would be economically viable, environmentally sensitive and sustainable. Considering the peculiar characteristics of the pest, management measures should be implemented in the large area (area-wide).

AWCP includes managerial and technical aspects. The managerial aspect consists of stakeholder's consultation, clustering of orchards for spray plan, orientation to spray persons & orchard owners and monitoring & feedback. Whereas, technical aspect includes fruit loss assessment, monitoring adult fly emergence date in the orchards, spot application of protein bait and sanitation to prevent pupation of maggots from infested fruit.

Achievements, challenges and lesson learned from AWCP

Flying capacity of fruit fly and transportation of maggot infested fruits. Thus AWCP!

The situation and the citrus growers:

- Citrus orchards at difficult geographical condition in hill region.
- Small and scattered orchards surrounded by forest ecosystem nearby.
- Subsidy in agri-inputs (50%), and willingness to participate in the program by all citrus growers.

Difficulty:

- 10-12 times protocol-based spot application.
- Rainy season during spray period.
- Sanitation measures not followed by all stakeholders (growers, traders and consumers).

Location specific life stages study primarily focused on:

- Adult emergence.
- Oviposition study.

6. Citrus Greening: Ways forward to be taken by stakeholders in Nepal

Presenter: Dr. Umesh Kumar Acharya, NCRP, Dhankuta
Name of Reviewer: Pradip Raj Rokaya, Binod Sharma

Major Highlights of Presentation:

Introduction/Background Information, Citrus cultivation in Nepal, Citrus decline, Citrus decline in Nepal, Citrus greening, Strategies for managing citrus decline in Nepal, at National Level (federal), At Palika and Provincial level - (For New orchard establishment), at Palika and Provincial level (for old orchard management), by Development sector (NGOs/INGOs), by Education sector, by Research sector were highlighted in the presentation.

Introduction

Citrus, an important agriculture sub-sector for farmers in the mid hills and terai plains to improve their economic status. Total fruit area 1,82,649 ha and citrus area 49,306 ha (MoALD 2023). This is a high-value product with strong demand in domestic and international markets. The citrus production is not sufficient and satisfactory to meet the demand of the country (Dahal et al., 2020).

Table 5 Area, production and productivity of citrus fruits during 2003/04 to 2021/22

Year	Total area (ha)	Productive area (ha)	% Productive area	Production (mt)	Productivity (mt/ha)
2003/04	24,799	13,931	56.18	1,48,010	10.62
2004/05	25,910	14,606	56.37	1,56,956	10.75
2005/06	26,681	15,206	56.99	1,64,075	10.79
2006/07	27,980	15,832	56.58	1,71,875	10.86
2007/08	30,790	19,915	64.68	2,26,404	11.37
2008/09	32,322	22,482	69.56	2,53,766	11.29
2009/10	33,898	22,903	67.56	2,59,191	11.30
2010/11	35,578	23,609	66.36	2,63,710	11.20
2011/12	37,565	24,089	64.13	2,40,793	10.00
2012/13	36,975	23,645	63.95	2,16,188	9.14
2013/14	38,988	25,497	65.40	2,24,357	8.80
2014/15	39,035	25,261	64.71	2,22,790	8.82
2015/16	40,554	24,854	61.29	2,18,447	8.82
2016/17	46,328	26,759	57.76	2,39,773	8.96
2017/18	44,424	25,946	58.41	2,45,176	9.44
2018/19	46,411	28,406	61.21	2,71,908	9.57
2019/20	46,715	27,339	58.52	2,74,140	10.03
2020/21	50235	32188	64.07	311188	9.67
2021/22	49306	32317	65.54	306149	9.47

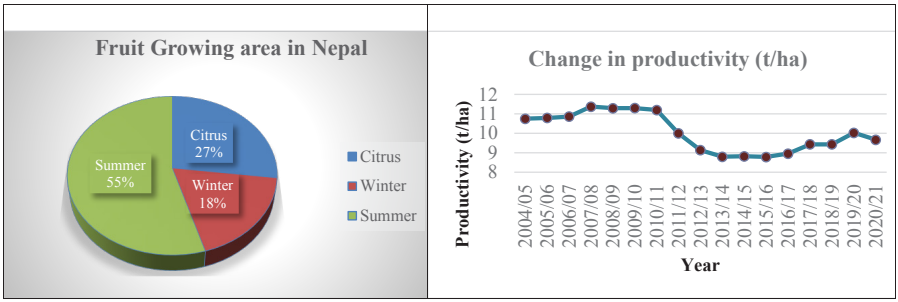


Figure 10 Fruit growing area and change in productivity over time

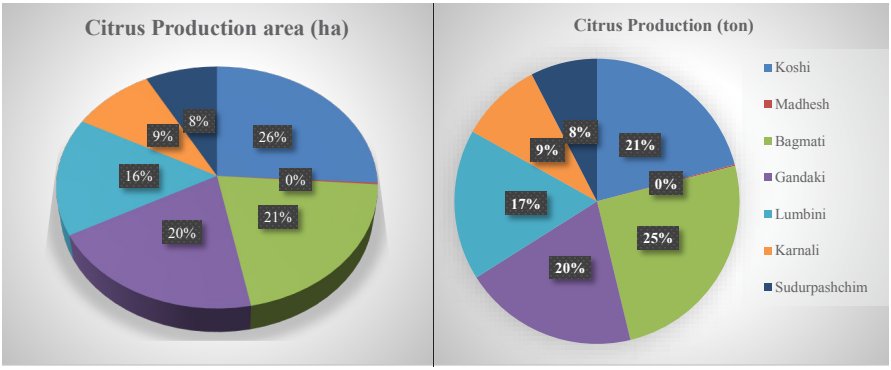


Figure 11 Province wise area and production of citrus in year 2021/22

Above data tells that area of cultivation is continuously increasing whereas the productivity is decreasing. The productivity is in declining trend and some studies revealed that such productivity deteriorated situation is mostly linked to poor orchard management and declining soil fertility in Nepal. Citrus decline is a multi-faceted issue including biotic (diseases and insect pests) and abiotic (soil, water, and nutrition) components. Although the citrus decline has been spread throughout Nepal, it is reported to be severe in the Western Development Region (NARDF, 2010). Thus, there has been a huge scope of increasing the production and productivity through the use of improved technologies.

Citrus decline in Nepal

Citrus decline is a condition that exhibits various problems in the plant, resulting in decreased productivity, shorter productive life, and poor fruit

quality (Panth & Dhakal, 2019; FAO, 2011; Poudel & Shrestha, 1995). Citrus decline has been a major challenge for citrus growers in Nepal (Poudel et al., 2022). According to the survey, 72.3 percent of mandarin-growing farmers in Myagdi district experienced citrus decline problems in their orchards (Poudel et al., 2022). Citrus decline was shown to be influenced by disease and pest incidence, climate extremes, poor soil fertility, low quality planting materials, and poor orchard management practices.

Figure 12 HLB hotspots in Nepal

Citrus decline has been a serious and current constraint on citrus production in Nepal. It appears on productive trees between the ages of 15-20 years (FAO, 2011). Citrus greening disease is a primary cause of citrus decline, and its severity is greater in lower belts (up to 900 meters above sea level) (Roistacher, 1996). CGD is rapidly expanding and presents a serious danger to citrus orchards (Regmi & Yadav, 2007; Knor et al., 1970). Foot/root rot or gummosis disease caused by Phytophthora species in citrus (Poudel & Shrestha, 1995). Several insect pests induce decline e.g., Citrus psylla, fruit fly, scale insects, bugs, stem borer, and leaf miner (Budathoki & Pradhanang, 1990; Nath & Sikha, 2019). The CCF (*Bactocera minax)*, is the most dangerous pest and causes extensive damage (Sharma et al., 2015). Greening disease caused by Asian Citrus psylla, widely recorded in Nepal (Regmi & Yadav, 2007).

Substandard and uncertified seedlings, poor and or improper orchard management, nutritional problem, extensive intercropping with exhausting

crops, incidence of greening and other diseases (Phytopthora, CTV, Canker, PM etc.), incidence of insect-pests (fruit fly, citrus psylla, scale insects, bugs, leaf miner, stem borer etc.) all pose a threat to citrus production (FAO, 2011).

Citrus greening (HLB) disease

Origin history, Geographical Distribution and Economic Impact

Citrus greening is a destructive disease of citrus that represents a major threat to the world citrus industry, and is slowly invading new citrus growing areas. HLB, whose name in Chinese means "yellow dragon disease", was first reported from southern China in 1919 and is now known to occur in next to 40 different Asian, African, Oceanian, South and North American countries (Bove, 2006). Greening disease was first reported in 1947 from South Africa, although the disease has been known since 1929. Until 1970, it was considered to be a virus disease, but it is now known to be caused by a phloem limited non-cultured bacteria *Candidatus liberibacter* spp belonging to alpha-proteobacterial subdivision. The disease probably originated in China and was common there in the early 1900 (Zhao, 1981).

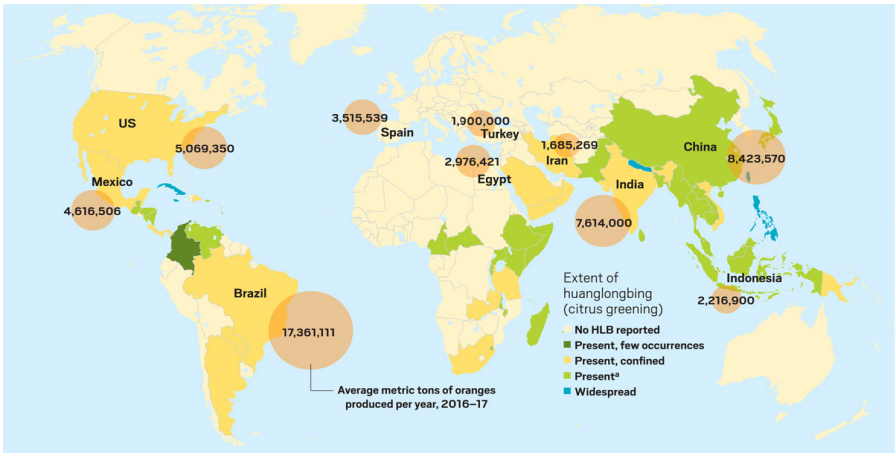


Figure 13 Distribution of HLB in across the world

Globally, HLB has been regarded as one of the most important threats to commercial and sustainable citrus production. (Da Graça, 1991), lists 24 countries and territories in east, south-east, south, and western Asia and in eastern and southern Africa, where HLB had been reported. Since then, its presence has been confirmed in four additional south-east Asian nations,

