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2077/78 (2020/21)

GOVERNMENT OF NEPAL

NEPAL AGRICULTURE RESEARCH COUNCIL

NATIONAL CITRUS RESEARCH PROGRAMME

PARIPATLE, DHANKUTA

2021

Nepal Agriculture Research Council (NARC)

National Citrus Research Programme (NCRP)

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FOREWORD

For the last few years, National Citrus Research Program (NCRP) has experienced a growing interest in citrus cultivation, most probably attributed to the increasing market demand even abroad (China). A large number of potential citrus growers from mid hills and terai plains have reached us for technical counseling and saplings. High demand was received for saplings, mainly of acid lime varieties viz. Sun Kagati-1, and Sun Kagati-2 from foot hills and terai plains. Similarly, Terhathum Local, a recently recommended acid lime variety for mid hills has also increased saplings demand. This could be backed up by the fact that NCRP, apart from private nurseries, had distributed more than twenty five thousand quality acid lime saplings at the cheapest price last year.

It is a matter of great satisfaction that we are working on exploring potential of mandarin and sweet orange production with introduction breeding. These mandarin germplasms from abroad have potential for commercial production in terai plains, where a great demand for suitable mandarin variety persists. In the last fiscal year, NCRP had been able to endorsed one local variety of acid lime (Terhthum) and one local variety of mandarin (Khoku) for registration. With better management of fruit orchard within NCRP, Paripatle, we had a record high fruit production last year. I would like to thank all the hard-working staff and wage laborers for this achievement. Hearty thanks also go to the Executive Director and Directors of NARC who supported NCRP all the way from program planning to implementation of the projects.

Despite having only a few scientists and technicians, we have been able to carry out all targeted activities and achieve expected output indicators. However, a few more scientists and technical staff are desperately needed in NCRP to address the burning research issues in citrus. Lab facilities, mainly of tissue culture lab had not properly utilized in absence of expert technical person. Positions of soil scientist, entomologist and plant breeder have been vacant for a long period.

I hope this citrus research related report will be useful to all stakeholders including farmers, students and others professionals who are interested in the citrus industry. Last but not least, I would like to thank Dr. Sabitri Adhikari, Mr. Roshan Pakka and Ms Dipti Adhikari for their conscientious help while preparing this annual report.

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Paripatle, Dhankuta

ACRONYMS

%	Percentage
@	at the rate
>	Greater than
2,4-D	2,4-Dichlorophenoxyacetic acid
Av	Average
B.S.	Bikram Sambat
BrimA	Brix minus acid
CFFT	Coordinated Farmers Field Trial
CIRAD	Centre of Agriculture Research for Development
Cm	Centimeter
CV	Coefficient of Variation
Cv	Cultivar
CVT	Coordinated Varietal Trial
DAP	Di-ammonium phosphate
DAS	Days after sowing
DBH	Days before harvest
DFTQC	Department of Food Technology and Quality Control
DGR	Dry Ginger Recovery
et. al.	et alia
FAO	Food and Agriculture Organization
FY	Fiscal Year
FYM	Farm yard manure
G	Gram
Ha	Hectare
HLB	Huanglongbing
i.e.	That is
IAAS	Institute of Agriculture and Animal Science
ICAR	Indian Council of Agriculture Research
ICIMOD	International Centre for Integrated Mountain Development
INGO	International non-governmental organization
INRA	French National Institute for Agriculture Research
JICA	Japan International Cooperation Agency
JTA	Junior technical assistant
K	Potassium
Kg	Kilogram
LSD	Least Significant Different
Lt	Liter
M	Meter

m asl	meter above sea level
Ml	Milliliter
Mm	Millimeter
MoAD	Ministry of Agriculture Development
Mt	Metric ton
Mt/ha	Metric ton per hectare
N	Nitrogen
NAA	Naphthaleneacetic acid
NARC	Nepal Agricultural Research Council
NCRP	National Citrus Research Program
NGO	Non-governmental organization
NGRP	National Ginger Research Program
NPR	Nepalese Rupee
NS	Non-significant
^{o}	Degree
P	Phosphorus
PCR	Polymerase chain reaction
p^{H}	Potential of Hydrogen
PMAMP	Prime Minister Agriculture Modernization Project
ppm	Parts per million
RARS	Regional Agricultural Research Station
RATWG	Regional Agricultural Technical Working Group
RCBD	Completely Randomized Block Design
Sept.	September
SLC	School leaving certificate
T	Ton
t/ha	Ton per hectare
TA	Titratable Acid
TPR	Turmeric Powder Recovery
TSS	Total Soluble Solid
VCDP	Value Chain Development Project
viz.	Videlicet
Wt	Weight

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

प्रमुख सार संक्षेप

सुन्तलाजात फलफुल खेती मध्य पहाड र तराईका नेपाली कृषकहरुको आर्थिक स्तर वृद्धिमा टेवा पुऱ्याउने महत्वपूर्ण कृषि क्षेत्र हो । सुन्तलाको बढ्दो आन्तरिक तथा वाह्य बजारको कारणले यसलाई एउटा उच्च मूल्य भएको क्षेत्रको रुपमा पहिचान गरिएको छ । यसर्थ नेपाल सरकारले बिगत केहि वर्षदेखि सुन्तला क्षेत्रको प्रवर्द्धन र विकासको लागि उच्च प्राथमिकता दिदै आएको छ । यद्यपी विगत केहि बर्ष देखि न्युन उत्पादकत्व र न्युन गुणस्तरले गर्दा उत्पादनमा समस्या देखिन थालेको छ । रोग र किराको बढ्दो आक्रमण, खस्कदो माटोको उर्वराशक्ति र सिंचाइको अभाव, सीमित जातीय विविधता तथा स्वस्थ बिरुवाको अभाब जस्ता कारणले उत्पादन र उत्पादकत्वमा समस्या देखा परेको हो ।

यस परिप्रेक्ष्यमा राष्ट्रिय सुन्तला जात अनुसन्धान कार्यक्रमले राष्ट्रिय जिम्मेवारीको रुपमा यस क्षेत्रको प्रवर्द्धन र विकास गर्न उपयुक्त प्रबिधि विकासको लागि अनुसन्धानका कार्यक्रमहरु संचालन गर्दै आएको छ । यस कार्यक्रमले आ.व. २०७७/७८ अवधिमा जम्मा ८ वटा परियोजना अन्तर्गत ३८ वटा अनुसन्धान क्रियाकलापहरु सम्पन्न गरेको थियो । यी कार्यक्रमहरु विशेष रुपमा जातीय अनुसन्धान, बाली उत्पादनोपरान्त भन्डारण, बगैचा ह्रास व्यवस्थापन र सुन्तलाको औंसा किरा व्यवस्थापनसंग सम्बन्धित थिए । फलफूल अनुसन्धान सम्पन्न गर्न लामो समय लाग्ने भएकोले धेरैजसो कार्यक्रमहरु नियमित संचालनमा छन् भने केहि सम्पन्न भई अपेक्षित उपलब्धिहरु ह्रासिल भएका छन । यसरी आ.व. २०७७/७८६ सम्म पुरा गरिएका क्रियाकलापहरुको उपलब्धिहरु संक्षिप्त रुपमा तल उल्लेख गरिएको छ ।

- जातीय संकलन र सम्बर्द्धन अन्तर्गत १४४ वटा स्थानीय र वाह्य श्रोतबाट सुन्तलाका विभिन्न जातहरु संकलन गरि कार्यक्रमको फारम भित्र फिल्ड जिन बैंकमा सम्बर्द्धन गरि राखिएको छ । यी संकलित जातहरु सुन्तला, जुनार, कागती, भोगटे, निबुवा, सुन्तलाका वर्णशंकर जातहरु र रुटस्टक वर्ग अन्तर्गत पर्दछन् । प्रारम्भिक अध्ययन अनुसार यी संकलित जातहरु फल लाग्ने समय, फलको गुण र बोटको बृद्धी विकास आदिको विशेषतामा निकै विविधता देखिएको छ । उपयुक्त जातको छनौट तथा विकाशको लागि अझ केहि वर्ष अध्ययन गर्न आवश्यक देखिन्छ ।

- सुन्तला, जुनार, कागति र ट्यांङगोर प्रचलनमा रहेका जातहरुको उत्पादन क्षमता कम रहेका छन । यस समस्यालाई हल गर्ने उदेश्यले विदेशबाट भित्राईएका र उपयुक्त स्थानिय जातहरुको खोजीगरी बिगत २०६३/६४ देखि उत्पादन र उत्पादन समयको मुल्यांकन गर्दै आएको छ । प्रारम्भिक नतिजा अनुसार वाह्य

सुन्तलाका जातहरु जस्तै ओकित्सुवासे, मियागावासे, नोभा, ओरोभल, मेरीसोल र स्थानीय जातमा खोकु स्थानीयले अगौटे र राम्रो उत्पादनको लागि उत्साहजनक परिणम दिएको पाईएको छ । गत आर्थिक बर्षमा कागतीको तेर्हथुम, सुन्तलाको खोकु स्थानीय जात पुर्वी पहाडमा खेती गर्न सिफारिस गरिएको छ । आउने बर्षमा सुन्तलाको एक जात ओकित्सुवासेलाई उन्मोचनको लागि प्रस्ताव गर्न तयारी गरीएको छ ।

- वासिगंटन नेभल जातको जुनारले राम्रो उत्पादनको लागि उत्साहजनक परिणाम दिएको छ । यो जात बेमौसमी जुनार उत्पादनको लागि राम्रो पाइएको छ । यस जातलाई उन्मोचनका लागि आगामी दिनमा प्रस्ताबको लागि सिफारिस गर्ने क्रममा छ । अन्य जातहरुमा माल्टा ब्लड रेड, डेलेसिओस सिडलेस, सुकारी र धनकुटा स्थानियको उत्पादन उत्साहजनक देखिन्छ ।
- दस वटा कागतिका जातहरु संकलन गरी बिगत २०६३/६४ देखि तराईमा परिक्षण गर्दै आएको छ । जातिय गुणको आधारमा आ.व.२०७०/७१ मा कागतिका दुई जातहरु क्रमसः सुनकागति -१ र सुनकागति -२ को नामवाट तराई, भित्रिमधेस, र बेशि क्षेत्रको लागि उन्मोचन गरीएको छ । गत आर्थिक बर्षमा कागतीको तेर्हथुम स्थानीय जात पुर्वी पहाडमा खेती गर्न सिफारिस गरिएको छ ।
- बर्षा मौसममा सुन्तालाजात बालीको कलमी बिरुवा उतपादन सम्बधि हाई-टेक नर्सरी घरमा गरिएको परिक्षणमा कागतीलाई तिनपातेको रूटस्टक प्रयोग गरि साउन महिना भर भिनियर र क्लेफ्ट तरिकाबाट कलमी गर्न उपयुक्त हुने पाईयो । तर स्थानीय जातको सुन्तलालाई सो मौसममा तिनपातेको रूटस्टकमा कलमी गर्न उपयुक्त नहुने बरू अभाना जातको सुन्तलाको कलमी सफल भएको पाईयो ।
- सुन्तलाको पोष्टहार्भेष्ट भन्डारण अवधि वढाउने सम्बन्धि अध्ययन अनुसार कुल बट भण्डारण घरमा सुन्तलाजात फलहरू भण्डारण गर्दा कम क्षती भएको पईयो । त्यस्तै मोडिफाइड प्लास्टिकमा ४-६ वटा प्वाल बनाएर सुन्तलाजात फलहरूलाई भण्डारण गर्दा लामो अवधि सम्म भण्डारण गर्न सफल भईयो । यसरी परिक्षण गर्दा ९० दिनको भन्डारणबाट थोरै मात्र तौल घटेको, राम्रो स्वाद भएको र हेडोनिक मुल्याङकनकर्ताले मन पराएको पाईयो ।
- गत आ.व.२०७७/७८ मा करिव २५०० जना कृषक र सरोकारवालाहरुलाई अनुसन्धान कार्यक्रम वारे जानकारी र प्रविधिहरु बारे सल्लाह दिईयो ।

- कलमीको लागि सुन्तला र कागतिको माउ बोटबाट स्वस्थ सायन धनकुटा जिल्लाका नर्सरी व्यवसायीहरुलाई उपलब्ध गराईयो । त्यस्तै गरी खोकु लोकल, ओकित्सुवासे सुन्तला र कागतिका तीन जातहरु जस्तै सुनकागति -१, सुनकागति - २ र तेह्रथुम लोकलका कलमी बिरुवाहरु विभिन्न जिल्लाका कृषकहरुलाई वितरण गरियो ।
- गत आ.व. २०७७/७८ मा कृषकहरुलाई वितरण गरिएका जम्मा कलमी विरुवा ३६८५० मध्ये सुन्तलाको ७६५०, जुनारको १०००, कागतिको २७२०० र अन्य १५० बिरुवाहरु थिए ।
- यस कार्यक्रमको आ.व. २०७७/७८ को लागि विनियोजित वजेट रु तीन करोड चौतिस लाख थियो जस मध्ये अनुसन्धान कार्यक्रमको लागि जम्मा एक करोड तेतिस लाख विनियोजन गरिएको थियो । बार्षिक आम्दानी रु सत्र लाख थियो जुन खासगरी फल र बिरुवा बिक्रिवाट प्राप्त भएको थियो ।

Executive summary

Citrus production is an important agriculture sub-sector which helps raise economic standard of the Nepalese farmers in mid hills and terai plains. Citrus sector has been recognized as the high value commodity having high demand in domestic as well as international market. Thus, the government of Nepal has kept citrus sector under high priority for its growth and development in the country. However, lower productivity with low quality of production has been evident from past few years. This condition is attributed to increasing invasion of various insects, diseases, nutritional deficiency, moisture stress, limited choice of varieties and inadequate sources for quality planting materials. National Citrus Research Program (NCRP) with the national mandate of developing appropriate technologies has been conducting research programs for improving situation of the citrus industry in Nepal. During the fiscal year 2077/78 (2019/20), a total of 34 activities under 8 research projects were accomplished by the program. Particularly, these research projects comprised of varietal research, nursery management, post-harvest storage, citrus decline management and fruit fly control. Most of activities were continuation of those from last year, while some of them were concluded with worthwhile outputs that are summarized below.

- A field gene bank was maintained with a total of 144 different citrus germplasms which were collected from local and exotic sources in past periods. These conserved germplasm includes mandarin orange, sweet orange, acid lime, lemon, grapefruit, tangor, tangelo and different rootstock species. A distinct variation with respect to flowering, fruiting behavior, fruit traits and morphological characteristics has been observed. Further selection is necessary to screen the best variety based on economic characters.
- As the existing cultivars of mandarin, sweet orange, acid lime and tangor had low yield, the exotic cultivars inclusive of elite local cultivars have been introduced and evaluated since 2063/64. The preliminary performances of varietal evaluation of mandarin revealed some exotic genotypes such as Miyagawase, Okitsuwase, Oraval, Page and Marisol were promising with early maturity and high fruit yield. Khoku local mandarin genotype has been registered for cultivation in eastern hills in this fiscal year. One genotype of mandarin viz., Okitsuwase is in process of being proposed for variety release based on its performance for yield and yield attributes.
- Washington navel, a variety of sweet orange had been performing more excellent in terms of higher fruit yield than those of other varieties. This genotype was noted to be suitable for off season production. This genotype is in the process of being proposed for variety release. Similarly, other

genotypes viz., Malta blood red, Delicious seedless, Succari and Dhankuta local had shown good fruit yield characteristics.