namely Vietnam (Garnier & Bové, 1996) Myanmar, Laos and Cambodia (Garnier & Bové, 2000). For other major citrus production regions such as North and South America, Australia and the Mediterranean countries, HLB remains a major threat if introduced. For instance, HLB has resulted in the destruction of 30 million trees in Indonesia (Tirtawidjaja et al., 1965). On the Indonesian island of Bali four million trees were eradicated during 1986-88, although these trees were replaced with mandarins in 1991, 40% were infected in 1993, and 90 % in 1996 (Aubert, 1993; Da Graça & Korsten, 2004). In the early 1960's, nearly 25,000 ha were planted to citrus, but 10 years later five million (i.e., 60% of the plantings) were lost due to HLB. In Thailand, many trees are dying and going out of production five to six years after planting. Such losses are significant, since profits are only attainable 10 years after planting resulting in losses of over US$8,000/ha (Roistacher, 1996). In south-western Saudi Arabia, all sweet orange and mandarin trees had declined by 1986 leaving only limes (Aubert, 1993; Bové, 1986). Crop losses of 30-100% have been reported in South Africa during the 1932- 1936 and 1939-1946 periods (Oberholzer et al., 1965; Schwarz, 1964). By 1958, the disease affected 100 000 sweet orange trees (Oberholzer et al., 1965) and by the mid 1970's, it was estimated that four of the eleven million trees planted in South Africa (36%) were affected with HLB (Buitendag & von Broembsen, 1993). By then, major citrus production areas, which represented 20% of the industry, were eliminated, making it the most serious disease in South Africa. Of even greater concern was that areas previously regarded as HLB-free were showing tree symptoms (Green & Catling, 1971). By the mid 1990's the disease was reported in the Cape which, with its Mediterranean type climate, was regarded as "not likely" to get HLB. The use of a national quarantine barrier and restriction on sales of citrus trees from the northern regions where the disease is endemic to the coastal areas where psylla are endemic and not controlled, proved ineffective (McClean et al., 1969). Although losses resulting from HLB has been more extensively documented in Asia than in Africa, it is estimated that globally more than 60 million trees had been destroyed by the disease by the early 1990's (Aubert, 1993). During 2007-2008 seasons total economic loss reported by CGD in Florida Citrus industry was $ 9.1 billion. Citrus huanglongbing (HLB) was first reported in Nepal in 1967 in the PokharaValley (Calavan, 1968; Knorr et al., 1970; Thrower, 1968) since then the disease has spread to all citrus growing districts (Lama & Amatya, 1993). Asiatic greening is present throughout Nepal (Regmi, 1994; Regmi et al., 1996). Greening and its vectors most

probably introduced from India (Knorr & Shah, 1971) during the spring flush of 1986. Lama et al. (1988) reported the presence of vector in the abundant numbers in the districts of Terai, Morang, sunsari, Sapturi, Siraha, Dhanusa, Mahotari, Sarlahi, Rauthat, Sindhuli, Chitwan, Dang, Pyuthan, Salyan, Bara, Parsa, and in Kathmandu. The vector was not found in Dhankuta, Gorkha and Lamjung districts. All species of Citrus appear susceptible, but the sweet orange, mandarin and Tangelo are most affected (Regmi & Lama, 1988a). Lemon, small fruited lime, and Murrayapeniculata (a citrus relative) are superior host for *D. citri* in Nepal. It is one of the quarantine pests of Nepal China Agreement, 2012 to export citrus fruit from Nepal. Surveillance of this disease has been done in Sindhuli and Syangjya districts as per the protocol endorsed by NPPO Nepal (Adhikari and GC, 2020). Limited availability of resistant rootstock (US 892) and scion varieties (Sugar Belly) only in USA so far. Effective chemicals (eg Zinkicide, Oxytetracycline hydroxide, Homobrasssinoloids, GA3) are on trial only.

Symptoms of HLB

Symptoms on whole tree

Depending on the age of a tree and time and stage of infection, the first symptoms of HLB usually start with the appearance of a yellow shoot. If infection occurs soon after propagation, yellowing progresses over the entire canopy. However, if infection occurs at a later stage of growth, the symptoms and the causal organism remain confined to the sector initially infected. If a sector of a tree is affected, then only those parts will show typical symptoms. While the rest of the tree exhibits normal growth and produces normal healthy fruit of good quality (Oberholzer et al., 1965). A range of symptoms can be observed on infected trees and branches, which include heavy leaf and fruit drop, followed by out of season flushing and blossoming (Catlong, 1969; Martinez, 1972). Severely infected trees often appear stunted, usually are sparsely foliated, and can die back. Chronically infected trees are sparsely foliated and show extensive twig die-back symptoms. Infected trees produce reduced crops of low-quality fruit.

Symptoms on leaf

Initial foliar symptoms of African HLB are vein yellowing and a variegated type of chlorosis (blotchy mottle), which appear on fully mature leaves (Schneider, 1968; Manicom & van-Vuuren, 1990). Blotchy mottle, pattern

on the leaves is asymmetrical using the mid rib as a symmetric line while with nutrient deficient plant and other disorder the patterns seen would be symmetrical. HLB plants will usually show the nutrient deficiency symptoms in addition to blotchy mottle Secondary symptoms include small, upright leaves ("rabbit's ears") with a variety of chlorotic patterns resembling those induced by zinc, iron, manganese, calcium, sulphur and/or boron deficiencies (Schneider, 1968). Many of the latter may be almost entirely devoid of chlorophyll, except for occasional circular green spots ("green islands") distributed at random on the leaves. The Asian form of the disease induces similar symptoms, but with more extensive yellowing, die-back and decline (Martinez & Wallace, 1968; Zhao, 1981) and in some cases death of small trees (1-2 years) (Lin, 1963). It is also more tolerant to heat, and thus is found in lower lying, hotter areas. In South Africa, leaf symptoms are more pronounced in the cool areas, compared to the lower lying hotter areas, and are more pronounced in winter (Schwarz, 1968). African HLB can also be eliminated by exposure to extended periods of heat (Labuschagne & Kotze, 1980). Both forms of greening have only been found in Reunion and Mauritius, usually separated by the temperature preferences, although both forms were detected in some trees using molecular probes (Garnier & Bové, 1996)

Symptoms on fruit

The most reliable diagnostic symptom of HLB represent the fruits which when infected, are small, oblong shape, lopsided with a curved columella or central core and seed, if present, is mostly aborted. A bitter, salty taste is also characteristic of affected fruit. With infected trees there is a continuous and premature shedding of greened fruit while those remaining on the tree do not color properly (McClean & Schwarz, 1970), hence the former name "greening disease". Symptoms can be exacerbated by the presence of other pathogens. Some varieties, such as sour orange are more tolerant i.e., the symptoms are not as severe as on other varieties.

Symptoms on root

Root systems are usually poorly developed in severely affected trees, with relatively few fibrous roots (Oberholzer et al., 1965), possibly due to root starvation. New root growth is suppressed and the roots often start decaying from the rootlets (Zhao, 1981). Co-infection with Citrus tristeza virus (CTV) is common, and there are reports from several Asian countries that such trees

have more severe symptoms (Martinez, 1972; Bhagabati & Nariana, 1980; Huang et al., 1980) of interest is that some isolates of CTV apparently protect trees from HLB infection (Van Vuuren et al., 2000). Blotchy mottle, the most characteristic leaf symptom, can be confused with other diseases such as stubborn (Spiroplasma citri), severe forms of CTV, Phytophthora root rot and water logging (Calavan, 1968; McClean & Oberholzer, 1965; Schneider, 1968). Due to the non-specific nature of leaf symptoms, HLB can often be confused with mineral deficiency or other stress related leaf symptoms (Korsten et al., 1993). Symptoms of zinc deficiency are also associated with the early stages of citrus blight. HLB pathogen (Laflèche & Bové, 1970) reported mycoplasma-type bodies in sieve tubes of sweet orange infected with HLB. The observation of cellular organisms in the phloem of HLB-infected citrus and their absence in healthy material indicated that a prokaryotic organism was responsible (Laflèche & Bové, 1970). Two distinct forms of greening were recognized based on the wider geographical spread (Capoor et al., 1967) Electron microscope studies suggested that the organism was a true bacterium, belonging to the Gracilicute division, (Garnier & Bové, 1978). Molecular diagnosis suggests that, HLB pathogen is member of sub division Proteobacteriacea Subsequently the Asian species was designated "Candidatus Liberobacter asiaticum", and the African species "Candidatus L. africanum". These names have since been corrected to "Candidatus Liberibacte rasiaticus" and "Candidatus L. africanus" (Garnier et al., 2000b). However, on the basis of molecular phylogenic study (Teixeira et al., 2005) reported three HLB pathogens as:

- Candidatus Liberibacter africanus, heat sensitive, found at higher elevation (900m above sea level) transmitted by Trioza erytreae vector (African strain),
- Candidatus Liberibacter asiaticus", more severe, heat tolerant, found at lower elevation (360m above Sea level), and higher temperature (30-35^{o} C) transmitted by by Diaphorina citri vector (kuwayama) (Asian strain)
- Candidatus L. americanus, heat- tolerant, by D. citri vector (American strain) The Asian citrus psyllid (ACP), Diaphorina citri, Kuwayama, (Homoptera: Psyllidae) is a well-established pest of citrus and close relatives of citrus. Asian citrus psyllid damages plant through its feeding activities. Adult psyllids are 3 to 4 mm in length with mottled wings held "roof-like" over the body (Mead, 1977).

Host range

All species of citrus appear to be susceptible, irrespective of the rootstock used (Aubert, 1993; Da Graça, 1991). However, symptoms are often severe on sweet orange, mandarin and their hybrids; moderate on grapefruit, lemon and sour orange; while lime, pummel and trifoliate orange are regarded as being more "tolerant" (Manicom & van-Vuuren, 1990). Both species of liberibacter have been transmitted to periwinkle (Catharanthu sroseus) via dodder inducing marked foliar yellowing (Garnier & Bové, 1983; Ke et al., 1988), the dodder itself also appears to support HLB multiplication.

The psylla species which transmit HLB from citrus to citrus, feed on many other rutaceous species. D. citri has a preference for Murraya spp. (Chakrabarty et al., 1976), and it has been suggested that Trioza erytreae's original hosts include Vepris undulata, Clausena anisata and Zanthoxylum capense (Moran, 1978). Su et al. (1992) has reported the detection of Asian HLB by DNA-hybridization in Severinia buxifolia and Limonia acidissima, and African HLB was detected in Toddalia lanceolata (Vepris undulata). The Cape chestnut (Calodendrum capense), an ornamental rutaceous tree in South Africa, has been shown to be infected with HLB, subsequently this organism was shown to be a subspecies of the African form of greening. (Garnier et al., 2000b).

Transmission and Epidemiology

Transmission by grafting

HLB was first transmitted experimentally by grafting (Chen, 1943), thereby establishing the causal agent as a pathogen. Natural spread was demonstrated by exposing healthy seedlings in an infected citrus orchard (Schwarz, 1964). The variability in graft transmission of Candidatus. Liberibacter depends upon the plant part used for grafting, the amount of tissue used and the pathogen isolate with single buds (Batool et al., 2007). Transmission of HLB by grafting was first reported in china by Lin in the late 1940s. (Zhao, 1981). Kinds of tissue used (buds, side grafts or left pieces), age of the tissue, and the season of the year when inoculums collected are the major factors that led to success the graft transmission of pathogen. African greening is most rarely transmitted by grafting than Asian greening (Roistacher & Bar-Joseph, 1987).

Transmission by vector

Transmission of HLB by Asian Citrus psyllid vector Diaphorina citri, was reportd in 1967 in India (Capoor et al., 1967)and in the Phillippines (Martinez & Wallace, 1968).Diaphorina citri Kuwayama (Homoptera:Psyllidae) is a Hemipterian insect brown in color measuring 3-4 mm in length with piercing- sucking mouth part that allows this insect to feed on the phloem of Citrus species and other related Rutaceous plant While eating their bodies are lifted at the angle of 45^{o} on the surface of leaf. Both the nymph (fourth and fifth instar and adult can transmit the greening agent in 15 min acquisition feeding time. Orange jasmine (Murraya paniculata) has been found to be the host of Ca. Liberibacter spp and can serve as a potential source of inocula (Brlansky et al., 2011). Another insect vector is Trioza erytreae. This vector is responsible to transmit African form of greening bacterium. It has been shown experimentally that T. erytreae is also able to transmit the Asian form (McClean & Oberholzer, 1965). C. Transmission by Dodder Greening is also transmitted by dodder (cuscuta spp., Cuscutaceae) to non-rutaceous plant such as Catharanthusroseus L. G. Don (Periwinkle-apocynaceae) and Nicotiana tobacum L. Cv. 'Xanthii' (tobacco, Solanaceae) (Garnier & Bové, 1996), 'Ca. L. asiaticus' can multiply and spread within infected Cusutaceanothi Behr (Syn. Cu. Subinclusa Dur, and Hilg."), Cuscutacam pestris and Cu. australis. (Ghosh et al., 1977), observed that the pathogen multiplies more favorably in dodder in diseased sweet orange.

Methods for Detection of HLB

Correct identification of the Greening disease under field condition is important for disease management. Greening disease can tentatively be identified in the field by foliage and fruit symptoms. Irregular distribution of the disease within the tree and slow disease development makes visual detection difficult. Moreover, diagnosis of Citrus greening based on symptomatology is very often difficult as it can be confused with mineral deficiency, root rot or other stress related leaf symptoms and it needs to be confirmed by other diagnostic tests. For many years the only way to detect the pathogen was by biological indexing on sweet orange seedlings, observation of the bacterium in the phloem sieve tubes of leaf mid vein or columella by electron microscopy or using fluorescent Chromatographic technique. Fluorescent chromatographic technique however sometimes produces false negative/positive, so it cannot be used alone for definitive diagnosis. More recently, several molecular detection methods have been

developed. Detection by polymerase chain reaction using specific primers in the 16s rDNA (OI1/ OA1/OI2C) or in the ribosomal protein genes (A2/ J5) is the easiest and most sensitive method for Libribacter detection and identification. Indeed, these techniques allow distinction between the two Liberibacter species. Nucleic acid hybridization using radioactive or non-radioactive probes to detect the greening bacterium in plans as well as psylla vector have been reported. The two Liberibacter spp can be detected in plants and insect by DNA/DNA hybridization with probes In-2.6 for Candidatus Liberobacter asiaticus and AS-1.7 for Candidatus Liberibacter africanus. These probes contain genes of the β-operon encoding, in particular ribosomal proteins. Monoclonal antibodies are also available to distinguish serotypes within species but are too strain specific for general diagnostic purposes. Real time PCR based detection of Greening pathogen both in plant and insect vectors has become very popular in developed countries (FAO Nepal, 2012).

Control measures

Chemical Control

The evidence that a procaryote was the causal organism led to research on the use of tree injections with antibiotics to eliminate the bacteria. Tetracycline hydrochloride had some beneficial effects but proved to be phytotoxic and attention turned to a more soluble less toxic derivative N-pyrrolidinomethyl tetracycline. Several insecticides against psylla are available, and the development of a trunk application technique has proved effective (Buitendag, 1988). Another way is the placing of sticky yellow traps in orchards which could detect a population threshold but this method has not been widely adopted and scouting is often used. Due to the potential for re-infection, and high costs, attention turned to vector control (Buitendag & von Broembsen, 1993).

Biological Control

The use of these parasites (vector), combined with the establishment of disease-free foundation blocks and nurseries, resulted in a dramatic reduction in the incidence of HLB - in 1995, 20 years after the launching of this strategy, only 0.5% of trees surveyed had symptoms (Aubert et al., 1996). Tamaraxia. radiata, and another wasp species, Diaphorencyrtusa ligarhensis, are evaluated in Florida for potential use (Hoy & Nguyen, 2000). In addition, Diaphorina. citri appears to be an excellent food source for several ladybeetle

species (Michaud et al., 2002) and used to feed on psylla, aphids, citrus leaf miner and other foliage pests. Similarly, the use of versatile chryospid predator Mallada boninensis @30 larva per plant and growing marigold as border crop has been reported very effective to suppress psylla population in the orchards.

Integrated Control measures

The only way to grow citrus productively in countries where the disease has become endemic such as in South Africa and Asia is by managing the disease using sound integrated pest management. In South Africa, (Buitendag & von Broembsen, 1993) recommend a strategy of providing growers with disease-free nursery trees, focusing on reducing the inoculums by removing infected trees or branches, and following an effective psylla control program. In China, there are reports of successful management by eradicating infected trees and non-citrus psylla hosts, planting HLB-free trees, and controlling psylla populations. (Bové et al., 2000), conducted program in Indonesia, and showed that if citrus is eradicated before replanting, only HLB-free bud-wood is used for replanting and the control *D. citri* using insecticide sprays is effective, rehabilitation of a citrus industry could be possible. Eradication of alternate hosts in close proximity (5 km) to nurseries or commercial plantings of citrus, have been suggested and shown to be effective in Asia where Murraya spp are the principal alternate hosts (Aubert, 1993) (Aubert & Xia, 1990). Soil application of micro nutrient viz zincs sulphate, iron sulphate and manganese sulphate in the rate of 150- 200 g each per plant improves the general health condition of plant. Spraying Neem oil in the rate of 5ml/lit of water is another effective way to control psylla and other insect. An intensive and integrated management approach has been recommended as the most effective against greening disease in any part of the world. This includes quarantine measures use of disease-free planting material, removal of alternative host of both the psylla and bacteria, reduction of inoculums by pruning of infected branches, disinfection of pruning tolls with 1-2 % sodium hypochlorite, removal of healthy infected trees and chemicals as well as biological control of insect vector Psylla.

HLB Pathogen

Domain: Bacteria
Phylum: Proteobacteria
Class: Alphaproteobacteria

Order: Rhizobiales
Family: Phyllobacteriaceae
Genus: citrus huanglongbing (greening) disease

A global issue of HLB

The bacteria that cause huanglongbing have been detected in 7 of the top 10 orange-producing countries across the globe (CABI,2019). Three species of *Candidatus* Liberibacter cause huanglongbing: *Ca. L. asiaticus*, *Ca. L. africanus*, and *Ca. L. americanus*. The Asian form is the most widespread and indicates that the disease is present in the area, but to what extent may be unknown.

Citrus Decline Management strategies

At National Level (federal) - Policy related

- Reformulation of seed act (2045), special law for citrus nursery establishment and distribution of saplings - Nursery act?
- Nursery guideline development and enforcement
- Strict prohibition of seedling/ sapling uses from open field nursery, unidentified source and sub-standard quality
- Strict quarantine regulation at international and internal boundary, inter district and inter province quarantine system for transport of citrus sapling
- Bud-wood certification guideline formulation and strict enforcement - mandatory for all Government and private nursery
- Formulation of national level HLB management guidelines which need to be followed by all three level of government (Local, Province and Federal).
- HLB / CTV awareness program
- Survey and surveillance of HLB and its vector ACP, annual program calendar development and training to agriculture technician
- Development of information system (Web portal) to ACP management on insecticide spray to ACP management –PMAMP & NCDF
- Support on ACP monitoring from Super/zone, PMAMP

At Palika and Provincial level - (For New orchard establishment)

- Establishment of orchard at least 3 km away from infected area
- Eradication or keep alternative host (Kamini, Curry leaf, Bael) plants

at least 3 km away from citrus plants.
- No prior history of HLB should be there
- Soil and environment condition suitable to cultivate citrus
- Use healthy sapling and identified source only
- Initiate guava and citrus intercropping practice
- No use of seedling plants (root rot)
- Containerized nursery establishment
- Plantation of diseases free grafted plants from identified source
- Regular monitoring of HLB disease and its vector
- Program for diseased plant removal if needed.
- HLB vector survey and management program
- Program on better nutrition management of citrus trees
- Initiate guava and citrus intercropping practice
- Better nutrition to diseased but fruiting trees
- Prepare decline management awareness campaign

By Development sector (I/NGOs)

- No distribution of substandard saplings
- Awareness program on decline management
- Prepare citrus related program in collaboration with related agriculture offices

By Education sector

- Prepare and update course on decline management
- Conduct post-graduate research in collaboration with GOs based on citrus industry need
- CGD/ CTV detection service to stakeholders (eg. AFU- Biotechnology Department)

By Research sector

- Research on vector mgmt. (use of IPM technique on ACP management., Kaolin use, Guava leaf extract spray, silver oak mulching)
- disease mgmt. (nano technology-Zinkicide, nutrition management)
- Rootstock selection trial for individual crop at different domain
- Resistant breeding (rootstock /scion: selection- introduction)
- Individual Plant Protective Cover (IPC) and CUPS study
- Heat treatment: 130^{o}F for 30-120 sec three time of the year (summer, spring and winter) but trouble of post bloom fruit drop.