- Ten elite acid lime genotypes collected locally have been evaluated since 2063/64 in terai districts. Two acid lime varieties: Sunkagati-1 and Sunkagati-2 were released in 2014 for upland condition of terai, inner terai, foothills and river basin areas. Moreover, NCRP 107 (Terhathum local) has been registered by Variety Release Sub-committee as suitable for eastern mid-hill condition recently.
- Rainy season sapling production inside high-tech nursery house study showed that Shrawan moth and cleft and vineer method of grafting are good for acid lime and mandrin (Avana) production using trifoliate as rootstock. The time is not good for Khoku local mandarin sapling production and also patch and micro-tip method were not successful using trifoliate as rootstock during this time.
- The result of postharvest storage study showed that citrus stored in cool-bot storage has very less loss. Further modified atmospheric packaging with 4-6 hope in 25 micro plastic bags also showed better storage of fruits. There was lower weight loss and good taste and also preferred by hedonic raters after 90 days of storage.
- The result of rootstock trial for mandarin and sweet orange showed that three types of rootstocks viz., Citrange, C-35 and Citrumelo 4475 showed better performance for different morphological and yield traits.
- During the fiscal year 2077/78, technical counseling was given to 2500 farmers and other stakeholders regarding the research programs and technologies for citrus sector.
- The scion source from the mother plant of mandarin and acid lime varieties was provided to the nearby nursery entrepreneurs. Likewise, grafted saplings of Khoku local mandarin, Okitsuwase and three varieties of acid lime viz. Sunkagati-1, Sunkagati-2 and Terhathum local were provided to the farmers in different districts.
- In the fiscal year 2077/78, total of 36850 grafted saplings constituting 7650 mandarin orange, 1000 sweet orange, 27200 acid lime and 1000 other saplings were made available to farmers.
- The total annual budget approved for the program was Rs. 33.4 million, while operational budget consisted of Rs. 23.6 million to carry out research projects. The revenue was 1.7 million Rupees in the fiscal year mainly from selling fruits and saplings.

1. PROGRAMME CONTEXT

Citrus fruits in Nepal occupy an important subsector of agriculture following the congenial geography and climate. In the light of growing awareness among young generation towards commercial agro-enterprises, it might become an economically viable enterprise for them, contributing to national economy.

Nepal is noted for the production of quality mandarin and sweet orange. The sub-tropical climates of mid hill districts ranging from 800 to 1,400 masl altitude along with favorable agro-climatic condition across the country are considered quite suitable for growing citrus fruits. Moreover, the production areas with deep sandy loam soil and soil pH range of 5.0 to 6.5 are the most suitable for the cultivation of citrus. In recent years, citrus is grown commercially in 48 hill and 16 terai districts of Nepal.

The statistics shows that the area and production under citrus fruit crops are increasing during last 16 years. The current area is recorded to be 46,715 ha producing 2,74,140 metric tons with productivity of 10.03 mt/ha (Table 1), which is very low compared to the most citrus growing countries in the world. 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. Thus, there has been a huge scope of increasing the production and productivity through the use of improved technologies.

Table 1: Area, production and productivity of citrus fruits during 2003/04 to 2018/19

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

Source: MoALD, Nepal, 2021

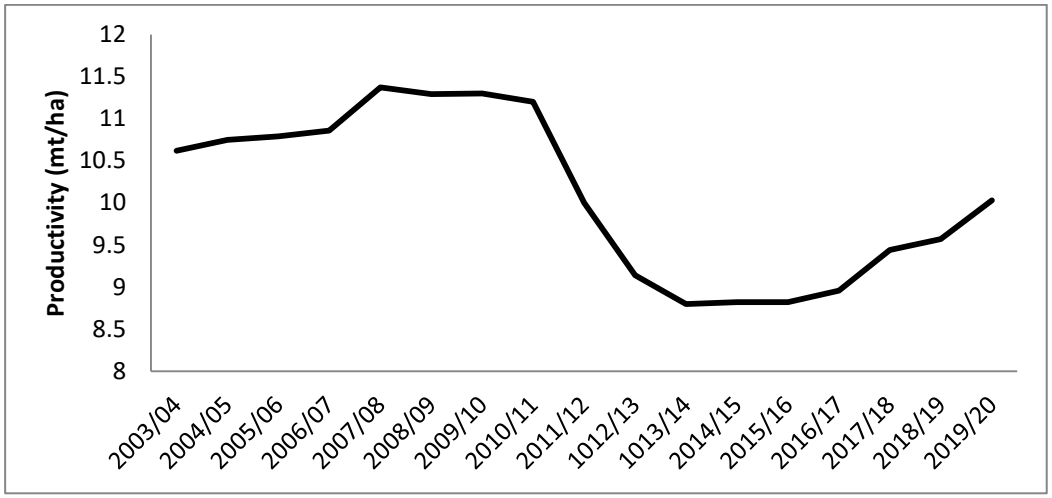

Figure 1: Productivity (mt/ha) of citrus crops during 17 years period

Table 2 highlights the total area, productive area, production and productivity of major citrus fruit crops such as mandarin orange, sweet orange, acid lime, lemon and other citrus fruit crops. In terms of total area, productive area and production; mandarin has acquired the first position with 26,591 ha, 14,551 ha, 1,56,180 mt respectively, with the the productivity of 10.73 mt/ha. On the other hand, lemon fruit acquired the lowest area (2303 ha), productive area (1489 ha), and production (11,796 mt). The the highest productivity was from sweet orange (11.58) and the lowest productivity of 6.7 mt/ha was recorded with acid lime.

Table 2: Total area, productive area, production and productivity of major citrus fruits in Nepal (2019/20)

Major citrus fruits	Total area (ha)	Productive area (ha)	Total production (mt)	Productivity (mt/ha)
Mandarin orange	26,591	14,551	156,180	10.73
Sweet orange	6,609	4,262	49,371	11.58
Acid lime	8,587	5,445	46,117	8.47
Lemon	2,303	1,489	11,796	7.92
Other citrus species	2,624	1,592	10,677	6.7
Grand Total	46,714	27,339	274,141	10.03

Source: MoALD, Nepal, 2021

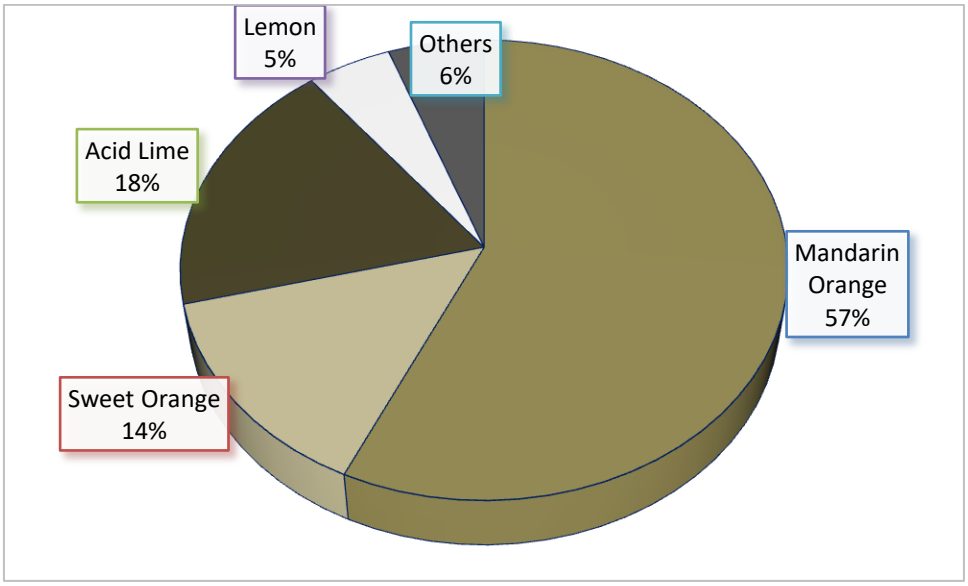

Figure 2: Total area (in percentage) of major citrus fruits in Nepal during 2019/20

The result shown in above pie-chart reveals that mandarin orange covers the maximum production area among citrus fruit. Mandarin orange covers 57.0% area among the citrus cultivated area. Similarly, acid lime, sweet orange, lemon and other citrus covers 18.0%, 14.0%, 5.0% and 6.0% respectively.

Table 3 shows the total orchard area, productive area, production and productivity of five groups of citruses based on provinces of the country. In terms of total cultivated area, productive area and production of citrus crops, regardless of respective group Province 1 has occupied the first position with 11,638 ha, 7405 ha and 72167 mt respectively, but Gandaki province has stood the first position for productivity (10.95 mt/ha) followed by Bagmati Province with 10.22 mt/ha and Karnali Province 5 with 10.1 mt/ha. Although, area, productive area and production of mandarin orange is the highest in Gandaki Province with 7,795 ha, 3,534 ha and 39266,925 mt; productivity is noted to be the highest in Lumbini (11.45 mt /ha) followed by Gandaki (11.1 mt/ha) and Karnali (10.97 mt/ha) while the lowest productivity of mandarin is in Bagmati Province (9.34 mt/ha). As for sweet orange, Province 3 has had considerably the highest area (2902 ha), productive area (1789 ha), production (24,622 mt) and productivity (13.76 mt/ha) whereas Karnali Pradesh showed the lowest productive area (177 ha) and production (920 ha). The lowest productivity was found in Gandaki Province (8.48 mt/ha). Province 1 showed considerably the maximum acid lime area (3,334 ha), productive area (2,450 ha) and production (21,549 mt). However, highest productivity for lime was recorded from Province Gandaki (13.76 mt/ha). The Province 2 reflected the lowest for acid lime in respect of area (43 ha), productive area (28 ha) and production (174 mt). In regards

with lemon fruit crop, its' total area (724 ha), productive area (548 ha), production (4,8642 mt) and productivity (8.48 mt/ha) are recorded to be highest in Bagmati pradesh. In contrast, the lowest production area, productive area and production was found in Lumbini province with 44 ha, 29 ha and 249 mt respectively. As for other citrus fruit crop, cropped area (970 ha), productive area (402 ha), production (2,836 mt) was recorded the highest in Province 1 where as productivity of (7.05 mt/ha) have been noted. The highest productivity was noted from Gandaki Province 5 (8.96 mt/ha), whereas the lowest productivity (6.62 mt/ha) was recorded from Karnali Province.

Table 3: Total area, total productive area, total production and productivity of different citrus species in different province of Nepal (2019/20)

Province	Crop	Area (ha)	Productive Area (ha)	Production (ton)	Yield (t/ha)
Province No.1	Mandarin	5,996	3,603	39,369	10.93
Province No.2	Mandarin	-	-	-	-
Bagmati Pradesh	Mandarin	4,348	2,478	23,130	9.34
Gandaki Pradesh	Mandarin	7,795	3,534	39,226	11.1
Lumbini Pradesh	Mandarin	3,089	1,791	20,507	11.45
Karnali Pradesh	Mandarin	3,617	2,118	23,240	10.97
Sudurpashchim Pradesh	Mandarin	1,746	1,027	10,708	10.43
Total	**Mandarin**	**26,591.00**	**14,551.00**	**156,180.00**	**10.73**
Province No.1	Sweet orange	837	649	6,181	9
Province No.2	Sweet orange	-	-	-	-
Bagmati Pradesh	Sweet orange	2,902	1,789	24,622	13.76
Gandaki Pradesh	Sweet orange	844	559	4,741	8.48
Lumbini Pradesh	Sweet orange	465	375	4,092	10.91
Karnali Pradesh	Sweet orange	177	97	920	9.47
Sudurpashchim Pradesh	Sweet orange	1,384	793	8,815	11.12
Total	**Sweet orange**	**6,609.00**	**4,262.00**	**49,371.00**	**11.58**
Province No.1	Lime	3,334	2,450	21,594	8.81
Province No.2	Lime	43	28	174	6.16
Bagmati Pradesh	Lime	1,277	812	6,434	7.92
Gandaki Pradesh	Lime	748	444	6,096	13.74
Lumbini Pradesh	Lime	2,012	1,153	7,649	6.63
Karnali Pradesh	Lime	546	235	1,415	6.03
Sudurpashchim Pradesh	Lime	627	323	2,755	8.52
Total	**Lime**	**8,587.00**	**5,445.00**	**46,117.00**	**8.47**
Province No.1	Lemon	502	301	2,188	7.28
Province No.2	Lemon	-	-	-	-
Bagmati Pradesh	Lemon	724	548	4,642	8.48
Gandaki Pradesh	Lemon	130	94	898	9.51
Lumbini Pradesh	Lemon	44	29	249	8.59
Karnali Pradesh	Lemon	208	126	989	7.87
Sudurpashchim Pradesh	Lemon	695	391	2,830	7.23
Total	**Lemon**	**2,303.00**	**1,489.00**	**11,796.00**	**7.92**
Province No.1	Others	970	402	2836	7.05
Province No.2	Others	-	-	-	-
Bagmati Pradesh	Others	559	462	3429	7.42
Gandaki Pradesh	Others	191	131	1175	8.96
Lumbini Pradesh	Others	814	542	2864	5.28
Karnali Pradesh	Others	16	10	68	6.62
Sudurpashchim Pradesh	Others	74	45	305	6.76
Total	**Others**	**2,624.00**	**1,592.00**	**10,677.00**	**6.7**

Source: MoALD, Nepal, 2021

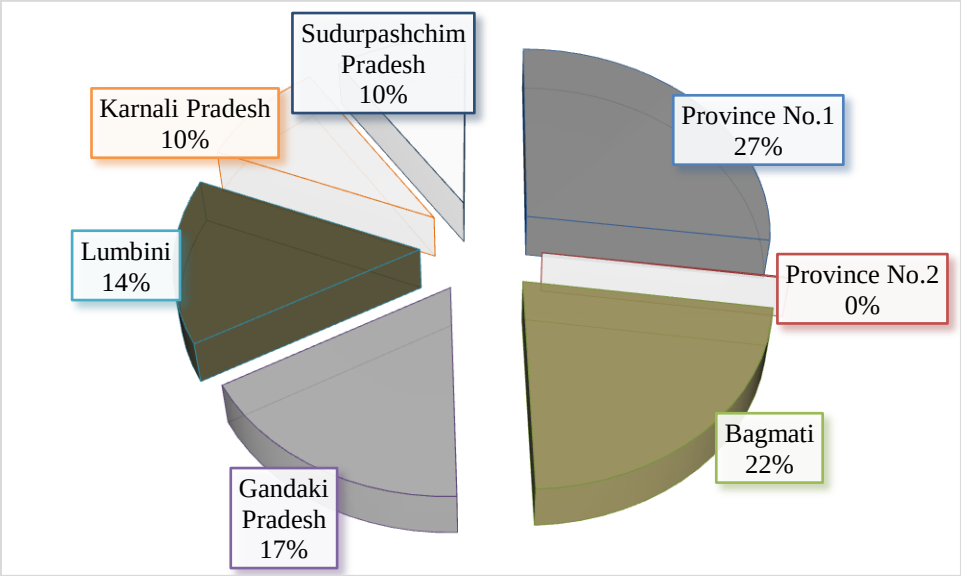

Figure 3: Total production of citrus in seven provinces during 2019/20

The pie-chart shows the status of citrus fruit production of the seven provinces of Nepal. Out of total citrus production; i.e. 274138 mt, Province 1 contributes maximum (27%) citrus production with total production of 72167 mt followed by Bagmati (62257 mt) and Gandaki province (52136 mt). There is very negligible production from citrus crops in Province 2 (174 mt). Citrus crops share about 28% of the total fruit area in Nepal. The government of Nepal has recognized mandarin and sweet orange as the potential export commodities, taking place of an initiative for exporting sweet orange in Tibet. Nevertheless, citrus industry is still facing several problems, some important are: traditional practices for crop management, short production season of existing varieties, declined soil fertility and water resources, citrus greening and fruit fly, poor quality and small production scale, poor infrastructures and legal and institutional mechanism for marketing and lack of entrepreneurship for this crop.