- Help on disease detection for development sector (PCR, LAMP, ELISA) and bud wood certification
- Microbial therapy and transgenic technology
- Provide disease free sapling to nursery (tissue culture)

HLB: Management

- Cultivation of healthy sapling and removal of diseased plants
- Inoculum's reduction and vector control (pesticide, natural enemies)
- Tree therapy (nano-technology, GA_3 use, peptides and antibacterial peptides, antibiotics, heat treatment)
- Better nutrition and orchard management program
- Hybrid breeding-use of tolerant rootstock (Pumelo as interstock and root stock flying dragon and US897, US892) and scions Sugar Belly, Donaldson
- Use of Kaolin as cover spray
- Individual plastic cover at early stage of crop
- Growing trees under protective covers (CUPS)

Figure 14 Orchard before decline and after decline at Syadul, Dhading

Monitoring of Citrus Psylla in Dhankuta

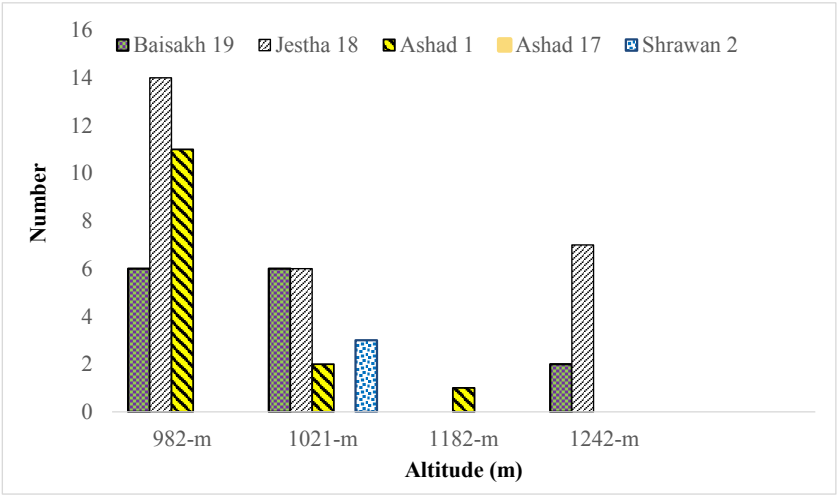


Figure 15 Number of citrus psylla at different altitude

Bud wood certification strategies

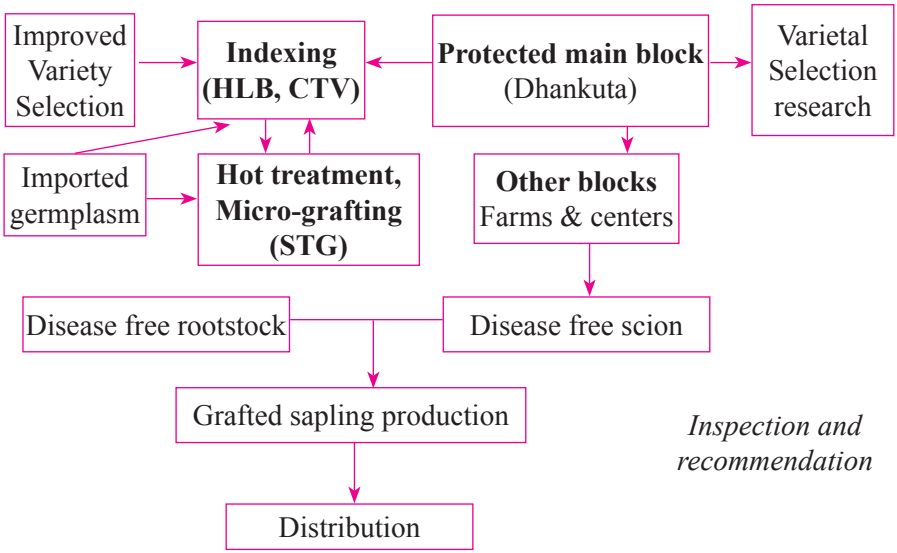


Figure 16 Different stages of bud wood certification

7. Distribution, Biology and Management of Citrus Psylla in Nepal

Presenter: Dr. Kashi Nath Chiluwal, NERC, Khumaltar
Name of Reviewer: Dr. Deb Raj Adhikari, Mr. Madhav Prasad Lamsal

Major Highlights of Presentation:

Introduction, Crop hosts and Alternate hosts, Biology of pests (Egg, Nymphs, Adults), Why it is important? Nature of damage, Vectoring efficiency, Mode of bacteria transmission, HLB disease cycle, Psyllid distribution, Distribution in Nepal, Management of Citrus Psylla, Cultural practices, Chemical management, some prospects, Expected Hi-tech interventions were the major points covered in the presentation.

Introduction

There are two species of citrus psylla namely; Asian citrus psylla (Class: Insecta, Order: Hemiptera, Family: Lividae, Genus: *Diaphorina,* Species: *D. Citri* Kuwayama) and African citrus psylla (Class: Insecta, Order: Hemiptera, Family: Triozidae, Genus: *Trioza,* Species: *T. erytreae* Del Guercio)

Genus *Diaphorina* has 74 reported species. Out of which six of the species have association with citrus or close relatives. *D. citri* is the Asiatic one, among two vector species of HLB, prevalent in majority part of the world.

Host range of Citrus Psylla

Occasional & reproductive hosts	Alternate Hosts
Mandarin Orange, Sweet Orange, Tangerines, Grapefruit, Kumquat, Pumelo, Lime, Lemon, Citron, Round Lemon, Trifoliate Orange	Kamini Flower (Orange Jasmine), *Murraya peniculata/M.exotica,* Kadi Patta (Curry tree), (*Murraya koenigii*)

Biology of Citrus Psylla

Eggs

- Oviposition on terminal flush growth
- Eggs initially light yellow
- Bright orange with two distinct red eye spots at maturity
- Female fecundity approximately

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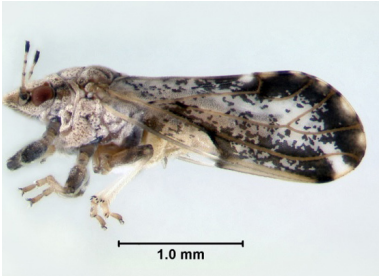
- Egg duration is 4 days at 25^{0}C

Nymphs

- Five nymphal instars
- Nymphal period is 13 days at 25^{0}C

Adults

- Adults reach reproductive maturity at 2-5 days after emergence
- Diurnal (feeding and mating during days hours)
- Multiple mating
- Mean egg-adult generation time is 20-22 days
- Sex ratio is 1:1
- Sexually dimorphic
- Adult life is 40-44 days at 25^{0}C



Why it is important?

- It is a sap sucking insect
- Effective vector of HLB (Citrus greening), a lethal citrus disease
- So serious quarantine pest (Level 3 which means quarantine pest of high risk)

Nature of Damage

- Direct damage: Removal of phloem sap weakens the plant and causes a metabolic imbalance, twisting of the leaves and in extreme cases, leaf loss
- Indirect damage: Secreted honey dew is an ideal food for argentine/driver ants (guards against psylla's enemies), culture medium for various fungi forming a barrier stopping taking in all the light.

Most harmful damage is the transmission of HLB bacteria.

Vectoring efficiency

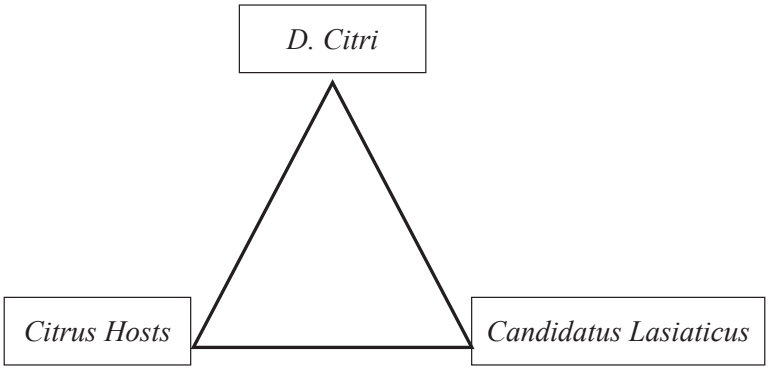


Figure 17 Vector Host Relationship

Mode of bacteria transmission

- Persistent & Propagative
- The bacteria circulate in the host body and replicated in the vector
- No trans-ovarial transmission of the bacteria to the psyllid progeny

Distribution in Nepal

In the areas 100-1350 m asl from Terai to Kathmandu Valley. And also said to be colonized at 1400-1500 m asl.

Management of Citrus Psylla

Detection and sampling

- Visual searches of flush shoot protocol for eggs, nymphs and adults
- Sweep net sample protocols for adults
- Suction trap protocols for adults
- HVac sample protocol for adults
- Yellow sticky trap protocol for adults
- Stem-tap sampling protocol for adults

8. Status of Citrus Pests and Diseases in Gandaki Province, Nepal

Presenter: Mr. Shalik Ram Adhikari, PPL, Gandaki

Name of Reviewer: Dr. Kashi Nath Chiluwal, Dr. Umesh Kumar Acharya

Major Highlights of Presentation:

Introduction about citrus, some initiatives taken by the Government of Nepal for citriculture development, some technical issues reported in Gandaki province, production issues, great issues on import substitution or export, some constraints on production level, harvesting and market level, intervention to be taken by Governments at all tires were the points discussed on that presentation.

Introduction

Citrus is the main fruit crops of Nepal contributing about 21.93 percent of the total fruit production. Among citrus, mandarin orange is predominant which shares about 67 percent of the total citrus production in the country. Citrus production in Gandaki Province occupies 4.17% of total fruit production, 19% of total citrus production of Nepal. Citrus research stations (Pokhara, 1961 and Dhankuta, 1962): Mainly involved in research. National Citrus Development Programme (NCDP), 1972: to promote commercial citriculture (was mandated for both R&D). "Agriculture Year"-1974, many private nurseries established since then. A special "Junar Production Programme", initiated from 1980/81 followed by Horticulture Development Project supported by JICA. A national priority programme (1983/84) was operated with objective of commercializing citrus production in 20 mid-hill districts (Ilam to Dailekh). The Master Plan for Horticulture Development (MPHD)- 1991 gave the highest priority to citrus. Commercial Agriculture Development Programme (CADP) was carried out during 1994/95. Agriculture Perspective Plan (APP, 1995) recognized citrus as the main high value crop for mid-hills and carry out in pocket package approach. During which 210 citrus pockets were developed. Mission Programme of lime was carried out in 4 districts (Dhankuta, Bhojpur, Tehrathum & Makawanpur) during 2007/08 through which subsidy on planting materials, horticulture equipment and plant protection chemicals were provided. PMAMP developed 2 Super-zones, 8 Zones, 61 Blocks (078/79), 87 Pockets (078/79). At Gandaki Province, 1 Superzone, 3 Zones, 18 Blocks (078/79), 24 Pockets (078/79) were developed. Despite many initiatives taken by the government, the conditions of the orchards have remained the same or even worse or some orchards remain in history.