The domestic production meets only fewer percentage of national demand during main season that fresh as well as processed citrus worth hundred million rupees is being imported every year. Hence, Nepal holds an important potential area for commercialization of citrus sector towards import substitution and export promotion.

Majority of farmers are small scale producers characterized by small land holdings with low investing and risk bearing capacity. This is the major reason of poor crop management that requires high level of external inputs; high skills and good crop management knowledge, which are not within the capacity of most farmers. There is serious short coming on crop husbandry practices in most citrus orchards like manuring,

training/pruning, disease and pest control among others. As a result, many orchards are in declining states.

Mostly farmers have no access to the certified planting materials free of diseases including Phytophthora root rot, citrus greening, canker and tristeza virus. Similarly, there is a lack of varietal diversity for extending the production season at farmer's field. Therefore, the production of existing varieties is limited to very short period during normal season. As a result, Nepal imports mandarin, sweet orange and acid lime worth more than two hundred million annually (MoALD, 2019). Poor fruit quality due to insect pests and diseases as well as poor orchard management, and physical damage during harvest and transport are some the important aspects to be considered for the export business in the future.

These contexts bring about to many areas of research and development to be carried out, ranging from variety improvement, tree health management, integrated soil management, plant protection, postharvest handling, processing, and marketing. Eventually the sector could be transformed into commercial and export industry producing quality fruits in sizeable volume.

2. INTRODUCTION

2.1 Background

Citrus is an important subsector of Horticulture for raising economy of Nepalese farmers. Because of appropriate geography and climate, citrus is grown throughout the mid-hills (800-1400 masl) from east to west across the country. Moreover, the government of Nepal has recognized it as potential crop for income and employment generation through import substitution and export promotion.

Taking the importance of this sector into account, government of Nepal had initially established Citrus Research Station, Paripatle in 1961 (2018 B.S.). Then, it has been recognized as National Citrus Research Programme (NCRP) in 2000 (2057 B.S) under NARC with the national mandate of conducting citrus research and studies and producing & distributing healthy saplings of various citrus species. Located at Dhankuta-10, Paripatle of Dhankuta district between 27°1' north latitude and 87°18’ east longitudes with the elevation of 900-1,390 masl, the research farm occupies 20 ha area with south-east aspect. It is situated at about 8 kilometers in north-west direction from Dhankuta district headquarters in the eastern region of Nepal.

The research farm extending on 20 ha of terrace land, most of area is occupied by production orchard of major citrus species including mandarin, sweet orange and acid lime. A field gene bank has been maintained for conserving exotic as well as local citrus genotypes. Similarly, on-station varietal research plots occupy larger portion of the farm. The NCRP has seven screen houses, where mother plants of promising varieties of mandarin, sweet orange, kinnow and acid lime are maintained. It has a separate nursery block extending on three hectare, where research activities related with plant propagation and nursery production are carried out. Other infrastructures include tissue culture lab, agronomy lab and cellar store, irrigation canal and ponds. Under these narrow facilities including limited human resources, the programme has given thrust on variety improvement and selection, crop husbandry, citrus decline management, nursery management and plant propagation, citrus pest management, tissue culture for nursery production, high density planting and postharvest studies.

2.2 Goal

Contribute to increase productivity and quality production of citrus fruit crops through use of modern technologies.

2.3 Purpose

Increase economy and living standard of farmers through commercialization of citrus sector by technology advancement.

2.4 Objectives

1. To conduct research on variety, husbandry management, postharvest, disease/pest control, nursery, tissue culture and genetic resource conservation and utilization
2. To coordinate with various research and development line agencies for collaborative citrus research and development programs
3. To establish linkage with national and international citrus research organizations
4. To prioritize research areas in the country
5. To document and maintain information on citrus research and development
6. To provide technical supports and services to citrus stakeholders

2.5 Strategies

1. Conduct participatory, holistic and systematic research and studies on citrus fruit crops
2. Prioritize research areas and policy formulation based on problems and demands in citrus sector
3. Variety improvement and selection for extended harvesting season
4. Enhancing production and productivity by generating technologies
5. In-vitro technology for healthy propagation
6. Conservation and improvement of citrus genetic resources
7. Technologies advancement on citrus-based farming system
8. Marketing and export promotion of citrus industry
9. Ensuring effective dissemination and adoption of developed technologies
10. Coordination and collaboration with line agencies including farmers' communities

2.6 Responsibilities

1. Identify problems and needs of citrus sector for setting up the research areas
2. Develop appropriate technologies on different aspects of citrus fruit crops
3. Genetic resources conservation and utilization
4. Mother plant maintenance and nursery plant production
5. Out-scaling of technologies for wider impact
6. Coordinate with other national and international organizations for collaborative research and studies
7. Publications and documentation
8. Provide technical and consultancy services to the clients

2.7 Prioritized Research for upcoming years

- Integrated approach to combat citrus decline
- Postharvest processing and value addition

- Marketing and export business
- Cost effective and eco-friendly production technologies
- Integrated nutrient management
- Breeding new varieties for extended harvest period
- Biological pest and disease control
- Water use efficiency
- *In-vitro* technology for healthy propagation
- Citrus based farming system
- Socio-economic studies

2.8 Infrastructure and resources

National Citrus Research Programme (NCRP), initially established in 1961 (2018 B.S.) as Citrus Research Station, is the commodity research programs under the Nepal Agricultural Research Council (NARC) since 2000 (2057 B.S) with mandate of technology generation on citrus fruit crops at national level. NCRP has 20 ha of farm area including forest and ditch areas.

The production block of mandarin and sweet orange comprising of Khoku local and Dhankuta local varieties respectively, occupy larger area of the farmland. There are five separate blocks for varietal research of mandarin, sweet orange, acid lime, rootstock species and hybrid mandarin around the farm. Likewise, a field gene-bank is maintained for in-situ conservation of citrus species. Furthermore, a block is also established for demonstrating the released acid lime varieties including other promising lines.

For nursery propagation and research, the farm has an isolated nursery segment expanding in two-hectare area accommodating seven screen house and ne hi-tech nursery house and more than fourty nursery beds where mother-plants for various citrus species are planted. Similarly, there is well-equipped tissue culture laboratory including general laboratory-building and two glasshouses. Several irrigation ponds are set up across the farmland while one seven-hundred-meter-long pipe-fitted canal was established for irrigation.

2.9 Organization structure and human resource

NCRP is mainly constrained with a shortage of human resources for many years. Currently, the national mandated programme is working with a small team of human resource comprised of one senior scientist (1 Horticulture), two scientists, two technical officers, four support staffs and one administrative and one account staff. Thus, it seems an urgent need to fulfill the vacant positions approved by the council. The detail of the working human resource in fiscal year 2077/78 is depicted in Annex 3.

3. RESEARCH HIGHLIGHTS

3.1 VARIETAL RESEARCH

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 varieties alternative to these varieties for expanding the production period are necessary in Nepal.

NCRP, Dhankuta has introduced several exotic varieties of mandarin, sweet orange and acid lime including elite local cultivars in different periods. The performance of these genotypes has been studied for last few years in order to select and determine the appropriate varieties in different specific agro-climates.

3.1.1 FIELD GENE BANK

Collection and maintenance of genotypes is an important thrust of National Citrus Research Program. A total of 144 citrus genotypes have been collected from local and exotic sources during different periods since 2001. These are preserved at field gene bank of NCRP, Paripatle, Dhankuta. These species includes mandarin, sweet orange, acid lime, grapefruit, lemon, tangor, tangelo, and rootstock species. The exotic genotypes were introduced mainly from India, Pakistan, France, Japan and Vietnam, while local genotypes were collected from different regions of Nepal. In 2004, 39 exotic citrus varieties including 16 mandarin, 6 sweet orange, 4 grapefruit, 3 tangor, 3 tangelo, and 7 rootstock varieties were introduced from France with the support of Prf. Joseph Bove of French National Institute for Agriculture Research (INRA), CIRAD. Similarly, three dwarf varieties of Unshiu mandarin were introduced form JICA, Japan in 2001. Likewise, promising 12 varieties of sweet orange were introduced from ICAR, India during 2006. Several varieties of sweet orange, grapefruit and acid lime were collected with the support of ICIMOD, Vietnam and IAAS, Rampur during different period. Beside these, 8 new varieties comprising of 3 mandarin orange, 4 sweet orange and 1 rootstock was introduced from Australia in FY 2017/18. Similarly, 21 promising acid lime cultivars were collected from different districts and other local sources during different periods (Annex 1). These cultivars are to be screened based on fruit yield and fruiting characteristics. Preliminary characterizations of each variety were carried out and distinct variations with respect to fruiting behavior, fruit traits and morphological characteristics have been observed. Further selection is necessary to screen the best variety based on economic characters.

3.1.2. VARIETAL EVALUATION

3.1.2.1 MANDARIN

Mandarin (*Citrus reticulate* Blanco) is ah high potential fruit crop in Nepal. It is widely grown throughout the mid hills across the country. In Nepal almost all mandarin varieties are of local origin that are specific to the location and vary each other. These varieties are characterized as declining yield potential and short production period within same season. Therefore mandarin production is confined to three to four months leading to shortage for the rest of the year. A huge amount is being imported to make the national demand during other period of year.

Thus, NCRP has continued the study on the variety introduction and selection to determine appropriate varieties instead of local varieties to expand the production period. In this line, variety selection and evaluation has been continued and 19 varieties introduced from abroad and local sources have been evaluated since 2063/64.

Fruit physical parameters and yield attributing characteristics of mandarin orange

Yield attributing parameters like individual fruit weight, fruit diameter, fruit rind thickness, fruit rind weight, number of segments per fruit and number of seed per fruit were significantly different among the genotypes (Table 4).

Fruit weight (g)

Fruit weight was found varying from 87.7 g to 215 g with mean value of 124.72 g. The highest fruit weight was found in Satsumawase (215 g) followed by Pongan, Tangarine (163 g) and Satsuma URSS (162). The lowest fruit weight was found in Calamentine Mandarin Commune (83.8 g) followed by Frutrel Early (87.7 g).

Fruit diameter (mm)

Fruit diameter was found statistically different and ranged from 54.4mm to 79.4mm with mean value of 65.91 mm. The highest fruit diameter was found in Satsuma URSS (79.45 mm) followed by Okitsuwase (78 mm) and Satsumawase (76.9 mm). The lowest fruit diameter was found in Baskharka local (54.4 mm) followed by Frutrel Early (54.2 mm).

Fruit rind thickness (mm)

Fruit rind thickness was found significantly different and ranged from1.85mm to 3.89 mm with mean value of 2.67 mm. The highest fruit rind thickness was found in Kinnow (3.89 mm) followed by Frutrel Early (3.76mm). The lowest fruit rind thickness was found in Miyagawawase Unshiu (1.85mm) followed by Satsuma Okitsu (1.98mm).

Fruit rind weight (g)

Fruit rind weight was found significantly varying and ranged from 21.4 g to 57.3 g with mean value 32.5 g. The highest fruit rind weight was found in Pongan, Tangarine (57.3 g) followed by Satsuma URSS (50.9 g). The lowest fruit rind weight was found in Satsuma Okitsu (21.4g) followed by Calamantine Mandarine Commune (24.4 g).

Number of segments

The number of segments per fruit was found significantly different and ranged from 8 to 11.6 with mean value of 9.99. The maximum number of segments per fruit was found in Satsuma URSS (11.6) followed by Satsumawase (11.3) and Satsuma Okitsu (11.2). The minimum number of segments per fruit was found in Calamantine Mandarine Merisol (8) followed by Calamantine Mandarine Oroval (8.6) and Kamala (8.7).

Number of seeds per fruit

Number of seeds per fruit was found varying from 0 to 18.8 with mean value 6.6. The maximum number of seeds per fruit was found in Frutrel Early (18.8) followed by Kinnow (17.1) and Khoku (12.6). The lowest number of seeds per fruit was found in Miyagawawase Unshiu (0) followed by Okitsuwase (0) and Satsuma Okitsu (0).

Total number of fruits per tree

The total number of fruits per tree was found significantly different among the genotypes ranged from 27 to 1550 with mean value of 288.26. The highest number of fruit was found in Kinnow (1550) followed by Kamala (646) and Satsuma Mino (455). The lowest number of fruit was found in Murkotte (27) followed by Calamentine Mandarin Nulus (72) and Okitsuwase (85).

Total fruit yield per hectare

The total fruit yield per tree was found significantly different and ranged from 0.47 t/ha to 22.41 t/ha with mean value of 6.36 t/ha. The highest fruit yield was found in Kinnow (22.41 t/ha) followed by Satsuma Mino (11.59 t/ha) and Calamentine Mandarin Merisol (8.97 t/ha). The lowest fruit yield was found in Calamandarin (0.47 t/ha) followed by Murkotte (0.49 t/ha) and Calamentine Mandarin Commune (1.01 t/ha).

Table 4: Fruit physical parameters and yield attributing characteristics of mandarin at NCRP in 2020/2021

Genotypes	Fruit weight (g)	Fruit diameter (mm)	Fruit rind thickness (mm)	Fruit rind weight (g)	No. of segments	No of seed/ fruit	No. of fruits/ tree	Yield/ hectare (t/ha)
Frutrel early	87.70	55.20	3.76	30.10	10.30	18.80	271	7.17
Kamala	98.60	59.00	3.16	35.80	8.70	10.10	646	1.86
Kinnow	102.00	57.10	3.89	27.50	10.00	17.10	1550	22.41
Murkott	141.00	61.10	2.94	39.70	9.67	9.86	27	0.49
Calamentine mandarine Nules	111.00	64.70	3.56	30.50	9.40	11.85	72	1.89
Satsuma URSS	162.00	79.40	2.28	50.90	11.60	1.40	175	6.69
Baskharka local	99.40	54.40	2.10	25.00	9.48	12.32	197	8.21
Calamandarin	121.00	60.20	3.44	31.70	9.40	4.60	152	0.47
Calamentine mandarine Commune	83.80	56.60	2.86	24.40	9.00	6.60	339	1.01
Khoku	105.00	60.90	2.39	28.10	10.00	12.60	201	7.21
Calamentine mandarine Merisol	124.00	70.10	3.26	35.50	8.00	1.00	243	8.97
Satsuma Mino	96.70	67.10	2.11	18.40	10.60	0.40	455	11.59
Miyagawawase-Unshiu	139.00	68.90	1.85	27.70	10.90	0.00	240	8.30
Satsuma Okitsu	116.00	67.00	1.98	21.40	11.20	0.00	177	5.19
Okitsuwase	155.00	78.00	2.48	30.40	10.90	0.00	85	4.80
Calamentine mandarine Oroval	136.00	69.50	3.15	42.80	8.60	2.80	205	8.15
Pongan, Tangarine	163.00	70.70	3.40	57.30	11.10	4.85	201	5.12
Satsumawase	215.00	76.90	2.27	42.30	11.30	1.95	110	4.73
Sikkimesuntala	97.40	59.50	2.15	26.20	9.04	9.24	231	7.46
Mean	**124.72**	**65.91**	**2.67**	**32.50**	**9.99**	**6.60**	**288.26**	**6.36**
CV%	**4.27**	**0.82**	**1.77**	**2.13**	**0.82**	**20.95**	**27.99**	**19.50**
LSD	**58.43**	**5.97**	**0.51**	**7.60**	**0.90**	**8.51**	**496.43**	**7.46**
F-value	**	***	***	***	***	*	NS	NS

Physio –chemical properties of mandarin

Physico-chemical properties of mandarin like juice quantity, TA %, DA meter reading and citrus color index (CCI) were found significantly different at harvest among the genotypes (Table 5). DA meter is a device that measures the decline in chlorophyll content immediately below the skin during ripening. Likewise, CCI has been computed using an automatic computer vision system (spectrophotometer CM-700d). In the citrus industry CCI is used to determine the harvesting date or to decide if citrus fruits should undergo a degreening treatment. DA meter reading and CCI measurement are non-destructive method of citrus maturity/skin color measurement.

Juice %

Juice % was found significantly different among tested genotypes and ranged between 16.5% to 56.2% with mean value 41.49%. The highest juice quantity was found in

Okitusuwase (56.2%) followed by Satsuma Okitsu (55.4%) and Miyagawawase Unshiu (53.2%). The lowest juice quantity was found in Pongan, Tangarine (16.5%) followed by Murkotte (30.3%) and Kamala (30.7%).

Total soluble Solids (TSS %)

TSS % was found significantly different among the tested genotypes and varied from 6.71 % to 12.9% with mean value 9.82 %. The highest TSS % was found in Pongan, Tangarine (12.9%) followed by Kamala (12.3%) and Khoku (12.1%). The lowest TSS % was found in in genotype Satsumawase (6.71 %) followed by Satsuma Mino (7.26%).

Titrable acid (TA %)

Among the tested genotypes TA% was found significantly different and ranged from 0.58% to 1.96% with mean value 1.18%. The TA % was remarkably high in Calamentine Mandarin Oroval (1.96%). Other genotypes with higher percentage of TA were Miyagawawase Unshiu (1.62%) followed by Khoku (1.59%). Murkotte (0.58%) recorded significantly the lowest TA%. Other genotypes with lower values of TA% were Pongan, Tangarine (0.60%) and Sikkime Suntala (0.66%).

pH

The pH was found varying from 1.41 to 4.27 with mean value of 3.23. The highest pH was observed in Calamentine Mandarine Nulus (4.27) followed by Frutrel Early (4.02) and PonganTangarine (3.82). The lowest pH recorded was in Calamentine Mandarine Merisol (1.41) followed by Kinnow (2.87) and Calamentine Mandarin Oroval (2.95).

DA (chlorophyll) reading:

The decline in chlorophyll content of the fruit skin, measured on the tree by DA meter (Table 5) showed significantly different among the genotypes at harvest time. The value ranges from 0.002 to 0.508 with the mean value of 0.18. Minimum of DA reading (0.002) was recorded in Murkott and Sikkime followed by Frutrel Early (0.013) whereas, the Satsuma Mino (0.508) followed by Satsuma Okitsu (0.458) were recorded with maximum DA value among the genotypes (Table 5).

Citrus Color Index (CCI):

The CCI value for tested mandarin genotypes were significantly different with each other. Higher the CCI value means no uniform orange color development. The CCI value of the fruit ranged from 4.47 to 13.1 with the mean value of 9.36. Minimum CCI was recorded in Satsuma Okitsu followed by Satsuma Mino (5.51) and maximum was in Oroval followed by Frutrel Early (12.80).

Table 5: Physio–chemical properties of mandarin orange genotypes at NCRP in 2020/2021

Genotypes	Juice volume (%)	TSS(%)	TA %	pH	DA meter reading	Citrus Color Index (CCI)
Frutrel early	33.70	10.40	1.01	4.02	0.013	12.80
Kamala	30.70	12.30	0.93	3.24	0.016	12.70
Kinnow	31.30	11.80	1.27	2.87	0.275	7.85
Murkott	30.30	11.60	0.58	3.52	0.002	6.56
Calamentine mandarine Nules	31.80	11.30	1.49	4.27	0.289	10.50
Satsuma URSS	46.30	8.32	0.91	3.09	0.223	8.93
Baskharka local	41.10	11.40	0.72	3.45	0.117	9.15
Calamandarin	36.90	10.40	0.96	2.95	0.031	10.00
Calamentine mandarine Commune	42.20	11.40	1.29	2.97	0.176	12.80
Khoku	39.50	12.10	1.59	3.52	0.072	9.65
Calamentine mandarine Merisol	35.50	7.81	0.85	1.41	0.175	10.80
Satsuma Mino	53.10	7.26	1.34	2.98	0.508	5.51
Miyagawawase-Unshiu	53.20	7.91	1.62	3.04	0.190	7.26
Satsuma Okitsu	55.40	7.58	1.40	3.59	0.458	4.47
Okitsuwase	56.20	7.88	1.42	3.01	0.134	7.81
Calamentine mandarine Oroval	40.10	10.70	1.96	2.95	0.224	13.10
Pongan, Tangarine	16.50	12.90	0.61	3.82	0.131	12.00
Satsumawase	42.70	6.71	1.29	3.45	0.257	8.04
Sikkime suntala	42.10	11.00	0.67	3.78	0.002	10.30
Mean	**41.49**	**9.82**	**1.18**	**3.23**	**0.180**	**9.36**
CV%	**1.61**	**1.31**	**2.73**	**0.90**	**7.78**	**1.96**
LSD	**7.33**	**1.41**	**0.35**	**0.32**	**0.15**	**2.01**
F-value	***	***	***	***	***	***

3.1.2.2 SWEET ORANGE

Sweet orange (*Citrus sinensis* Osbeck) is the second most important citrus fruit after mandarin in Nepal. The major sweet orange growing districts include: Dhankuta, Khotang, Sindhuli, Parbat, Palpa and Dadeldhura.

The harvesting time of present local varieties remains only two months during December-January and beyond this period, Nepal imports fresh sweet orange fruit as well as processed fruit juice throughout the year.

Thus, NCRP has focused on variety selection of this species, so that there will be varietal diversity for expanding the fruit harvesting period beyond normal season, especially for early and late harvesting seasons. With this objective varietal evaluation of sweet orange has been continued including 23 exotic and local varieties since 2064/65.

The performance of the sweet orange genotypes being evaluated in NCRP, Paripatle are described as follows.

Fruit characteristics and yield of different genotypes of sweet oranges

Fruit characteristics and yield attributes like individual fruit weight, fruit diameter, pulp weight, number of seeds/fruit, number of fruits/tree and fruit yield/ hectare were statistically different due to the effect of different genotypes of sweet orange (Table 6).

Individual fruit weight (g)

The data in Table 7 shows that the individual fruit weight was statistically different among the tested genotypes. Fruit weight was varied from 122g to 229g with the mean value of 157.33g. Washington Navel (229g), Cara Cara Navel (205g) and Valencia Late (182g) had the biggest individual fruit sizes. Lower individual fruit sizes were recorded in Sevelle Common (122g) followed by Malta Blood Red (125g) and Delicious Seedless (127g).

Fruit diameter (mm)

Individual fruit diameter was significantly different and ranged between 62mm to 77.5mm with the mean diameter of 66.86mm. The smallest fruit diameter was observed in Hamlin (59.5mm) followed by Vanelle (61.2mm) and Sevelle Common (62mm). The biggest fruit diameter was observed in Washington Navel (77.5mm) followed by Cara Cara Novel (71.6mm).

Fruit rind thickness (mm)

Fruit rind thickness of the tested genotypes varied significantly and ranged between 2.67mm to 4.49mm with the mean thickness of 3.45mm. The thinnest rind was found in Hamlin (2.67mm) followed by Tamango (2.72mm). The thickest rind was found in Valencia Late (4.49mm) followed by Lane Late (3.81mm).

Fruit rind weight (gm)

The rind weight differed significantly among the tested genotypes and ranged between 72.4gm to 159gm with mean value 101.01gm.Washington Navel (159g) gave the most fruit rind weight followed by Cara Cara Novel (131g) and Valencia Late (122g). Lower fruit rind weights were observed in Sevelle Common (72.4g), Delicious Seedless (73.7 g) and Malta Blood Red (76.3 g).

Number of seeds per fruit

The number of seeds per fruit differed significantly among tested genotypes and ranged from 0.08 to 20.6 with the mean value of 4.7. Succari (20.6) had the highest number of seeds per fruit followed by Pineapple (8.76). In contrast, number of seeds per fruit was found minimum with Lan Late (0.08) followed by Washington Navel (0.4).

Fruit number per tree

The number of fruits/plant was significantly different and ranged from 10 to 450 with the mean value of 105. Lue Gim Gong (450) recorded the highest number of fruit/plant followed by Delicious Seedless (204) and Cara Cara Novel (195). Genotype like Navelencia (10), Vanelle (20) and Pineapple (23) were found to produce significantly lower number of fruits per plant.

Fruit yield per hectare

The difference in total weight of fruit/hectare was highly significant among the tested genotypes and ranged between 0.06t/ha and 18.704t/ha with a mean value of 5.05 t/ha. Lue Gim Gong (18.704) gave the highest yield/ha followed by Cara Cara Novel (13.784 t/ha) and Delicious Seedless (11.148 t/ha). Navelencia (0.06 t/ha) produced the least fruit yield per hectare followed by Vanelle (0.816 t/ha) and Pineapple (0.972t/ha). Total fruit yield per tree was influenced due to the repeated hailstone in orchard area in 2020/21.

Table 6: Fruit characteristics of different sweet orange genotypes at NCRP in 2020/2021

Genotypes	Fruit weight (g)	Fruit diameter (mm)	Fruit rind thickness (mm)	Fruit rind weight (g)	No. of seed/ fruit	No of fruit/ tree	Fruit yield/ hectare (t/ha)
Malta Blood Red	125	62.10	3.42	76.30	4.80	27	1.40
Cara Cara Novel	205	71.60	2.98	131.00	0.533	195	13.78
Delicious Seedless	127	66.00	3.23	73.70	3.55	204	11.14
Hamlin	136	59.50	2.67	78.50	6.00	120	6.21
Lane Late	172	69.40	3.81	110.00	0.08	90	5.51
LueGim Gong	144	64.70	3.73	91.50	4.07	450	18.70
Navelencia	130	63.50	3.66	79.50	5.40	10	0.06
PineApple	162	68.30	3.61	114.00	8.76	23	0.97
Salustiana	133	63.90	3.50	90.00	1.89	65	2.42
Sevelle Common	122	62.00	3.78	72.40	5.10	70	3.86
Succari	131	64.10	2.84	77.70	20.60	80	1.50
Tamango	138	63.30	2.72	84.60	2.95	53	2.56
Valencia Late	182	71.00	4.49	122.00	3.51	58	2.42
Vanelle	151	61.20	3.29	84.80	5.90	20	0.81
Washington Navel	229	77.50	3.77	159.00	0.40	110	4.84
Mean	**157.33**	**66.86**	**3.45**	**101.01**	**4.70**	**105**	**5.08**
cv%	**11.61**	**5.55**	**10.25**	**14.21**	**5.21**	**87.57**	**78.65**
LSD	**26.14**	**5.30**	**0.50**	**20.53**	**2.19**	**140.46**	**6.10**
P-value	***	***	***	***	***	*	**

Physiochemical properties of different genotypes of sweet orange

Physico-chemical properties of sweet orange like juice quantity, TA %, DA meter reading and citrus color index (CCI) were found significantly different at harvest among the genotypes (Table 7). DA meter is a device that measures the decline in chlorophyll content immediately below the skin during ripening. Likewise, CCI has been computed using an automatic computer vision system (spectrophotometer CM-700d). In the citrus industry CCI is used to determine the harvesting date or to decide if citrus fruits should undergo a degreening treatment. DA meter reading and CCI measurement are non-destructive method of citrus maturity/skin color measurement.

Fruit juice Volume (%)

The volume of fruit juice was significantly different among test genotypes and ranged between 35.8ml to 64.1 ml with average value of 50.11ml. Cara Cara Novel (64.1ml) was found to give the highest juice volume followed by Valencia Late (58.6ml) and Washington Navel (58.2ml). Similarly, Navelencia (35.8ml), Salustiana (39.7ml) and Malta Blood Red (41.7) produced low fruit juice volume (Table 8).

Juice Weight (g)

Fruit juice weight ranged from 36.1g to 66.4gwith an average fruit juice weight of 51.03g. The highest fruit juice weight was recorded with genotype Cara Cara Novel (66.4g) followed by Lane Late (61.5g) and Valencia Late (59.2g). Lower fruit juice weight was found in genotype Navelencia (36.1g) followed by Salustiana (40g) and Malta Blood Red (41.7g).

Total soluble Solids % (TSS %)

Among the tested genotypes the percent TSS varied from 9.52% to 13.9%with the mean value of 11.2%. TSS% was found significantly higher in Succari (13.9%) and Pineapple (12.3%). Lower TSS% values were observed in Malta Blood Red (9.52%) and Salustiana (9.58%).

Titrable acid% (TA %)

Among the tested genotypes percent of TA ranged from 1.3% to 2.6% with mean value of 1.81%. The TA percent was remarkably high in Navelencia (2.6%) followed by Sevelle Common (2.58%) and Lue Gim Gong (2.07%). Succari (1.3%) recorded significantly the lowest TA followed by Valencia Late (1.68%) and Salustiana (1.68%).

pH

The pH was found varying from 2.73 to 4.51 with average of 3.18. The highest pH was observed in Succari 4.51 followed by Washington Navel (3.44) and Lane Late (3.37).

The lowest pH recorded was in Lue Gim Gong (2.69) followed by Sevelle Common (2.73) and Navelencia (2.73).

DA (chlorophyll) reading:

The decline in chlorophyll content of the fruit skin, measured on the tree by DA meter (Table 7), showed significantly different among the genotypes at harvest time. The values ranges from 0 to 0.048. Minimum of DA reading was recorded in Vennele, Blood Red and Pineapple whereas the Salustiana (0.048) followed by Sevelle Common (0.044) were recorded with maximum DA value among the genotypes.

Citrus Color Index (CCI):

The CCI value for tested sweet orange genotypes were significantly different with each other. Higher the CCI value means no proper color development. The CCI value of the fruit ranged from Highest 6.06 to 9.98 with the mean value of 7.88. Minimum CCI was recorded in Washington Navel followed by Succari (7.17) and maximum was in Valencia Late followed by Pineapple (9.61).