Figure 18 Branch of Mandarin infected with Felt Disease (white band of fungi inside the red circle

Figure 19 Leaf of a lime damaged with the Leaf Mining Flea Beetle (Pointed with red arrow: Larvae of LMFB)

Figure 20 New flushed twigs affected with the Citrus scale insect

Figure 21 Damaging bugs in Mandarin leaf (red-Nymph & black-egg mass)

Figure 22 Zinc deficiency symptoms observed in new leaves of a mandarin plant

Figure 23 A to be declined tree (Problems associated with complex factors)

Results of PCR testing

PPL had completed testing over 126 samples from various regions of Nepal based on the protocol prepared by Plant Protection Laboratory, Gandaki Province, Nepal based on following primers.

Name of the Primer	Sequence (5'-3')
Forward (Las606)	GGAGAGGTGAGTGGAATTCCGA
Reverse (LSS)	ACCCAACATCTAGGTAAAAACC

Fiscal Year: 2078/79				
Location	**Date of Leaves sample collection**	**Positive**	**Negative**	**Total**
Syangja	Mangsir 14	4	9	13
Tanahun	Poush 7	6	7	13
Myagdi	Poush 26	4	8	12
Total		**14**	**24**	**38**

Fiscal Year: 2079/80				
Location	**Date of Leaves sample collection**	**Positive**	**Negative**	**Total**
Kirtipur	Mangsir 2	1	5	6
Syangja 01	Kartik 4	7	3	10
Lamjung	Mangsir 11 & 12	3	13	16
Syangja 02	Mangsir 29	6	4	10
AKC	Poush & Magh	7	9	16
Myagdi	Poush 19	3	7	10
Rishing (Tanahun)	Magh 24	3	7	10
Lumle	Poush	4	6	10
Total		**33**	**55**	**88**

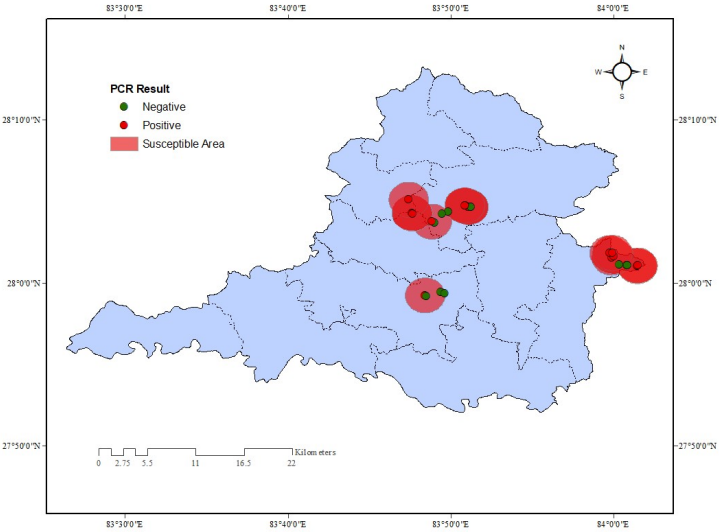


Figure 24 Major Hotspots of HLB at Syangja district

Positive identification of samples within range of 579m to 1000m above sea level, in the aspect category of North, East and North east faces. The samples included trees from 500m to 1100m facing all aspect categories, but positive identification didn't occur in aspect categories.

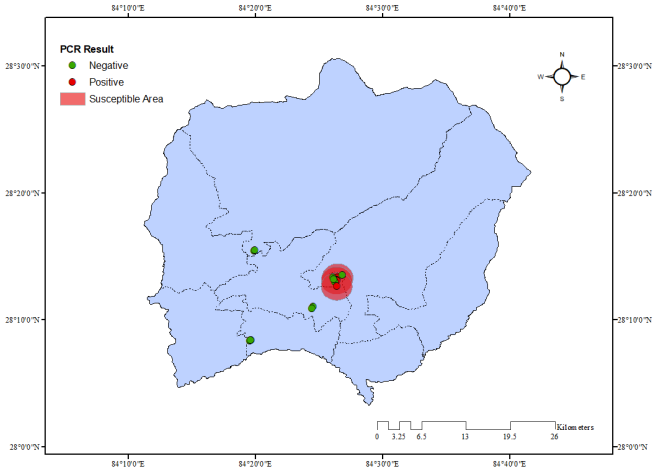


Figure 25 Major Hotspots of HLB at Lamjung district

Positive identification of samples within range of 1000m to 1100m above sea level, in the aspect category of North, East and North east faces. The samples included trees from 900m to 1200m facing all aspect categories, but positive identification didn't occur in aspect category of West.

Figure 26 Declined Mandarin Orchard at Tanahu Sur of Tanahun District

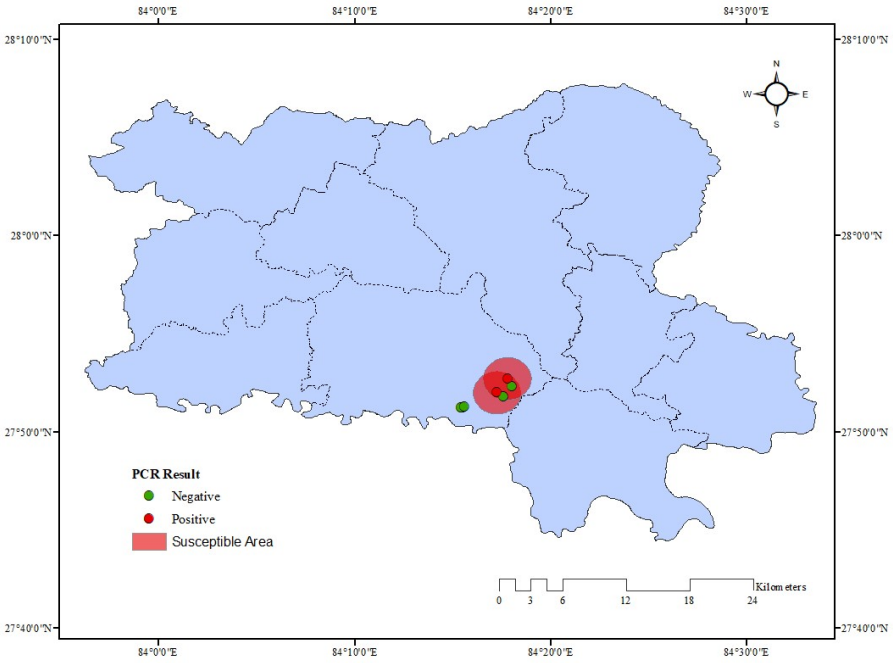


Figure 27 Major hotspots of HLB at Tanahun district

Positive identification of samples within range of 800m to 900m above sea level, in the aspect category of North, and North east faces. The samples included trees from 800m to 1150m facing all aspect categories, but positive identification didn't occur in aspect category of West.

Figure 28 Asian Citrus Psylla (ACP), a vector of Citrus greening disease; observed on a twig of a mandarin (Adults of ACP inside the red circle)

Figure 29 Nymps of ACPs observed on the new flush of a lime tree

Figure 30 Observation of Asian Citrus Psylla population on the twigs of mandarin tree

Some Issues

- Existing citrus trees are predominantly of seedling origin
- Plants coexist with various seasonal inter-crops without additional plant nutrients

- Very less attention to citrus orchard management and inputs in terms of labor and materials
- Very less use of Fertilizers, irrigation and plant protection chemicals
- Infected trees with deadly disease like foot rot & greening are not removed (source of inoculum for new & healthy orchards)
- Haphazard distribution of citrus seedlings without the consideration of technical aspects
- Abandoned orchards by migrated owners
- Timely availability of chemical fertilizers (quality control of CuSo4)
- Pest & disease constraints
- Human Resources (Grafting, training pruning, disease identification, etc.)

Present trend of orange production in Syangja District

Supply Source/ Production Period	Supply in Market according to the months										
	Shrawan	Bhadra	Ashoj	Karkik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha
Nepali (Local Khoku)											
Indian (Kinnow)											
Indian (Nagpure)											

Potentiality of offseason orange production is very high in Syangja district because of :

- Introduction of "Kinnow" variety
- For the late season, introduction of Negpure variety

Present trend of Lime Production in Syangja District

Supply Source/ Production Period	Supply in Market according to the months										
	Shrawan	Bhadra	Ashoj	Karkik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha
Nepali (Local, Sun Kagati 1&2)											
Indian (Andhra Pradesh)											

Supply of Lime during Ashoj, Kartik & Mangsir can be replaced by the Lime Pocket operated by AKC

A great issue

Import substitution or export with the existing market intelligence.

Production Constraints

1. Rootstock availability
   - Non-availability of Trifoliate seed
   - Non-availability of quality rootstock of recommended variety

2. Labour
   - Reduction of household labour (migration, higher study, etc)
   - High labour wages
   - Lack of skilled labour

3. Manures and fertilizers
   - Non-availability of fertilizers at required time
   - Non-availability of fertilizer in required quantity
   - Lack of knowledge about fertilizers use
   - High cost of fertilizers
   - Non-availability of fertilizers mixture of required ingredients

4. Irrigation
   - Drip irrigation system – High cost
   - No fruit friendly irrigation system

5. Harvesting
   - Cost of harvesting is very high
   - Most of the farmers has still less knowledge of harvest techniques and period of harvest

6. Post-Harvest Management
   - Less knowledge about the value of grading
   - Very less focus on post-harvest management (by our program also)
   - Fruit damage during transportation

7. Marketing
   - Lower farm gate price comparing its perishability and market absorption of vegetables (vegetables are more perishable and less market absorption which have to be stored/dumped for more time)
   - Not organized organizations/cooperatives for its marketing (market

control strategies)
- Sometime winter rain & cold temperature reduces the quality as well as the price

8. Plant protection
   - Emerging pest: Chinese Citrus Fly
   - Abandoned orchards as the source of inoculum

9. Technology
   - Technology generation is very less in number (Validity of AWCP is still unknown and in study phase by NARC)
   - Less adoption and investment of and on available technologies

10. Haphazard distribution of citrus seedlings (no regulation)

11. Capital & Subsidy
   - No provisions of orchard as the collateral for credit by financial institutions (collateral as the land but the valuation is very less for the land (slopy) suitable for citrus cultivation)
   - No positive discrimination between the annual crops & perennial orchards for subsidy
   - High production cost and lack of sufficient capital

12. Technical Information
   - Non-availability of required information in time
   - Specialized human resources development, recognition and utilization in farmers field in prioritized less.