Table 7: Physio-chemical properties of different sweet orange genotypes at NCRP in 2020/2021

Genotypes	Juice volume (%)	Juice wt(g)	TSS(%)	TA(%)	pH	DA meter reading	CCI
Malta Blood Red	33.30	41.70	9.52	1.86	3.20	0	7.53
Cara Cara Novel	31.60	66.40	11.30	1.81	3.25	0.015	9.27
Delicious Seedless	38.50	49.60	11.50	1.81	3.06	0.007	8.03
Hamlin	36.00	48.70	11.90	1.99	2.85	0.013	7.38
Lane Late	33.10	61.50	12.10	1.73	3.37	0.007	7.81
LueGim Gong	32.50	46.90	9.65	2.07	2.69	0.007	7.41
Navelencia	27.50	36.10	11.30	2.60	2.73	0.001	7.33
PineApple	30.40	49.80	12.30	1.80	3.35	0.000	9.61
Salustiana	29.80	40.00	9.58	1.68	3.18	0.048	8.36
Sevelle Common	34.90	42.90	10.70	2.58	2.73	0.044	7.69
Succari	34.50	45.70	13.90	1.30	4.51	0.001	7.17
Tamango	35.30	49.30	10.70	1.75	2.97	0.001	7.70
Valencia Late	32.30	59.20	10.50	1.68	2.78	0.012	9.98
Vanelle	32.40	48.50	11.30	1.91	2.80	0.000	7.55
Washington Navel	25.30	58.60	10.40	1.78	3.44	0.021	6.66
Mean	32.33	51.03	11.20	1.81	3.18	**0.01**	**7.88**
cv%	1.21	13.11	8.21	10.47	3.60	**39.19**	**2.93**
LSD	3.50	9.57	1.31	0.27	0.16	**0.062**	**2.93**
P-value	***	***	***	***	***	***	*

3.1.2.3 ACID LIME

Acid lime (*Citrus aurantifolia* Swingle) is an important fruit crop of commercial value, ranking third after mandarin and sweet orange in Nepal. Traditionally, acid lime cultivation was limited to range of 800-1400 masl in mid hill districts with production of small volume and confined to short time duration (September-November). Due to the changes in feeding habit and being more conscious about health benefits (Vitamin C) of acid lime consumption, the demand of the fruit has increased dramatically. As the domestic production is far below to meet the demand, Nepal imports more than 90% of fresh lime fruit in the country every year. Moreover, the cultivation practice is attributed to marginal land with poor yielding varieties. Similarly, the potential of cultivating range could be much wider from 125 to 1400 masl in Nepal. After the release of two acid lime varieties viz. Sunkagati-1 and Sunkagati-2 for terai region in 2072 B.S., the cultivation area of acid lime has increased significantly. These two varieties are becoming popular among acid lime cultivating farmers in Terai region of Nepal.

Acid lime production status for the year 2077/78 could not be made because of the damage to fruit by repeated hailstone in the farm area.

3.1.2.4 GRAPEFRUIT AND TANGELO

There are five accessions of grapefruit and three accessions of tangelo under bearing stage and are presented in the Table 8, 9 and Table 10, 11 respectively.

Table 8: Fruit physical parameters and yield attributing characteristics of grapefruit genotypes at NCRP in 2077/78

Variety	Fruit wt. (g)	Peel thickness (mm)	Pulp wt. (g)	Fruit diameter (mm)	No. of seed/fruit	Juice volume per fruit (ml)	Fruit number/ tree	Fruit yield/tree (g)
Shamber	262±20.7	6.4±0.39	180±16.4	85.1±1.8	0	70.9±8.11	106	18545
Henderson	241±12.9	4.04±0.13	149±8.01	83.5±1.29	4.05±0.42	83.5±4.54	105	16503
Star Ruby	220±19.1	4.47±0.19	139±10.5	77.6±2.35	4.3±0.47	73.3±7.68	50	8795
Reed	934±108	5.49±0.95	636±78.9	125±5.79	29.7±11.6	274±29.7	10	7270
Pink Rubi	266±23.8	5.6±0.23	176±15.7	85.2±2.09	3.4±0.82	82.4±9.28	110	23576

Table 9: Physico-chemical properties of grapefruit genotypes at NCRP in 2077/78

Variety	Juice wt. (g)	TSS%	TA%	pH	DA meter reading	Citrus Color Index (CCI)
Shamber	75.6±8.07	9.65±0.611	2.99±0.12	2.56±0.03	0.098±0.03	1.64±0.13
Henderson	83.2±4.34	9.78±0.147	2.97±0.08	2.46±0.01	0.127±0.02	3.01±0.26
Star Ruby	73.4±7.77	10.4±0.183	3.51±0.11	2.44±0.02	0.125±0.05	3.88±0.13
Reed	278±29.3	11.9±0.249	2.74±0.29	2.76±0.04	0.078±0.06	1.9±0.27
Pink Rubi	82.9±9.21	8.44±0.555	2.81±0.15	2.66±0.03	0.371±0.09	2.42±0.12

Table 10: Fruit physical parameters and yield attributing characteristics of tangelo genotypes at NCRP in 2077/78

Variety	Fruit wt (g)	Peel thickness (mm)	Pulp wt. (g)	Fruit diameter mm	Seed/fruit	Juice volume per fruit (ml)	Fruit number/ tree	Fruit yield/ tree (g)
Minneola	154±11.3	2.84±0.08	33.7±1.86	65.9±1.87	11.5±1.29	60±4.9	112	11210
Oriando	80.4±7.17	2.99±0.09	23.5±1.85	56.3±2.07	5.6±1.44	25.4±2.11	21	1810
Seminole	150±8.6	2.24±0.19	34.7±3.53	66.1±0.81	11.6±2.86	70.6±3.31	20	2820

Table 11: Physico-chemical properties of tangelo genotypes at NCRP in 2077/78

Variety	Juice wt. (g)	Pal brix	TA	pH	DA meter reading	Citrus Color Index (CCI)
Minneola	60.6±4.94	10.1±0.232	2.02±0.10	2.96±0.03	0.0182±0.01	20±0.93
Oriando	25.7±2.15	9.86±0.273	2.05±0.09	2.88±0.19	0.012±0.01	13.8±0.95
Seminole	70.7±3.27	9.82±0.107	2.75±0.1	2.64±0.03	0.026±0.01	15.5±0.82

3.2 POST-HARVEST RESEARCH

3.2.1 Effect of different holes in plastic on enhancing storage life of sweet orange (var. Dhankuta Local) in cellar store and coolbot storage.

Citrus fruits are cultivated all over the world in tropical and sub tropical region having suitable soil and climatic conditions. Mid hills of Nepal ranging from 800 to 1400 masl altitude all across the country are considered favourable for all types of citrus fruits cultivation. However, pumelo, acid lime and lemon can be cultivated successfully in upland condition of terai, inner terai, foothills and river basin areas of Nepal. Citrus crops cover about 30% of the total area under fruit cultivation. Citrus crops are potential exportable commodities particularly to India, Bangladesh and China. At present, major citrus producing districts of Nepal having more then 1000-hectare area under cultivation

are Taplejung, Terathum, Dhankuta, Ramechhap, Sindhuli, Kavrepalanchowk, Lamjung, Syangja, Salyan and Dailekh.

Citrus production and international trade in fresh citrus have increased manifold during the last decade. World citrus production is around 73.3 million metric tons, with Brazil being largest producer, while European Union being the largest importer of citrus (Anonymous, 2004; FAO, 2003). Although citrus production in many citrus growing countries has increased, the overall profitability of the industry in developing countries has been limited by high post harvest losses due to the lack and use of proper post harvest handling system of fresh fruit. From sustainability and economic prospective, there will be less investment needed to improve the situation through better post harvest management of existing produced and the production area to compensate for these losses (Kader, 2002).

Methodology

The experiment was carried out to identify suitable plastic holes to enhance storage life of sweet orange (var. Dhankuta Local) at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2077/2078. Cellar store and coolbot store house constructed at NCRP were used for the experiment. The experiment was carried out in completely randomized block design and was given five treatments and replicated thrice.
The treatments given are stated below:
T1: tray (Open)
T2: Plastic bag (2 holes)
T3: Plastic bag (4 holes)
T4: Plastic bag (6 holes)
T5: Plastic bag (8 holes)

The observations were taken on physiological weight loss in percentage (PLW %), juice content (%), TSS, TA and pH. Specifications for storage was more than 85% RH and temperature ranged from 10-12 ºC. The fruits were surface sterilized with distilled water which then was dipped in 4% $CaCl_2$ dip for 4 minutes before storage for better protection against post harvest storage pathogens. Then they were packed in plastic bags (25 microns, Length: 22 cm, Breadth: 15.5 cm, rubber band at one end, sealed at the other).

Result and Discussion

The experiment was carried out to identify suitable plastic holes to enhance storage life of sweet orange (var. Dhankuta Local) at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2077/2078. All the treated fruits were stored in cellar and coolbot store for 58 days and observation on different parameters were taken four times at 15,30,44 and 58

days at 15 days interval. 30 fruits were initially taken for each treatment and subjected to observation at 15 days interval for all parameters.

Table 12 illustrate that there were no any significant difference on physiological weight loss in percentage (PLW %). The minimum loss percentage was found in 4 holes (-18.3%) in 58 days of storage. Similarly, the minimum loss percentage was found in open (tray) (7.2%) for up to 15 days of storage followed by 2 holes (7.38%) for up to 15 days of storage in cellar store.

Table 12: Effect of postharvest treatments on physiological loss weight percentage (%) of sweet orange (var. Dhankuta Local) fruit during storage at cellar store in FY 2077/2078.

	Physiological loss weight on days indicated (%)			
Treatments	**15 days**	**30 day**	**44 days**	**58 days**
Open (tray)	7.20	15.50	23.00	67.70
2 holes	7.38	12.30	14.00	25.30
4 holes	20.90	26.60	34.70	-18.30
6 holes	27.50	29.90	48.90	50.90
8 holes	23.20	14.50	13.10	29.70
Grand Mean	**17.22**	**19.79**	**26.74**	**31.05**
CV%	**17.39**	**25.36**	**37.27**	**67.51**
LSD	**11.67**	**19.56**	**38.86**	**81.72**
P-value	**NS**	**NS**	**NS**	**NS**

Table 13 illustrates that juice volume percentage (%) was found significantly different ranging from 27.27 to 41.87 with mean value of 34.72 at 30 days and there was no any significant difference in other days among various treatments in any storage duration in cellar. Maximum juice volume percentage was found in 8 holes (41.87%) up to 30 days of storage followed by 4 holes (37.92%) up to 44 days of storage.

Table 13: Effect of postharvest treatments on juice volume percentage (%) of sweet orange (var. Dhankuta Local) fruit during storage at cellar store in FY 2077/2078.

	Juice volume percentage (%)			
Treatments	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	31.90	27.27	36.39	32.45
2 holes	33.43	33.51	31.97	31.91
4 holes	32.48	33.88	37.92	32.87
6 holes	36.08	36.16	34.66	31.48
8 holes	29.31	41.87	34.37	30.11
Grand Mean	**32.67**	**34.72**	**35.09**	**31.78**
CV%	**5.14**	**2.33**	**4.29**	**1.34**
Lsd	**6.55**	**3.15**	**5.87**	**1.66**
P-value	**NS**	******	**NS**	**NS**

Table 14 illustrates that there was no significant difference in TSS among various treatments in any storage duration in cellar. Maximum TSS was found in 6 holes (9.85°Brix) up to 44 days of storage. Similarly, maximum TSS was found in in 4 holes (9.78 °Brix) up to 44 days of storage followed by open(tray) (9.63 °Brix) upto 30 days of storage**.**

Table 14: Effect of postharvest treatments on TSS of sweet orange (var. Dhankuta Local) fruit during storage at cellar store in FY 2077/2078.

	TSS (°Brix)			
Treatments	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	9.40	9.63	7.87	5.93
2 holes	8.93	9.70	9.57	5.69
4 holes	8.82	7.78	9.78	6.21
6 holes	8.47	8.93	9.85	5.68
8 holes	9.28	9.07	9.40	5.25
Grand Mean	**8.98**	**9.02**	**9.26**	**9.47**
CV%	**2.61**	**5.28**	**4.77**	**3.56**
Lsd	**0.91**	**1.85**	**1.72**	**1.31**
P-value	**NS**	**NS**	**NS**	**NS**

Table 15 illustrates that there was no significant difference in TA% among various treatments in any storage duration in cellar store. Minimum TA% was found in open (tray) (1.86%) upto 58 days of storage. Similary minimum TA% was found in 8 holes (1.91%) followed by 6 holes (1.93%) up to 30 days of storage in cellar store.

Table 15: Effect of postharvest treatments on TA of sweet orange (var. Dhankuta Local) fruit during storage at cellar store in FY 2077/2078.

	TA			
Treatments	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	2.14	2.07	2.13	1.86
2 holes	2.35	1.70	2.75	1.98
4 holes	2.17	2.56	2.27	2.08
6 holes	2.10	1.93	1.97	2.31
8 holes	2.66	1.91	1.95	1.96
Grand Mean	**2.28**	**2.03**	**2.21**	**2.03**
CV%	**5.67**	**10.51**	**8.15**	**4.93**
Lsd	**0.50**	**0.83**	**0.70**	**0.39**
P-value	**NS**	**NS**	**NS**	**NS**

Table 16 illustrates that there was no significant difference in pH among various treatments in any storage duration in cellar store. Minimum pH was found in 2 holes (2.85) followed by 4 holes (2.85) up to 44 days of storage in cellar store. Similary, maximum pH was found in open (tray) (4.51) followed by 8 holes (4.11) up to 15 days of storage in cellar store.

Table 16: Effect of postharvest treatments on pH of sweet orange (var. Dhankuta Local) fruit during storage at cellar store in FY 2077/2078.

	pH			
Treatment	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	4.51	3.20	2.97	2.90
2 holes	3.81	3.10	2.85	3.05
4 holes	4.20	3.15	2.85	3.00
6 holes	4.13	3.15	3.00	2.85
8 holes	4.11	3.30	2.95	2.95
Grand Mean	**4.15**	**3.18**	**2.92**	**2.95**
CV%	**3.84**	**1.35**	**1.52**	**1.75**
Lsd	**0.62**	**0.16**	**0.17**	**0.20**
P-value	**NS**	**NS**	**NS**	**NS**

Table 17 illustrate that there were no any significant difference on physiological weight loss in percentage (PLW %). The minimum loss percentage was found in open (tray) (0.21%) followed by 2 holes (0.22%) upto 15 days of storage. Similarly, the maximum loss percentage was found in 8 holes (19.5%) for up to 44 days of storage followed by 6 holes (13.1%) for up to 58 days of storage in coolbot store.

Table 17: Effect of postharvest treatments on physiological loss in weight percentage (%) of sweet orange (var. Dhankuta Local) fruit during storage at coolbot store in FY 2077/2078

	Physiological loss weight on days indicated (%)			
Treatments	**15 days**	**30 day**	**44 days**	**58 days**
Open (tray)	0.21	8.19	7.28	8.10
2 holes	0.22	10.30	8.63	14.70
4 holes	0.41	9.87	11.90	8.73
6 holes	0.46	15.00	8.45	13.10
8 holes	3.63	10.80	19.50	11.50
Grand Mean	**0.98**	**10.83**	**11.15**	**11.22**
CV%	**65.33**	**12.25**	**18.95**	**16.03**
Lsd	**2.52**	**5.17**	**8.24**	**7.01**
P-value	**NS**	**NS**	**NS**	**NS**

Table 18 illustrates that there was no any significant difference on juice volume percentage (%). The maximum juice volume (%) was found in open (tray) (37.57%) up to 15 days of storage followed by 8 holes (34.89%) and 4 holes (31.68%) up to 44 days of storage in coolbot store.

Table 18: Effect of postharvest treatments on juice volume percentage (%) of sweet orange (var. Dhankuta Local) fruit during storage at coolbot store in FY 2077/2078.

	Juice volume (%)			
Treatment	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	37.57	25.48	27.81	23.60
2 holes	30.25	22.73	33.33	27.78
4 holes	29.69	26.61	31.68	26.85
6 holes	30.63	25.68	31.37	27.27
8 holes	28.81	30.77	34.89	28.36
Grand Mean	**31.38**	**26.26**	**31.81**	**26.77**
CV%	**4.87**	**4.23**	**3.81**	**2.97**
Lsd	**5.96**	**5.17**	**4.73**	**3.10**
P-value	**NS**	**NS**	**NS**	**NS**

Table 19 illustrates that there was no significant difference in TSS among various treatments in any storage duration in coolbot. Maximum TSS was found in 8 holes (10.3 °Brix) up to 44 days of storage. Similarly, maximum TSS was found in in 2 holes (9.65 °Brix) up to 30 days of storage followed by 2 holes (9.45°Brix) and 6 holes (9.45 °Brix) upto 15 days of storage**.**

Table 19: Effect of postharvest treatments on TSS of sweet orange (var. Dhankuta Local) fruit during storage at coolbot store in FY 2077/2078.

	TSS (°Brix)			
Treatments	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	8.60	8.97	7.65	5.73
2 holes	9.45	9.65	9.55	5.78
4 holes	8.93	8.90	9.10	5.97
6 holes	9.45	8.18	9.38	6.21
8 holes	8.80	8.28	10.3	5.96
Grand Mean	**9.04**	**8.79**	**9.19**	**9.66**
CV%	**2.81**	**2.94**	**3.88**	**2.32**
Lsd	**0.99**	**1.00**	**1.39**	**0.87**
P-value	**NS**	**NS**	**NS**	**NS**

Table 20 illustrates that TA% was found significantly different ranging from 1.88% to 2.39% with mean value of 2.12% at 30days of storage and there was no any significant difference in other days among various treatments in any storage duration in coolbot store. Minimum TA% was found in open (tray) (1.88%) up to 30 days of storage. Similary minimum TA% was found in 8 holes (1.89%) up to 15 days followed by 4 holes (1.99%) up to 44 days of storage in coolbot store.

Table 20: Effect of postharvest treatments on TA of sweet orange (var. Dhankuta Local) fruit during storage at coolbot store in FY 2077/2078.

	TA			
Treatments	**Day 15**	**Day 30**	**Day 44**	**Day 58**
Open (tray)	2.11	1.88	2.35	2.01
2 holes	2.17	2.00	2.09	2.46
4 holes	2.25	2.06	1.99	2.13
6 holes	2.08	2.30	2.10	2.17
8 holes	1.89	2.39	2.23	2.22
Grand Mean	**2.10**	**2.12**	**2.15**	**2.2**
CV%	**3.37**	**1.17**	**4.09**	**4.95**
Lsd	**0.27**	**0.09**	**0.34**	**0.42**
P-value	**NS**	******	**NS**	**NS**

Table 21 illustrates that pH was found significantly different ranging from 2.9 to 3 with mean value of 2.94 at 44days of storage and there was no any significant difference in other days among various treatments in any storage duration in coolbot store. Minimum pH was found in 6 holes (2.9) followed by 8 holes (2.9) up to 44 days of storage in

coolbot store. Similary, maximum pH was found in 8 holes (4.16) followed by open (tray) (4.03) up to 15 days of storage in coolbot store.

Table 21: Effect of postharvest treatments on pH of sweet orange (var. Dhankuta Local) fruit during storage at coolbot store in FY 2077/2078.

	pH			
Treatment	**Days 15**	**Days 30**	**Days 44**	**Days 58**
Open (tray)	4.03	3.15	3.00	3.05
2 holes	3.79	3.30	2.95	3.05
4 holes	3.06	3.25	2.95	2.95
6 holes	3.35	3.20	2.90	2.95
8 holes	4.16	3.25	2.90	2.95
Grand Mean	**3.67**	**3.23**	**2.94**	**2.99**
CV%	**8.39**	**1.13**	**0.31**	**0.61**
Lsd	**1.20**	**0.14**	**0.03**	**0.07**
P-value	**NS**	**NS**	*****	**NS**

3.2.2 Effect of different holes in plastic on enhancing storage life of Mandarin (Khoku local) in cellar store and coolbot storage.

Methodology

The experiment was carried out to identify suitable plastic holes to enhance storage life of mandarin (var. Khoku Local) at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2077/2078. Cellar store, coolbot store and normal room house constructed at NCRP were used for the experiment. The experiment was carried out in completely randomized block design and was given five treatments and replicated thrice.

The treatments given are stated below:

T1: tray (Open)
T2: Plastic bag (2 holes)
T3: Plastic bag (4 holes)
T4: Plastic bag (6 holes)
T5: Plastic bag (8 holes)

The observations were taken on physiological weight loss in percentage (PLW %), juice content (%), TSS, TA and pH. Specifications for storage was more than 85% RH and temperature ranged from 10-12 ºC. The fruits were surface sterilized with distilled water which then was dipped in 4% $CaCl_2$ dip for 4 minutes before storage for better protection against post harvest storage pathogens. Then they were packed in plastic bags of dimension (32.5cm*26cm) 20 microns, rubber band at one end, sealed at the other).

Result and Discussion

The experiment was carried out to identify suitable plastic holes to enhance storage life of mandarin (var. Khoku Local) at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2077/2078. All the treated fruits were stored in cellar, normal room and coolbot store for 44 days and observation on different parameters were taken three times at 15,29 and 44 days at 15 days interval. 30 fruits were initially taken for each treatment and subjected to observation at 15 days interval for all parameters.

Table 22 illustrate that there were no any significant difference on physiological weight loss in percentage (PLW %). The minimum loss percentage was found in 2 holes (7.31%) in 29 days of storage. Similarly, the minimum loss percentage was found in 6 holes (8.71%) in 29 days of storage followed by open (tray) (9.24%) for up to 29 days of storage in cellar store.

Table 22: Effect of postharvest treatments on physiological loss weight percentage (%) of Mandarin (var.Khoku Local)) fruit during storage at cellar store in FY 2077/2078

	Physiological loss weight (%)		
Treatment	**Day 15**	**Day 29**	**Day 44**
Open (tray)	21.70	9.24	9.86
2 holes	22.60	7.31	21.20
4 holes	19.60	13.10	15.00
6 holes	17.90	8.71	15.10
8 holes	18.60	10.20	14.60
Grand mean	**20.10**	**9.72**	**15.19**
cv%	**8.25**	**11.59**	**15.55**
Lsd	**9.14**	**6.20**	**12.97**
P-value	**NS**	**NS**	**NS**

Table 23 illustrates that there was no any significant difference on juice volume percentage (%). The maximum juice volume (%) was found in 2 holes (37.9%) up to 15 days of storage followed by 6 holes (34.9%) in 15 days and 6 holes (34.8%) up to 44 days of storage in cellar store.

Table 23: Effect of postharvest treatments on juice volume percentage (%) of Mandarin (var. Khoku Local) fruit during storage at cellar store in FY 2077/2078.

	Juice volume (%)		
Treatment	**Day 15**	**Day 29**	**Day 44**
Open (tray)	27.90	20.40	25.20
2 holes	37.90	31.30	28.00
4 holes	32.40	28.10	30.00
6 holes	34.90	29.00	34.80
8 holes	33.00	27.20	28.00
Grand mean	**33.22**	**27.22**	**29.20**
cv%	**4.14**	**5.36**	**4.91**
Lsd	**7.59**	**8.04**	**7.89**
P-value	**NS**	**NS**	**NS**

Table 24 illustrates that TSS °Brix was found significantly different ranging from 12.1 °Brix to 13.1°Brix with mean value of 12.68°Brix at 44 days of storage and there was no any significant difference in other days among various treatments in any storage duration in cellar store. Maximu TSS °Brix was found in open (tray) (13.2°Brix) up to 15 days of storage. Similary minimum TSS °Brix was found in 6 holes (11.5°Brix) up to 15 days followed by 4 holes (11.8°Brix) up to 15 days of storage in cellar store.

Table 24: Effect of postharvest treatments on TSS of Mandarin (var. Khoku Local) fruit during storage at cellar store in FY 2077/2078.

	TSS °Brix		
Treatment	**Day 15**	**Day 29**	**Day 44**
Open (tray)	13.20	12.90	13.10
2 holes	12.60	12.80	12.90
4 holes	11.80	12.40	12.60
6 holes	11.50	12.30	12.80
8 holes	12.60	13.00	12.10
Grand mean	**12.33**	**12.66**	**12.68**
cv%	**1.32**	**0.88**	**0.97**
Lsd	**0.90**	**0.61**	**0.67**
P-value	**NS**	**NS**	*****

Table 25 illustrates that TA% was found significantly different ranging from 1.42% to 1.64% with mean value of 1.5% at 44 days of storage and there was no any significant difference in other days among various treatments in any storage duration in cellar store. Minimum TA% was found in 8 holes (1.21%) upto 15days of storage. Similary

minimum TA% was found in 6 holes (1.23%) up to 15 days followed by 2 holes (1.34%) up to 15days of storage in cellar store.

Table 25: Effect of postharvest treatments on TA of Mandarin (var. Khoku Local) fruit during storage at cellar store in FY 2077/2078.

	TA %		
Treatment	**Day 15**	**Day 29**	**Day 44**
Open (tray)	1.47	1.64	1.64
2 holes	1.34	1.50	1.49
4 holes	1.53	1.63	1.45
6 holes	1.23	1.56	1.53
8 holes	1.21	1.33	1.42
Grand mean	**1.35**	**1.53**	**1.50**
cv%	**5.22**	**3.05**	**1.58**
Lsd	**0.39**	**0.25**	**0.13**
P-value	**NS**	**NS**	*****

Table 26 illustrates that pH was found significantly different ranging from 3.49 to 3.82with mean value of 3.64 at 44days of storage and there was no any significant difference in other days among various treatments in any storage duration in cellar store. Minimum pH was found in 4 holes (3.09) followed by open (tray) (3.1) up to 15 days of storage in cellar store. Similary, maximum pH was found in 8 holes (3.82) followed by 4 holes (3.72) up to 44 days of storage in cellar store.

Table 26: Effect of postharvest treatments on pH of Mandarin (var. Khoku Local) fruit during storage at Cellar store in FY 2077/2078.

	pH		
Treatment	**Day 15**	**Day 29**	**Day 44**
Open (tray)	3.10	3.57	3.49
2 holes	3.14	3.63	3.56
4 holes	3.09	3.70	3.72
6 holes	3.28	3.70	3.64
8 holes	3.21	3.72	3.82
Grand mean	**3.16**	**3.66**	**3.64**
CV%	**1.34**	**1.26**	**1.17**
LSD	**0.23**	**0.25**	**0.26**
P-value	**NS**	**NS**	*****

Table 27 illustrate that Physiological loss weight percentage (PLW %) was found significantly different ranging from 5.28% to 17.6% with mean value of 11.6% at 30 days of storage and there was no any significant difference in other days among various

treatments in any storage duration in cellar store. Minimum PLW% was found in 8 holes (0.59%) upto 15 days of storage. Similary minimum PLW% was found in 2 holes (2.73%) up to 15 days followed by open(tray) (2.59%) up to 15 days of storage in coolbot store.

Table 27: Effect of postharvest treatments on physiological loss weight percentage (%) of Mandarin (var. Khoku Local) fruit during storage at coolbot store in FY 2077/2078

	Physiological loss weight (%)		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	2.59	5.28	4.41
2 holes	2.73	9.81	6.81
4 holes	2.95	16.70	13.10
6 holes	3.22	8.58	8.79
8 holes	0.59	17.60	9.18
Grand mean	**2.44**	**11.6**	**8.46**
CV%	**2.13**	**12.64**	**10.64**
LSD	**0.28**	**8.07**	**4.96**
P-value	**NS**	*****	**NS**

Table 28 illustrates that there was no any significant difference on juice volume percentage (%). The maximum juice volume (%) was found in 2 holes (39.2%) up to 30 days of storage followed by 6 holes (36.9%) and 4 holes (36.4%) up to 30 days of storage in coolbot store.

Table 28: Effect of postharvest treatments on juice volume percentage (%) of Mandarin (var. Khoku Local) fruit during storage at coolbot store in FY 2077/2078.

	Juice volume (%)		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	26.30	33.00	23.70
2 holes	33.10	39.20	28.20
4 holes	33.90	36.40	26.30
6 holes	33.80	36.90	28.10
8 holes	33.70	33.60	26.10
Grand mean	**32.15**	**35.82**	**26.48**
CV%	**3.74**	**4.76**	**4.13**
LSD	**6.63**	**9.40**	**6.03**
P-value	**NS**	**NS**	**NS**

Table 29 illustrates that there was no significant difference in TSS°Brix among various treatments in any storage duration in coolbot. Maximum TSS °Brix was found in open (tray) (13.2 °Brix) up to 45 days of storage. Similarly, maximum TSS °Brix was found in in 4 holes (13.1 °Brix) up to 30 days of storage followed by 8 holes (13°Brix) and 6 holes (12.9 °Brix) upto 30 days of storage**.**

Table 29: Effect of postharvest treatments on TSS of mandarin (var. Khoku Local) fruit during storage at coolbot store in FY 2077/2078.

	TSS °Brix		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	11.90	12.70	13.20
2 holes	11.80	12.70	12.60
4 holes	11.90	13.10	12.50
6 holes	11.70	12.90	12.50
8 holes	11.80	13.00	12.50
Grand mean	**11.83**	**12.86**	**12.65**
CV%	**1.30**	**1.02**	**1.15**
LSD	**0.85**	**0.72**	**0.80**
P-value	**NS**	**NS**	**NS**

Table 30 illustrates that there was no significant difference in TA % among various treatments in any storage duration in coolbot. Minimum TA% was found in 2 holes (1.28%) and 6 holes (1.28%) up to 15 days of storage. Similarly, maximum TA% was found in in 4 holes (2.25%) up to 45 days of storage followed by 8 holes (2.16%) and 6 holes (2.09%) upto 45 days of storage**.**

Table 30: Effect of postharvest treatments on TA of Mandarin (var. Khoku Local) fruit during storage at coolbot store in FY 2077/2078.

	TA%		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	1.39	1.85	2.07
2 holes	1.28	2.09	2.02
4 holes	1.33	1.82	2.25
6 holes	1.28	1.85	2.09
8 holes	1.30	2.03	2.16
Grand mean	**1.31**	**1.92**	**2.11**
CV%	**3.06**	**6.18**	**4.81**
LSD	**0.22**	**0.65**	**0.56**
P-value	**NS**	**NS**	**NS**

Table 31 illustrates that pH was found significantly different ranging from 3.38 to 3.56 with mean value of 3.64 at 45 days of storage and there was no any significant difference in other days among various treatments in any storage duration in coolbot store. Minimum pH was found in open tray (3.23) followed by 8 holes (3.6) up to 15 days of storage in coolbot store. Similary, maximum pH was found in 2 holes (3.56) followed by 4 holes (3.46) up to 45 days of storage in coolbot store.