Suggested interventions

1. Human Resources/Specialists Development

   (Capacity building exposure and visits to India/Pakistan and abroad)
   - Policy level: studies the organizational strengths, quality control system, MI systems and coordinates/has a dialogue to exchange genetic resources
   - Supportive Policy level: Facilitate the visit, meeting
   - Implementation level: Composed of different tires (who will engaged there on training for longer period of time)
   - Producer's level: Farmers ready to work on orchard

- Higher study (PhD/Masters Research) on citrus decline (with the collaboration of TU/AFU)
- Coordination (Meeting, workshop, interaction) with the Research institutions and other stakeholders
- Regular trainings for Officers/JTs/JTAs/Farmers
- Multiyear agreement (at least 3 years) with pocket/blocks of PMAMP for a JTA/JT with specified TOR to open the avenue for development of specialist technician
- Revisit of training curriculum/training guidelines (for all the trainings organized)
- Development of roasters for the training by MoALM
- On hand training to the farmers during the critical development stages (Nursery preparation, grafting, pit preparation, seedling transplanting, manuring, training-pruning, harvesting, post-harvest management)

2. Quality control of seedlings
    - Specify the age and quality of seedling (compulsorily)
    - Stop the haphazard distribution of seedlings (only after the certification of authorized agency– regulation needed)
    - Coordination with local administration for the quality control of seedling

3. Quality control of orchards
    - Destruction of PCR +Ve plants
    - Regeneration of nutrients/micro-nutrients deficient plants (vermicompost, composting, FYM improvements, Urine collection campaign)
    - Mass campaign to reduce the population of Citrus psylla, CCF, and other pests

4. Loan & Subsidy
    - Policy for project collateral system, validation of business plan from authorized agency (specify the authorized agency)
    - 85% subsidy for quality seedlings (three years, grafted, and seedlings complete with specified qualities), no subsidy for other seedlings
    - 10% promotion subsidy based on the production: implementable by making guidelines (might have a multiyear agreement between government and farmers for 5-15 years)

GROUP DISCUSSION SESSION

Group discussion was made on the following topics and major points of discussion were taken for formulating strategies.

Government Policy (Review and Analysis) regarding citrus orchard management

Prioritize research and extension in a parallel way

Focus the research by universities based on the real problems of farmers

Organizational Set-up (Review and Analysis) for citrus orchard management

Establishment of Citrus Development Board in the Province Level

Scope of Co-ordination with Stakeholders for Knowledge and Financial Out-sourcing

Technical Cooperation Project with FAO to combat the citrus problems in Gandaki province

Program Design for the management of overall citrus orchard

Pest Prioritization, Survey and surveillance, IPM in citrus orchards, mass testing campaign for HLB and tresteza virus, mass awareness against Chinese Citrus Fly (CCF), irrigation, nutrient management, capacity building, production and regulation of quality sapling.

Citrus Pest Prioritization and potential biological management practices (suggestions for the research as well as ready on hand for extension)

The workshop finalized the prioritization of pests and diseases as following.

Prioritized Diseases	Prioritized Insect Pests
1. HLB (Citrus Greening Disease)	1. Chinese Citrus Fly
2. Foot and Root Rot	2. Asian Citrus Psylla
3. Citrus Canker	3. Scale insect
4. Powdery Mildew	4. Leaf Miner
5. Shooty Mold	5. Citrus Stink Bug
6. Felt Disease	6. Fruit Sucking Moth

THE WORKSHOP CLOSING SESSION

The closing session of two-day long workshop was chaired by Director General Basu Dev Regmi. He delivered the vote of thanks to all the citrus experts, chief guests, other guests and all the stakeholders of citrus farming for their active participation and valuable inputs during the workshop. Special guest, secretary of MOALM, Gandaki province promised to include the strategies formulated through workshop discussion on the periodic plan, policies and programs of Gandaki province in coming days.

अनुसूचीहरु

Annex 1. कार्यक्रमको कार्यतालिका

"सुन्तला बगैंचा व्यवस्थापन तथा सुदृढिकरण सम्बन्धी विशेषज्ञ अन्तरक्रिया": कार्यतालिका

समुद्घाटन कार्यक्रम (०८:३०)

आशन ग्रहण तथा स्वागत

क्र.स	आसन ग्रहण	पद	कार्यालय
१	अध्यक्ष	श्रीमान सचिव ज्यू (सहदेव प्रसाद हुमागाईं)	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
२	प्रमुख अतिथि	माननीय मन्त्री ज्यू (महेन्द्रध्वज जी.सी.)	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
३	विशिष्ट अतिथि	उपकुलपति (प्रा.डा.नवराज देवकोटा)	श्री गण्डकी विश्वविद्यालय, पोखरा
४	विशिष्ट अतिथि	महानिर्देशक ज्यू	श्री कृषि विभाग,हरिहरभवन, ललितपुर
५		महानिर्देशक ज्यू	श्री कृषि विकास निर्देशनालय, गण्डकी प्रदेश, पोखरा
६	विशेष अतिथि	उप प्रध्यापक (उप-प्रा. डा. प्रदिप राज रोकाया)	श्री कृषि तथा वन विश्वविद्यालय, चितवन
७	विशेष अतिथि	प्रमुख	श्री कृषि अनुसन्धान निर्देशनालय, गण्डकी प्रदेश, पोखरा
८	विशेष अतिथि	Arjun Thapa	FAO Representative in Nepal, Kathmandu
९	विशेष अतिथि	Dr. Vinod Pandit	CABI-South Asia, New Delhi, India
१०	अतिथि	योजना तथा अनुगमन महाशाखा प्रमुख	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
११	अतिथि	प्रमुख	श्री प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, परियोजना कार्यान्वयन इकाई, स्याङ्गजा, लमजुङ, नवलपरासी (ब.सु.पू.), कास्की, गोरखा

क्र.स	आसन ग्रहण	पद	कार्यालय
१२	अतिथि	प्रमुख	श्री बागवानी अनुसन्धान केन्द्र, मालेपाटन, पोखरा
१३	अतिथि	बैज्ञानिक	श्री सुन्तलाजात अनुसन्धान कार्यक्रम,पारिपात्ले, धनकुटा
१४	अतिथि	बैज्ञानिक	श्री बाली रोग अनुसन्धान केन्द्र,खुमलटार, ललितपुर
१५	अतिथि	बैज्ञानिक	श्री राष्ट्रिय किट विज्ञान अनुसन्धान केन्द्र,खुमलटार, ललितपुर
१६	अतिथि	वरिष्ठ बाली संरक्षण अधिकृत	श्री प्लान्ट क्वारेन्टाइन तथा बिषादी व्यवस्थापन केन्द्र,हरिहरभवन, ललितपुर
१७	अतिथि	भैरव राज कैनी	सुन्तलाजात फलफूल विज्ञ
१८	अतिथि	बेनी बहादुर बस्नेत	
१९	अतिथि	हरि प्रसाद सुवेदी	
२०	अतिथि	प्रमुख	श्री कृषि व्यवसाय प्रवर्द्धन सहयोग तथा तालिम केन्द्र, पोखरा
२१	अतिथि	प्रमुख	श्री बाली संरक्षण प्रयोगशाला, पोखरा
२२	अतिथि	प्रमुख	श्री माटो तथा मल परिक्षण प्रयोगशाला, पोखरा
२३	अतिथि	प्रमुख	श्री बीउ विजन प्रयोगशाला, पोखरा
२४	अतिथि	प्रमुख	श्री बागवानी विकास श्रोत केन्द्र, पोखरा
२५	अतिथि	प्रमुख	श्री कृषि ज्ञान केन्द्र बागलुङ, पर्वत, म्याग्दी, कास्की, स्याङ्गजा, तनहुँ, लमजुङ, गोरखा, नवलपरासी (ब.सु.पू.)
२६	अतिथि	उप प्रध्यापक	श्री प्राकृतिक श्रोत व्यवस्थापन कलेज, पोखरा
२७	अतिथि	प्रमुख	श्री कृषि तथा पशुपन्क्षी विकास महाशाखा,पोखरा महानगरपालिका

क्र.स	आसन ग्रहण	पद	कार्यालय
२८	अतिथि	प्रमुख	रेडियो नेपाल प्रादेशिक प्रशारण केन्द्र, पोखरा
२९	अतिथि	सम्बददाता	नेपाल टेलिभिजनपोखरा
३०	अतिथि	सम्पादक	आर सी टाइम्सपोखरा
३१	अतिथि	पत्रकार	पोखरा टेलिभिजन पोखरा
३२		शाखा प्रमुख ज्यूहरु तथा सम्पूर्ण कर्मचारीहरु	कृषि विकास निर्देशनालयगण्डकी प्रदेश, पोखरा
३३	अतिथि	कृषि तथा भूमि ब्यवस्था मन्त्रालयका माननीय मन्त्री ज्युको निजि सचिव, स्वकीय सचिव तथा सचिवालयका सम्पूर्ण कर्मचारी तथा सुरक्षाकर्मी साथीहरु	
३४	अतिथि	सुन्तलाजात फलफूल व्यवसायमा संलग्न कृषि उद्यमी	
३५	अतिथि	बिभिन्न क्षेत्रबाट उपस्थित सम्पूर्ण भद्र महिला तथा पुरुष सज्जनबृन्द	
३६	**हमास समूहको आक्रमणमा परी इजरायलमा दिवंगत नेपालीहरु प्रति श्रद्धान्जली व्यक्त गर्दै मौन धारण**		
३७	**राष्ट्रिय गान सामुहिक**		
३८	**स्वागत मन्तव्य (वरिष्ठ बाली संरक्षण अधिकृत, शालिकराम अधिकारी)**		
३९	कार्यक्रम उद्घाटन (सुन्तलाको बोट सहितको गमलामा पानी हालेर, माननीय मन्त्री महेन्द्रध्वज जि. सी. ज्यू बाट)		
४०	**रिफ्रेसमेन्ट ब्रेक**		
४१	**प्रस्तुतिकरण**		
	प्रस्तुतकर्ता		कार्यपत्र
प्र. १	बालकृष्ण अधिकारी (वरिष्ठ बागवानी विकास अधिकृत), कृषि विकास निर्देशनालय, गण्डकी प्रदेश		Citrus farming in Gandaki Province: Status, Problems and Prospects
४२	**छलफल**		
४३	**मन्तव्य**		

क्र.स	आसन ग्रहण	पद	कार्यालय
४३.१	**मन्तव्य :** विशिष्ठ अतिथि (उपकुलपति डा. नवराज देवकोटा ज्यू)		
४३.२	**मन्तव्य :** प्रमुख अतिथि (माननीय मन्त्री महेन्द्रध्वज जि सी ज्यू)		
४३.३	**उद्घाटन समारोहको समापन तथा धन्यवाद मन्तब्य:** कार्यक्रमका अध्यक्ष एवम् श्रीमान सचिव सहदेव प्रसाद हुमागाईं		
४४	खाजा/खाना ब्रेक		
४५	दोश्रो सत्र: प्रस्तुतीकरण/प्राविधिक सत्र		
४६	कार्यक्रमको अध्यक्षता महानिर्देशक (बासुदेव रेग्मी ज्यू)		
४७	प्रस्तुतीकरण/प्राविधिक सत्रहरु		

	प्रस्तुतकर्ता	कार्यपत्र
प्र. २	भैरब राज कैनी सुन्तलाजात फलफूल विज्ञ	Existing policies, organizational set-up and human resources (is it sufficient ? Or need more alternatives – suggested options) for the Citrus industry
प्र. ३	डा. देवराज अधिकारी वरिष्ठ बाली संरक्षण अधिकृत श्री प्लान्ट क्वारेन्टाइन तथा बिषादी व्यवस्थापन केन्द्र,हरिहरभवन, ललितपुर	Ecology of Chinese FF and its management in Nepal
प्र. ४	श्री डा. काशिनाथ चिलुवाल बैज्ञानिक श्री राष्ट्रिय किट विज्ञान अनुसन्धान केन्द्र, खुमलटार, ललितपुर	Distribution, Biology and Management of Citrus Psylla in Nepal
४८	**छलफल**	
४९	**प्रथम दिनको समापन**	
	दोश्रो दिन	
५०	**कार्यक्रमको अध्यक्षता महानिर्देशक (बासुदेव रेग्मी ज्यू)**	
५१	प्रस्तुतीकरण/प्राविधिक सत्र	
प्र. ५	शालिकराम अधिकारी वरिष्ठ बाली संरक्षण अधिकृत श्री बाली संरक्षण प्रयोगशाला, पोखरा	Status of Citrus Pests (Insect and Diseases) in Gandaki Province and some initiatives taken by Province Government

प्र. ६	डा. उमेश कुमार आचार्य बैज्ञानिक-एस ३ श्री सुन्तलाजात अनुसन्धान कार्यक्रम, पारिपात्ले, धनकुटा	Citrus Greening – ways forward to be taken by stakeholders in Nepal (Some examples of Good Practices witnessed)
प्र. ७	बासुदेव रेग्मी महानिर्देशक श्री कृषि विकास निर्देशनालय, गण्डकी प्रदेश, पोखरा	An insight of Nursery Management directive enforced by Gandaki Province Government
प्र. ८	डा. उमेश कुमार आचार्य बैज्ञानिक-एस ३ श्री सुन्तलाजात अनुसन्धान कार्यक्रम, पारिपात्ले, धनकुटा	सुन्तलाजात बालीका उपलब्ध उन्नत प्रविधिहरु (Existing Technologies for citrus cultivation in Nepal)
५२	**छलफल तथा जिज्ञाशाहरुको सम्बोधन**	
५३	**खाजा ब्रेक**	
५४	गण्डकी प्रदेशमा सुन्तलाजात फलफूल खेतीको ठोस रणनीति निर्माणको लागि सामुहिक छलफल र प्रस्तुतीकरण	
५५	समापन समारोह	
५६	**मन्तव्य**	
५६.१	**मन्तव्य :** श्रीमान सचिव सहदेव प्रसाद हुमागाईं ज्यू	
५६.२	धन्यबाद ज्ञापन सहित समापन मन्तव्य: कार्यक्रमका अध्यक्ष एबम महानिर्देशक बासुदेव रेग्मी ज्यू	

Annex 2: List of participants

क्र.स	नाम, पद	ठेगाना/कार्यालय
१	सहदेव प्रसाद हुमागाईं, सचिव	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
२	मा. महेन्द्रध्वज जि.सी., मन्त्री	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
३	डा. नवराज देवकोटा, उपकुलपति	पोखरा विश्वविद्यालय
४	बासुदेव रेग्मी, महानिर्देशक	कृषि विकास निर्देशनालय, पोखरा
५	भैरव राज कैनी, बागवानी विज्ञ	
६	बेनी बहादुर बस्नेत, पूर्व सहसचिव	लि-बर्ड, पोखरा
७	अर्जुन सुवेदी, उप- प्राध्यापक	प्राकृतिक श्रोत व्यवस्थापन कलेज, पोखरा
८	डा.प्रदीपराज रोकाया, उप- प्राध्यापक	कृषि तथा बन बिश्वबिद्यालय, चितवन
९	परशुराम शर्मा, रिपोर्टर	नेपाल टेलिभिजन
१०	हरि प्रसाद सुवेदी, पूर्व ब.प्राविधिक अधिकृत	चितवन

क्र.स	नाम, पद	ठेगाना/कार्यालय
११	डा. सुनिल अर्याल, प्रमुख	बागवानी अनुसन्धान केन्द्र, मालेपाटन, पोखरा
१२	बिनोद हमाल, प्रमुख	कृषि ज्ञान केन्द्र, स्याङ्गजा
१३	परशुराम अधिकारी, प्रमुख	कृषि ज्ञान केन्द्र, पर्वत
१५	गोबिन्द राज कोइराला, प्रमुख	बागवानी विकास श्रोत केन्द्र, पोखरा
१६	डा. काशिनाथ चिलुवाल, बैज्ञानिक	राष्ट्रिय किट विज्ञान अनुसन्धान केन्द्र, खुमलटार, ललितपुर
१७	माधब प्रसाद लम्साल, प्रमुख	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, स्याङ्गजा
१८	रोशन अधिकारी, प्रमुख	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, कास्की
१९	रण बहादुर महतो, नि. प्रमुख	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, नवलपरासी (ब.सु.पु.)
२०	नविन क्षेत्री, भिडियो ग्राफर	असल साथी मिडिया
२१	मोहन रानाभाट, स्वकीय सचिव	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
२२	सुलोचना थापा, कृषि अधिकृत	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, कास्की
२३	बोधराज अर्याल, कृषक	स्याङ्गजा
२४	मुक्ति अधिकारी, कृषक	स्याङ्गजा
२५	इन्द्रमणि लामिछाने, पूर्व कृषि अधिकृत	पोखरा
२६	कमल पौडेल अथक, समाचार प्रमुख	रेडियो सराङकोट
२७	रामचन्द्र बराल, सम्पादक	आरसी टाइम्स
२८	फणी नारायण अर्याल, कृषक	स्याङ्गजा
२९	राजेश्वर सिलवाल, नि. प्रमुख	कृषि ज्ञान केन्द्र, बाग्लुङ
३०	राजेन्द्र अधिकारी, कृषक	पोखरा
३२	सुशील ढुंगाना, बायो टेक्नोलोजिस्ट	बाली संरक्षण प्रयोगशाला, पोखरा
३३	डा. उमेश कुमार आचार्य, संयोजक/बैज्ञानिक	राष्ट्रिय सुन्तालाजात अनुसन्धान कार्यक्रम, पारिपात्ले, धनकुटा

क्र.स	नाम, पद	ठेगाना/कार्यालय
३४	डा. देवराज अधिकारी, वरिष्ठ बाली संरक्षण अधिकृत	प्लान्ट क्वारेन्टाइन तथा विषादी व्यवस्थापन केन्द्र, हरिहरभवन, ललितपुर
३५	किरण सिग्देल, प्रमुख	कृषि ज्ञान केन्द्र, कास्की
३६	अजय अधिकारी, प्रमुख	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए,लमजुङ्ग
३७	शालिकराम अधिकारी, प्रमुख	बाली संरक्षण प्रयोगशाला, पोखरा
३८	सुनिल पाण्डे, प्रमुख	माटो तथा मल परीक्षण प्रयोगशाला, पोखरा
३९	प्रमोद गैहे, बागवानी विकास अधिकृत	कृषि ज्ञान केन्द्र, गोरखा
४०	सन्जिव बास्तोला, नि.प्रमुख	कृषि ज्ञान केन्द्र, म्याग्दी
४१	अस्मिता खनाल, बैज्ञानिक (एस-१)	बागवानी अनुसन्धान केन्द्र, मालेपाटन, पोखरा
४२	अर्जुन देव ज्ञवाली, नि.प्रमुख	कृषि व्यवसाय प्रवर्धन सहयोग तथा तालिम केन्द्र, पोखरा
४३	अमृत रेग्मी, नि.प्रमुख	वीउ विजन प्रयोगशाला, पोखरा
४४	किरण परियार, बाली संरक्षण अधिकृत	कृषि ज्ञान केन्द्र, तनहुँ
४५	मनोज ढकाल, बागवानी विज्ञ	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, कास्की
४६	नारायण प्रसाद पाठक, कृषि अर्थ विज्ञ	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
४७	गोबिन्द पाण्डे, कृषि प्रसार अधिकृत	बागवानी विकास श्रोत केन्द्र, पोखरा
४९	शशी अधिकारी, कृषि अर्थ विज्ञ	कृषि विकास निर्देशनालय, पोखरा
५०	घनश्याम पाण्डे, समाचार प्रमुख	पोखरा टेलिभिजन
५१	सन्देश श्रेष्ठ, समाचार प्रमुख	एभरेस्ट एफ एम
५२	बिभु भुसाल, सम्पादक	कटवाल न्युज
५३	कुल प्रसाद तिवारी, प्रमुख	कृषि ज्ञान केन्द्र, नवलपरासी (ब.सु.पु.)
५४	अजय क्षेत्री, रिपोर्टर	न्युज नेपाल टि.भि.
५५	खगेन्द्र प्रसाद अर्याल, व्यवस्थापक	पोखरा टि.भि.
५६	प्रकाश बहादुर खड्का, ह.स.चा.	कृषि विकास निर्देशनालय, पोखरा
५७	बैकुण्ठ राना, का.स	कृषि विकास निर्देशनालय, पोखरा
५८	बिष्णु प्रसाद कोइराला,	कृषि विकास निर्देशनालय, पोखरा