Table 31: Effect of postharvest treatments on pH of Mandarin (var. Khoku Local) fruit during storage at coolbot store in FY 2077/2078.

	pH		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	3.23	3.51	3.42
2 holes	3.36	3.50	3.56
4 holes	3.37	3.61	3.46
6 holes	3.29	3.52	3.38
8 holes	3.26	3.51	3.38
Grand mean	**3.30**	**3.66**	**3.64**
CV%	**0.84**	**1.31**	**1.25**
LSD	**0.15**	**0.25**	**0.23**
P-value	**NS**	**NS**	*****

Table 32 illustrate that there was no significant difference on physiological weight loss in percentage (PLW %). The minimum loss percentage was found in 8 holes (3.18%) in 30 days of storage. Similarly, the minimum loss percentage was found in open (tray) (3.96%) in 30days of storage followed by 2 holes (7.02%) for up to 30 days of storage in normal room store.

Table 32: Effect of postharvest treatments on physiological loss weight percentage (%) of Mandarin (var. Khoku Local)) fruit during storage at Normal room store in FY 2077/2078

	Physiological loss weight (%)		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	13.60	3.96	8.61
2 holes	22.60	7.02	39.70
4 holes	17.10	12.40	14.60
6 holes	24.10	7.83	18.20
8 holes	19.80	3.18	10.10
Grand mean	**19.45**	**6.88**	**18.24**
CV%	**10.87**	**20.06**	**20.68**
LSD	**11.64**	**7.60**	**20.79**
P-value	**NS**	**NS**	**NS**

Table 33 illustrates that juice volume percentage (%) was found significantly different ranging from 21.9% to 34% with mean value 29.46% in 15 days of storage. The maximum juice volume (%) was found in 6 holes (34%) up to 15 days of storage followed by 8 holes (33.9%). Juice volume percentage (%) was also found significantly different ranging from 20.4% to34.2% with mean value 29.6% in 30 days of storage. The maximum juice volume (%) was found in 6 holes (34.2%) up to 30 days of storage followed by 8 holes (32.6%). Juice volume percentage (%) was found significantly different ranging from 18.7 % to 34.1% with mean value 29 % in 60 days of storage. The maximum juice volume (%) was found in 8 holes (34.1%) up to 45 days of storage followed by 2 holes (32.4%).

Table 33: Effect of postharvest treatments on juice volume percentage (%) of Mandarin (var. Khoku Local) fruit during storage at normal room store in FY 2077/2078.

	Juice volume %		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	21.90	20.40	18.70
2 holes	26.30	30.20	32.40
4 holes	31.20	30.60	29.90
6 holes	34.00	34.20	29.90
8 holes	33.90	32.60	34.10
Grand mean	**29.46**	**29.60**	**29.00**
CV%	**3.35**	**4.21**	**4.20**
LSD	**5.44**	**6.86**	**6.71**
P-value	**	**	**

Table 34 illustrates that TSS °Brix was found significantly different ranging from 12.4 °Brix to 13.7°Brix with mean value of 13.02°Brix at 45 days of storage and there was no any significant difference in other days among various treatments in any storage duration in normal room store. Maximu TSS °Brix was found in open (tray) (13.7°Brix) upto 45 days of storage followed by open (tray) (13.5°Brix) upto 30 days of storage . Similary minimum TSS °Brix was found in 68 holes (11.4°Brix) up to 15 days followed by 2 holes (11.9°Brix) up to 15 days of storage in normal room store.

Table 34: Effect of postharvest treatments on TSS of Mandarin (var. Khoku Local) fruit during storage at normal room store in FY 2077/2078.

	TSS °Brix		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	12.00	13.50	13.70
2 holes	11.90	12.60	13.00
4 holes	12.20	13.40	13.00
6 holes	12.20	12.30	13.00
8 holes	11.40	13.20	12.40
Grand mean	**11.93**	**13.00**	**13.02**
CV%	**2.21**	**1.30**	**0.91**
LSD	**1.45**	**0.93**	**0.65**
P-value	**NS**	**NS**	******

Table 35 illustrates that TA% was found significantly different ranging from 1.42% to 1.64% with mean value of 1.5% at 44 days of storage and there was no significant difference in other days among various treatments in any storage duration in cellar store. Minimum TA% was found in 8 holes (1.21%) up to 15 days of storage. Similary, minimum TA% was found in 6 holes (1.23%) up to 15 days followed by 2 holes (1.34%) up to 15days of storage in cellar store.

Table 35: Effect of postharvest treatments on TA of Mandarin (var. Khoku Local) fruit during storage at Normal room store in FY 2077/2078.

	TA %		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	1.27	1.64	1.79
2 holes	1.29	1.63	1.80
4 holes	1.19	1.61	1.92
6 holes	1.36	1.54	1.65
8 holes	1.21	1.57	1.73
Grand mean	**1.26**	**1.60**	**1.77**
CV%	**2.46**	**2.23**	**2.50**
LSD	**0.17**	**0.19**	**0.24**
P-value	**NS**	**NS**	**NS**

Table 36 illustrates that pH was found significantly different ranging from 3.6 to 3.81 with mean value of 3.71 at 30 days of storage and there was no any significant difference in other days among various treatments in any storage duration in cellar store. Minimum pH was found in 8holes (3.13) followed by open (tray) (3.28) up to 15 days of storage in cellar store. Similary, maximum pH was found in 6 holes (3.81) followed by 8 holes (3.80) up to 30 days of storage in normal room store.

Table 36: Effect of postharvest treatments on pH of Mandarin (var. Khoku Local) fruit during storage at Normal Room store in FY 2077/2078.

	pH		
Treatment	**Day 15**	**Day 30**	**Day 45**
Open (tray)	3.28	3.60	3.59
2 holes	3.32	3.72	3.74
4 holes	3.38	3.66	3.54
6 holes	3.38	3.81	3.69
8 holes	3.13	3.80	3.78
Grand mean	**3.29**	**3.71**	**3.66**
CV%	**1.21**	**0.86**	**1.70**
LSD	**0.22**	**0.17**	**0.34**
P-value	**Ns**	*****	**Ns**

3.3 Plant Husbandry

3.4 High density planting trial of mandarin orange

Methodology

Mandarin cv. Khoku local saplings (grafted onto trifoliate) at the age of two years were transplanted at NCRP, Paripatle orchard at 1300 m altitude. The saplings were planted at six different spacing as shown in Table 38. The plants were replicated three times in terraced land. The data were recorded on various fruit physio-chemical parameters and yield parameters as shown in table below.

Fruit physical parameters and yield attributing characteristics of mandarin orange

The result showed that the individual fruit weight, fruit diameter, fruit rind thickness, fruit rind weight, number of segments per fruit and number of seed per fruit were non-significant of the different spacing they are planted (Table 37).

Fruit weight

Fruit weight was found varying from 74.9 to 107 g with mean value of 90.16 g. The highest fruit weight was found in 1.50 x 3 m (107g) spacing followed by 2.25 x 3 m spacing (95.7g). The lowest fruit weight was found in 1.15 x 3 m spacing (74.9g) followed by 4 m spacing (80.4 g).

Fruit diameter

Fruit diameter was ranged from 52.7mm to 58.5mm with the mean value of 56.2 mm. The highest fruit diameter was found in 2.50 x 3 mspacing (58.5mm) followed by 1.50 x 3 m spacing (56.9mm).The lowest fruit diameter was found in 1.8 x 3 m spacing (52.7mm) followed by 1.15 x 3m spacing (52.9 mm).

Fruit rind thickness

Fruit rind thickness was ranged from 1.73mm to 2.79 mm with mean value of 2.33 mm. The highest fruit rind thickness was found in 1.50 x 3 m spacing (2.79 mm) followed by3.50 x 3m(2.45mm). The lowest fruit rind thickness was found in 1.15 x 3m spacing (1.73mm) followed by 4m spacing (1.82mm).

Fruit rind weight

Fruit rind weight was ranged from 20.2g to 31.1 g with mean value 25.59 g.The highest fruit rind weight was found in 1.50 x 3 m spacing (31.1g) followed by 2.50 x 3m spacing (27.2 g).The lowest fruit rind weight was found in 1.15 x 3m spacing (20.2g) followed by 4m spacing (21.2g).

Number of segments

The number of segments per fruit was found significantly different ranging from 9 to 11 with mean value of 9.58. The maximum number of segments per fruit was found in 1.50 x 3m spacing (11) followed by 1.8 x 3m spacing (10.6). The minimum number of segments per fruit was found in 3 x 3 m spacing (9) followed by 3.50 x 3m spacing (9.1).

Number of seeds per fruit

Number of seeds per fruit was found varying from 8.6 to 15.3 with mean value 12.29. The maximum number of seeds per fruit was found in 1.50 x 3m spacing (15.3) followed by 1.8 x 3m spacing (14). The lowest number of seeds per fruit was found in 4m spacing (8.6) followed by 3 x 3m spacing (9.5).

Total number of fruits per tree

The total number of fruits per tree was ranged from 20.5 to 45 with mean value of 30.22. The highest number of fruits was found in 1.8 x 3m spacing (45) followed by 1.50 x 3 m spacing (42.5). The lowest number of fruit was found in 3.50 x 3m spacing (20.5) followed by 3 x 3m spacing (21.3).

Total fruit yield per hectare

The total fruit yield per tree was ranged from 0.62 t/ha to 1.29 t/ha with mean value of 0.87 t/ha. The highest fruit yield was found 1.8 x 3m spacing (1.29 t/ha) followed by 1.50 x 3m spacing (1.04t/ha). The lowest fruit yield was found in 3.50 x 3m spacing (0.62 t/ha) followed by 3 x 3m spacing (0.68 t/ha).

Table 37: Different yield and quality parameters of Khoku Local mandarin under various planting densities at NCRP Dhankuta in 2020.

Spacing	Fruit weight (g)	Fruit diameter (mm)	Rind thickness (mm)	Fruit rind weight (g)	No. of segments	Total no of fruit	Yield /ha (t/ha)
1.15 x 3	74.9	52.9	1.73	20.2	9.2	28	0.808
1.50 x 3	107	56.9	2.79	31.1	11	42.5	1.04
1.75 x 3	87.8	55.5	2.27	25.6	9.69	26.7	0.902
1.8 x 3	86.1	52.7	2.24	22.8	10.6	45	1.29
2.25 x 3	95.7	56.9	2.42	26	9.95	39.3	0.983
2.50 x 3	93.8	58.5	2.32	27.2	9.27	30.5	0.887
3 x 3	83.1	55.4	2.39	23.3	9	21.3	0.686
3.50 x 3	87.2	54.7	2.45	25.2	9.1	20.5	0.626
3 x 4	80.4	55.9	1.82	21.2	9.2	32	0.76
Grand Mean	**90.16**	**56.2**	**2.33**	**25.59**	**9.58**	**30.22**	**0.87**
CV%	**2.35**	**1.65**	**3.27**	**3.14**	**1.45**	**7.08**	**5.54**
LSD	**13.35**	**5.87**	**0.48**	**5.07**	**0.87**	**13.5**	**0.3**
P-value	**NS**	**Ns**	**Ns**	**Ns**	*****	**Ns**	**Ns**

Physicochemical properties of mandarin orange

The difference in physicochemical properties *viz*. juice quantity (%), TSS % and TA % and pH were non-significant among the treatments (Table 38).

Juice %

Juice% was ranged from 33.3% to 42.2% with the mean value of 40.38%. The highest juice volume was found in 2.50 x 3m spacing (42.2%) followed by 2.25 x 3m spacing (41.9%).The lowest juice volume was found in 4mspacing (33.3%) followed by 1.15 x 3 mspacing (38.2%).

Total soluble Solids (TSS %)

TSS % was found varied from 10.2 % to 11.3% with mean value 10.59 %. The highest TSS % was found in 3.50 x 3m spacing (11.3%) followed by 1.8 x 3mspacing (11.2%). The lowest TSS % was found in in spacing of 2.50 x 3m (10.2%) followed by 4 m spacing (10.2%).

Titrable acid (TA %)

Among the tested spacing of same genotype TA% was found non-significantly ranging from 1.12% to 1.75% with mean value 1.34%. The TA % was remarkably high in 4mspacing (1.75%) followed by 1.75 x 3m spacing (1.49%). 2.25 x 3m spacing (1.12%) recorded significantly the lowest TA% followed by 1.50 x 3m spacing (1.13%).

pH

The pH was found varying from 1.41 to 3.99 with mean value of 2.28. The highest pH was observed in 1.50 x 3mspacing (3.99) followed by 1.75 x 3m spacing (3.28). The lowest pH recorded was in 3.50 x 3mspacing (1.41) followed by 2.25 x 3mspacing (1.47).

Table 38: Physio–chemical properties of Khoku Local mandarin under various planting densities at NCRP Dhankuta in 2020.

Spacing	Juice (%)	Avg TSS	TA%	pH
1.15 x 3	38.2	11	1.46	2.84
1.50 x 3	40.2	10.3	1.13	3.99
1.75 x 3	38.2	10.7	1.49	3.28
1.8 x 3	41.1	11.2	1.25	1.41
2.25 x 3	41.9	11	1.49	1.47
2.50 x 3	42.2	10.2	1.12	1.88
3 x 3	41.3	10.3	1.32	2.11
3.50 x 3	40.9	11.3	1.33	1.41
3 x 4	33.3	10.2	1.75	2.84
Grand Mean	**40.38**	**10.59**	**1.34**	**2.28**
CV%	**1.57**	**1.4**	**4.93**	**13.4**
LSD	**4.01**	**0.94**	**0.41**	**1.93**
P-value	**Ns**	**Ns**	**Ns**	**Ns**

3.5 NURSERY MANAGEMENT

3.5.1 Management of leaf miner in nursery bed

The citrus leaf miner (*Phyllocnistis citrella* Stainton) is a moth of the family Gracillariidae. It is a potentially serious pest of citrus and related Rutaceae and some related ornamental plants. The activity of the leaf miner is normally observed through the year due to its overlapping generation; however new flushes leaves are more exposed. Their larvae feed on the chlorophyll of the tender leaves making serpentine mines due to leaves became distorted and crumpled. This adversely affects the photosynthesis activity which results in reduced vigour and growth of the plant.

Methodology

The efficacy of seven insecticides was studied for controlling citrus leaf miner in 2020 at nursery of NCRP. RCBD design was used to assign 4 replications of each of seven treatments. Spraying was done in the month of June. Citrus leaf miner larval count was done in 7, 14 and 21 days after treatment application. Observation on number of larva per 5 leaves and number of total leaves and infested leaves was taken. The percentage of infestation was calculated by number of infested leaves divided by total number of

leaves multiplied by 100. Mines in initial stage, that did not cause significant damage or curling of leaves was not considered and left to the subsequent counts.
The treatments are enlisted below:
T1: Spraying of Arrow (Thiamethoxan 25% WP) @ 2 gm/lt
T2: Spraying of Celcron (Profenofos 50% EC) @ 2 ml/lt
T3: Spraying of Vapcomic (Abamectin 1.8% EC) @ 2ml/lt
T4: Spraying of Imidacloprid 1 ml/lt
T5: Spraying of Hunted (Chlorfenapyr 10%) @ 1ml/lt
T6: Spraying of Vapcomic (Abamectin 1.8% EC) @ 3ml/lt
T7: Control

Result and discussion

Increment in number of larvae per five leaves was found to be significant after 14 days of spraying. But it was found to be non-significant after 7 and 21 days after spraying. However, there was found to be decreasing in larval infestation in all spraying at every 7 days interval. The larval infestation was found least with thiamethoxam @ 2 gm/lt at 7, 14 and 21 days after spraying with increment in larval infestation of value 0.25, 0.25 and 0.00 respectively. The larval infestation was found maximum with control up to 7 and 14 days with increment value of 1.15 and 1.80 respectively (Table 39).