क्र.स	नाम, पद	ठेगाना/कार्यालय
५९	केशब ब. पौडेल, ह.स.चा.	कृषि विकास निर्देशनालय, पोखरा
६०	शिव शर्मा, ह.स.चा.	कृषि ज्ञान केन्द्र, नवलपरासी (ब.सु.पु.)
६१	दुर्गा के.सी., का.स	कृषि विकास निर्देशनालय, पोखरा
६२	तोयनारायण सुवेदी, लेखा अधिकृत	कृषि विकास निर्देशनालय, पोखरा
६३	डोलराज पराजुली, शाखा अधिकृत	कृषि विकास निर्देशनालय, पोखरा
६४	झपट ब. के.सी., का.स	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
६६	ज्योती क्षेत्री, कृषि अर्थ विज्ञ	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
६७	यज्ञ गायक, ह.स.चा.	पोखरा महानगरपालिका
६८	प्रसित खड्का, ह.स.चा.	कृषि विकास निर्देशनालय, पोखरा
६९	भुवन ब. राना, ह.स.चा.	बाली संरक्षण प्रयोगशाला, पोखरा
७०	रन्जना पोखरेल, अधिकृत	कृषि विकास निर्देशनालय, पोखरा
७१	सुदिप खतिवडा, प्रमुख	कृषि ज्ञान केन्द्र, लमजुङ्ग
७२	ध्रुब गिरी, उप-सचिव/प्र.	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
७३	घनश्याम अधिकारी, ह.स.चा.	पशुपंक्षी तथा मत्स्य विकास निर्देशनालय, पोखरा
७४	बिनोद सारु मगर, ह.स.चा.	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
७५	रामकाजी गिरी, ह.स.चा.	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
७६	प्रेम आचार्य, अधिकृत	कृषि ज्ञान केन्द्र, पर्वत
७७	संजय ढकाल, कृषि अर्थ विज्ञ	कृषि ज्ञान केन्द्र, नवलपरासी (ब.सु.पु.)
७८	मनहर कडरिया, प्रमुख	कृषि तथा पशुपंक्षी विकास महाशाखा, पोखा मनपा
७९	कुमार तिमिल्सिना, ह.स.चा.	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
८०	मिलन आचार्य, बाली विकास अधिकृत	कृषि विकास निर्देशनालय, पोखरा
८१	ध्रुब कुमार कटवाल, प्रहरी जवान	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
८३	जीवन थापा, प्रहरी जवान	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
८४	बिबेक कंडेल, प्रहरी जवान	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
८५	सन्दिप परियार प्रहरी जवान	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा

क्र.स	नाम, पद	ठेगाना/कार्यालय
८६	दिपक बराल, प्रहरी जवान	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
८७	राजेश गुरुङ, वरिष्ठ कृषि प्रसार अधिकृत	कृषि विकास निर्देशनालय, पोखरा
८८	बिनोद शर्मा, कृषि प्रसार अधिकृत	कृषि विकास निर्देशनालय, पोखरा
८९	बालकृष्ण अधिकारी, व वा वि अ	कृषि विकास निर्देशनालय, पोखरा
९०	अर्जुन प्रताप राणा, कृषक	जनसेवा सुन्तालाजात फलफूल नर्सरी , गोरखा
९१	निर्मल बाबु श्रेष्ठ, कृषक	बिन्ध्यबासिनी मिश्रित फलफूल नर्सरी , गोरखा
९२	डा. गृष्म नेउपाने, ब.प.वि.अ	पशुसेवा तालिम केन्द्र, पोखरा
९३	ठाकुर प्रसाद ढकाल	कृषि तथा भूमि व्यवस्था मन्त्रालय, गण्डकी प्रदेश, पोखरा
९४	कृष्ण प्रसाद दवाडी, सम्वाददाता	हिमाली आवाज
९५	दिननाथ बराल, सम्वाददाता	रेडियो नेपाल
९६	भगवान बोगटी,, ह.स.चा.	कृषि ज्ञान केन्द्र, लमजुङ्ग
९७	राम प्र. ढुंगाना, ह.स.चा.	कृषि ज्ञान केन्द्र, कास्की
९८	भोलानाथ आचार्य, सहायक	कृषि ज्ञान केन्द्र, पर्वत
१००	सबिन तामाङ, ह.स.चा.	प्रधानमन्त्री कृषि आधुनिकीकरण परियोजना, प.का.ए, कास्की
१०१	शंकर पौडेल, बागवानी वि.अ.	कृषि ज्ञान केन्द्र, पर्वत

Annex 3: Presentations and name of reviewers

	प्रस्तुतकर्ता	कार्यपत्र	टिप्पणी कर्ता
प्र. १	बालकृष्ण अधिकारी (वरिष्ठ बागवानी विकास अधिकृत), कृषि विकास निर्देशनालय, गण्डकी प्रदेश	Citrus farming in Gandaki Province: Status, Problems and Prospects	Beni Bahadur Basnet, Bhairab Raj Kaini

	प्रस्तुतकर्ता	कार्यपत्र	टिप्पणी कर्ता
प्र. २	भैरब राज कैनी सुन्तालाजात फलफूल विज्ञ	Existing policies, organizational set-up and human resources (is it sufficient ? Or need more alternatives – suggested options) for the Citrus industry	Bala Krishna Adhikari, Milan Acharya
प्र. ३	डा. देवराज अधिकारी वरिष्ठ बाली संरक्षण अधिकृत प्लान्ट क्वारेन्टाइन तथा बिषादी व्यवस्थापन केन्द्र,हरिहरभवन, ललितपुर	Ecology of Chinese Citrus fly and its management in Nepal	Dr. Sunil Aryal, Shalik Ram Adhikari
प्र. ४	डा.काशिनाथ चिलुवाल बैज्ञानिक राष्ट्रिय किट विज्ञान अनुसन्धान केन्द्र, खुमलटार, ललितपुर	Distribution, Biology and Management of Citrus Psylla in Nepal	Dr. Deb Raj Adhikari, Madhav Lamsal
प्र. ५	शालिकराम अधिकारी वरिष्ठ बाली संरक्षण अधिकृत बाली संरक्षण प्रयोगशाला, पोखरा	Status of Citrus Pests (Insect and Diseases) in Gandaki Province and some initiatives taken by Province Government	Dr. Kasinath Chiluwal, Dr.Umesh Kumar Acharya
प्र. ६	डा. उमेश कुमार आचार्य बैज्ञानिक-एस ३ सुन्तलाजात अनुसन्धान कार्यक्रम, पारिपात्ले, धनकुटा	Citrus Greening – ways forward to be taken by stakeholders in Nepal (Some examples of Good Practices witnessed)	Pradip Raj Rokaya, Binod Sharma
प्र. ७	बासुदेव रेग्मी महानिर्देशक कृषि विकास निर्देशनालय, गण्डकी प्रदेश, पोखरा	An insight of Nursery Management directive enforced by Gandaki Province Government	Bala Krishna Adhikari, Gobinda Raj Koirala
प्र. ८	डा. उमेश कुमार आचार्य बैज्ञानिक-एस ३ सुन्तलाजात अनुसन्धान कार्यक्रम, पारिपात्ले, धनकुटा	सुन्तलाजात बालीका उपलब्ध उन्नत प्रविधिहरु (Existing Technologies for citrus cultivation in Nepal)	Bala Krishna Adhikari, Milan Acharya

कार्यक्रमका केही झलकहरू

चित्र: प्रस्तुतीकरण दिनु हुँदै वरिष्ठ बैज्ञानिक डा. उमेश कुमार आचार्य ज्यू

चित्र: कार्यक्रममा कार्यपत्र प्रस्तुत गर्नुहुँदै वरिष्ठ बाली संरक्षण अधिकृत शालिकराम अधिकारी ज्यू

चित्र: कार्यक्रममा उपस्थित सहभागीहरु विज्ञहरुको कार्यपत्र सुन्ने क्रममा

चित्र: प्रस्तुतीकरणमा आफ्ना जिज्ञाशा र सुझाव राख्नुहुँदै वरिष्ठ कृषि विकास अधिकृत मनहर कडरिया ज्यू

चित्र: प्रस्तुतीकरणमा आफ्ना जिज्ञाशा राख्नु हुँदै सुन्तालाजात फलफूल कृषक

चित्र: प्रस्तुतीकरणमा आफ्ना जिज्ञाशा र सुझाव राख्नुहुँदै कृषि ज्ञान केन्द्र स्याङ्गजाका प्रमूख ज्यू

चित्र: प्रस्तुतीकरण दिनुहुँदै वरिष्ठ बाली संरक्षण अधिकृत डा. देवराज अधिकारी ज्यू

चित्र: प्रस्तुतीकरणमा आफ्ना जिज्ञाशा र सुझाव राख्नुहुदै आरसी टाइम्स् का सम्पादक डा. राम चन्द्र बराल ज्यू

फलफूल नर्सरी स्थापना तथा संचालन सम्बन्धी जानकारी

१. गण्डकी प्रदेशमा स्थापना तथा संचालन हुने फलफूल नर्सरीको नियमनको लागि गण्डकी प्रदेश सरकारले फलफूल नर्सरी व्यवस्थापन (स्थापना तथा संचालन) निर्देशिका, २०८० जारी गरेको छ।

२. निर्देशिकाको दफा १० बमोजिमको योग्यता पुगेका निजी नर्सरी स्थापना गर्न इच्छुक व्यक्ति/संस्थाले सम्बन्धित स्थानीय तहमा निवेदन दिई दफा ११ बमोजिम नर्सरी दर्ता गर्नुपर्नेछ।

३. दर्ता भएका नर्सरी धनीले कृषि ज्ञान केन्द्रबाट बिरुवा उत्पादन तथा बिक्रि वितरणको अनुमतिपत्र लिनुपर्नेछ। उक्त अनुमतिपत्र प्रत्येक तीन बर्षमा नवीकरण गर्नुपर्नेछ।

४. सूचीकृत/अनुमतिपत्र प्राप्त नर्सरी धनीले दर्ता प्रमाण पत्र र विरुवा उत्पादन तथा बिक्रि वितरणको अनुमतिपत्र वा सोको प्रतिलिपि बिक्रि कक्षमा देखिने गरी राख्नुपर्नेछ।

५. उत्पादित विरुवाको गुणस्तर प्रमाणीकरणको लागि कृषि ज्ञान केन्द्रमा निवेदन दिनुपर्नेछ र नर्सरी निरीक्षकले गुणस्तरयुक्त भनी प्रमाणित गरेका फलफूल बिरुवा मात्र बिक्रि वितरण गर्नुपर्नेछ।

६. उत्पादित विरुवा अन्य स्थानीय तह वा अन्य जिल्लामा ढुवानी तथा ओसारपसार गर्दा गुणस्तर प्रमाणपत्रको प्रतिलिपि अनिवार्य रुपमा साथमा राख्नुपर्नेछ।

७. अनुमतिपत्र प्राप्त नगरेका, निलम्बनमा परेका र दर्ता तथा वितरण अनुमतिपत्र खारेजीमा परेका र तोकिएको मापदण्ड पूरा नगरेका नर्सरीहरुमा उत्पादित फलफूल बिरुवाको बिक्रि वितरण गर्न पाइने छैन।

गण्डकी प्रदेश सरकार
कृषि तथा भूमि व्यवस्था मन्त्रालय
कृषि विकास निर्देशनालय
मालेपाटन, पोखरा
फोन नं. ०६१-५७०२७३/०६१-५७०२६३/०६१-५४३८९५
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