Table 39: Table showing increment in number of larva after 7, 14 and 21 days after spraying different insecticides

Treatments	Total no. of leaves per sapling	Total no. of infected leaves per sapling	Infected leaves % per sapling	Increment in no. of larvae per 5 leaves		
				After 7 days of spraying	After 14 days of spraying	After 21 days of spraying
Thiamethoxan 2 gm/lt	79.30	58.15	73.75	0.25	0.25	0.00
Profenofos 2 ml/lt	75.83	42.20	55.53	0.60	0.30	0.15
Abamectin 2ml/lt	74.10	53.55	72.98	0.10	0.50	0.10
Imidacloprid 1 ml/lt	73.95	44.90	59.12	1.00	0.60	0.20
Chlorfenapyr 1ml/lt	90.28	57.20	63.20	0.50	0.35	0.25
Abamectin @ 3ml/lt	83.50	52.80	63.98	0.60	0.50	0.05
Control	94.15	55.60	59.68	1.15	1.80	0.10
Mean				**0.69**	**0.61**	**0.12**
P-value				**NS**	******	**NS**
CV %				**68.38**	**69.52**	**21.72**

3.5.2 Management of weed in nursery bed

Weed is one of the main problems of citrus in early of growth period, and chemical herbicides are used against it that is accompanied with environmental pollutions. The weeds in Citrus decrease available water and nutrients of soil. They also may be host of a variety of pests, diseases, and even fungus. Pre-emergence herbicides are generally applied two to three times per year, so the maximum amount of herbicide is in the upper soil profile (0 to 2 inches) slightly before peak weed emergence. Post-emergence herbicides are used to control weeds that escape control by pre-emergence herbicides or mechanical cultivation. These herbicides are effective on small annual weeds and usually only suppress growth of perennials. These can be systemic or contact in activity.

Methodology

To find a good measure to manage weed in nursery bed, a study was designed and carried out in nursery bed at NCRP, Dhankuta in 2020. RCBD design was used to assign 3 replications of seven treatments. Initially, pendimethalin @ 2 ml/lt was sprayed in nursery bed as pre-emergence herbicide. Spraying of Post-emergence herbicides was done in the month of June. The treatments are enlisted below:

T1: Spraying of Glyphosate @ 2 ml/lt
T2: Spraying of Spirit (Pendimethalin 30% EC) @ 2 ml/lt
T3: Spraying of Spirit (Pendimethalin 30% EC) @ 4 ml/lt
T4: Spraying of Uniquat (Paraquat dichloride 24% SL) 2 ml/lt
T5: Spraying of Uniquat (Paraquat dichloride 24% SL) @ 4 ml/lt
T6: Hand weeding
T7: Control

The number of weeds and species of weeds present in one m^2 area in each plot was counted at 30, 60 and 90 days after transplanting. Beside these, transplanted sapling height, number of leaves per sapling, chlorophyll content and stem girth at collar region was recorded.

Result and discussion

Number of weed species:

The number of different weed species was found significant at 60 days after spraying herbicides. The minimum weed species was observed with herbicide paraquat dichloride @ 3 ml/lt (5.00) followed by paraquat dichloride @ 2 ml/lt and glyphosate @ 2ml/lt (5.33). The maximum weed species was seen in control (9.33) (Table 40).

Number of weeds:

The number of weed was found significant at 60 days after spraying herbicides. The minimum number of weed was observed with Pendimethalin @ 2ml/lt (16.00) followed

by paraquat dichloride @ 2ml/lt (19.00). The maximum weed was observed with control (40.33) followed by hand weeding (37.33) (Table 41).

Table 40: Table showing number of weed species and number of weeds at 30, 60 and 90 days after spraying herbicides

Treatment	No. of weed species			No. of weeds		
	30	60	90	30	60	90
Glyphosate @ 2ml/lt	11.00	5.33	6.33	92.00	22.00	78.67
Pendimethalin @ 2 ml/lt	7.33	5.67	5.00	58.00	16.00	15.33
Pendimethalin @ 4 ml/lt	9.00	7.33	4.33	75.67	26.67	18.00
Paraquat dichloride @ 2 ml/lt	8.00	5.33	7.00	64.00	19.00	28.00
Paraquat dichloride @ 3 ml/lt	7.33	5.00	5.00	79.33	19.67	31.67
Hand weeding	10.00	7.33	8.00	64.33	37.00	85.33
Control	8.67	9.33	6.33	57.00	40.33	24.00
Mean	**8.76**	**6.48**	**6.00**	**70.05**	**25.81**	**40.14**
P-value	**NS**	******	**NS**	**NS**	******	**NS**
CV %	**18.19**	**19.45**	**31.91**	**48.04**	**18.13**	**104.70**

Plant height:

The plant height of acid lime (Tehrathum local) was found non-significant throughout the research period. However, highest plant height was observed with hand weeding (93.87 cm) at 90 days (Table 41).

Number of leaves per plant:

The number of leaves was found non-significant up to 60 days of spraying. At 90 days after spraying it was found significant. The highest number of leaves per plant was observed with treatment paraquat dichloride @ 3 ml/lt (125.20) fllowed by pendimethalin @ 2 ml/lt (151.33). the lowest number of leaves per plant was observed with spraying pendimethalin @ 4ml/lt (97.33) (Table 42).

Table 41: Table showing plant height and number of leaves per plant of acid lime (Tehrathum local) at 30, 60 and 90 days after spraying herbicides

Treatment	Plant height (cm)			No. of leaves per plant		
	30	60	90	30	60	90
Glyphosate @ 2ml/lt	71.33	73.00	78.80	110.53	140.33	133.73
Pendimethalin @ 2 ml/lt	75.20	77.27	82.27	131.00	121.33	151.33
Pendimethalin @ 4 ml/lt	69.87	75.22	77.33	115.13	103.73	97.33
Paraquat dichloride @ 2 ml/lt	80.73	85.73	87.20	126.20	95.13	125.20
Paraquat dichloride @ 3 ml/lt	75.20	77.00	82.33	120.80	97.93	157.43
Hand weeding	81.93	85.00	93.87	119.87	113.33	118.20
Glyphosate @ 2ml/lt	81.13	81.67	81.67	111.53	117.33	106.20
Mean	**76.49**	**79.27**	**83.35**	**119.30**	**112.73**	**127.06**
P-value	**NS**	**NS**	**NS**	**NS**	**NS**	*****
CV %	**12.71**	**7.37**	**10.46**	**23.30**	**25.66**	**17.04**

Chlorophyll content:
The chlorophyll content in acid lime was found to be non-significant throughout research period. However, the highest chlorophyll content was found in paraquat dichloride @ 3 ml/lt (33.51). The lowest chlorophyll content was found in pendimethalin @ 4ml/lt (7.27) (Table 42).

Collar girth:
The collar girth in acid lime was found to be non-significant throughout research period. However, the highest collar girth was found in glyphosate @ 2 ml/lt (13.96 mm) followed by paraquat dichloride @ 3ml/lt (13.33) after 90 days of spraying. The lowest collar girth was found in pendimethalin @ 4ml/lt (11.37) at 90 days after spraying (Table 42).

Table 42: Table showing chlorophyll content and collar girth of acid lime (Tehrathum local) at 30, 60 and 90 days after spraying herbicides

Treatment	Chlorophyll content			Collar girth (mm)		
	30	**60**	**90**	**30**	**60**	**90**
Glyphosate @ 2ml/lt	26.65	32.19	10.31	5.35	11.68	13.96
Pendimethalin @ 2 ml/lt	15.83	35.26	9.56	5.97	11.57	12.34
Pendimethalin @ 4 ml/lt	14.89	32.60	7.27	4.89	10.81	11.37
Paraquat dichloride @ 2 ml/lt	30.13	23.91	9.94	5.04	11.04	11.44
Paraquat dichloride @ 3 ml/lt	24.02	33.51	11.35	5.44	11.89	13.33
Hand weeding	26.59	26.47	12.09	5.54	12.17	11.43
Glyphosate @ 2ml/lt	8.64	27.08	16.19	5.63	12.36	12.78
Mean	**20.97**	**30.14**	**10.96**	**5.41**	**11.64**	**12.38**
P-value	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV %	**47.90**	**64.46**	**34.48**	**7.56**	**16.65**	**6.85**

3.5.3. RAINY SEASON CITRUS GRAFTING STUDY INSIDE NURSERY HOUSE

Various methods for grafting and budding were tested in the high-tech nursery of NCRP, Paripatle in the month of Shrawan, the peak of the monsoon season in Nepal. In NCRP, the traditional time of propagation is considered to be the dry months, namely; Mangshir-Poush, which leaves a narrow time period of only 6 months for the plant to grow before it is sold to farmers starting from Jestha. The following experiment was carried out to find a feasible time in the monsoon season or the wet season for propagation so that the plants have more time to grow and stabilize and farmers are benefitted from the sale of hardy year-old plants. The experiment started on 2077/04/01 and ended on 2077/06/18, with Trifoliate used as rootstock in all except one of the trials.

The first set was grafted and budded on 2077/04/01 by five methods, T-budding, splice grafting, cleft grafting, veneer grafting and patch budding with NCRP-59 (Sunkagati-2) as scion. After 2 months, cleft grafting and veneer grafting proved to be the most successful method as 90% plants were successful among 20 in both the cases (Table 43). The highest plant height was achieved by cleft grafted plants (23.93 cm) closely followed by veneer grafted plants (23.33 cm), whereas maximum diameter (5.81 cm) was achieved by the latter. Splice grafting was found to be the most unsuccessful method as only 1 plant flourished among the 20 grafted.

Table 43: Table showing graft success %, plant height and collar girth of acid lime (Sunkagati-2) at 60 days after grafting on to trifoliate rootsock

Treatment	Variety	# grafted	% suceess	Plant Ht (cm)	Collar Dia(mm)
T-Budding	Sunkagati-2	20	15	-	-
Splice Grafting	Sunkagati-2	20	5	15	5.78
Cleft Grafting	Sunkagati-2	20	90	23.93	5.668
Veneer Grafting	Sunkagati-2	20	90	23.33	5.81
Patch Budding	Sunkagati-2	20	70	18.14	5.55

Subsequently, the next set comprised of Avana mandarin orange grafted and budded on trifoliate rootstocks on 2077/04/01, where veneer grafting (80%) turned out to be the most successful method followed by T-budding (70%) among the 20 grafted and budded plants (Table 44). The maximum height was found in cleft grafted plants (25.25 cm) whereas the lowest height (12.25 cm) was in T-budded plants whereas, maximum diameter was found in T-budded plants (8.14 cm) followed by cleft grafted plants (7.35 cm). The lowest success rate was observed in patch budded plants (2).

Table 44: Table showing graft success %, plant height and collar girth of Avana mandarin at 60 days after grafting on to trifoliate rootsock

Treatment	Variety	# grafted	% suceess	Plant Ht (cm)	Collar Dia (mm)
T-Budding	Avana Orange	20	70	12.25	8.14
Splice Grafting	Avana Orange	20	50	22.83	5.15
Cleft Grafting	Avana Orange	20	20	25.25	7.35
Veneer Grafting	Avana Orange	20	80	19.46	5.74
Patch Budding	Avana Orange	20	10	20.50	6.12

Similarly, the next set was of NCRP-01 (Khoku Local) variety grafted on Trifoliate rootstock. The experiment started on 2077/04/25 and not much success was observed in any of the methods (Table 45). The highest among these was T-budding with a success of 35% plants out of 20 budded in totals. 28 cm height was observed in cleft grafted plants whose diameter was also the highest (6.75 cm).

Table 45: Table showing graft success %, plant height and collar girth of Khoku local mandarin at 60 days after grafting on to trifoliate rootsock

Treatment	Variety	# grafted	% suceess	Plant Ht (cm)	Collar Dia (mm)
T-Budding	Khoku Local	20	35	17.5	6.15
Splice Grafting	Khoku Local	20	0	-	-
Cleft Grafting	Khoku Local	20	5	28	6.75
Veneer Grafting	Khoku Local	20	10	21	4.68
Patch Budding	Khoku Local	20	30	17.5	6.16

As the experiment continued success rates of the subsequent sets declined; the next set was where NCRP-55 (Sunkagati-1) was grafted and budded onto different rootstocks. The most distinctive and successful method was Micro-tip budding method (40%) on Trifoliate rootstock which trumped all the other methods by a fair margin (Table 46). The most unsuccessful one was the micro-tip budding method in Flying dragon rootstock. The maximum height (42.5 cm) was obtained in Rangpur Lime with micro-tip budding which also obtained the maximum diameter (7.31 cm).

Table 46: Table showing graft success %, plant height and collar girth of various acid lime varieties at 60 days after grafting on to various rootsock species

Rootstock	Budding/Grafting	Variety	# grafted	% suceess	Plant Ht (cm)	Collar Dia (mm)
Flying Dragon	Micro Tip Budding	Sunkagati-1	40	2.5	31	5.64
Rangpur Lime	Splice Grafting	Sunkagati-2	40	10	16	4.83
Citrange(C-35)	Micro Tip Budding	Sunkagati-2	40	7.5	22.67	6.27
Rangpur Lime	Micro Tip Budding	Sunkagari-2	40	5	42.5	7.31
Trifoliate	Micro Tip Budding	Sunkagari-1	40	40	31.45	6.72
Pommelo	Micro Tip Budding	Terhthum Local	40	0	-	-

3.6 CITRUS DECLINE MANAGEMENT

Citrus decline is the foremost threat to the future of citrus industry in Nepal. Unless this problem is managed, citrus will get declined (Roistacher, 1996). It has now been widespread serious threat for mandarin production in almost citrus growing regions in Nepal. Furthermore, most of the citrus nurseries are located at the altitude below 1000 masl that insect vectors of many diseases including citrus greening and citrus tristeza virus are considered to be active because of the favorable environment.

Besides HLB, the decline is associated with many other diseases and pests as well as management factors that tristeza virus, root rot, poor orchard management, unfavorable soil and climate and low quality planting material are among the major factors. The former studies illustrate that the citrus decline responds well to pruning treatment with adequate scientific management, irrigation and plant protection measures. Similarly, it is stated that application of 300-500 g N, 200-250 g P + 250-350 g K per tree of bearing stage will result optimum yield minimizing decline gradually.

3.6.1 Evaluation of effectiveness of guava inter-cropping on HLB infection

Citrus greening disease, commonly known as huanglongbing, is a lethal disease of citrus, and no effective controls have yet been established for this disease. Citrus greening disease is a disease of citrus caused by a vector-transmitted pathogen. The causative agents are motile bacteria, *Candidatus Liberibacter* spp. The disease is vectored and transmitted by the Asian citrus psyllid, *Diaphorina citri*, and the African citrus psyllid, *Trioza erytreae*, also known as the two-spotted citrus psyllid. It has also been shown to be graft-transmissible.

HLB is distinguished by the common symptoms of yellowing of the veins and adjacent tissues; followed by splotchy mottling of the entire leaf, premature defoliation, die-back of twigs, decay of feeder rootlets and lateral roots, and decline in vigor, ultimately followed by the death of the entire plant. Affected trees have stunted growth, bear multiple off-season flowers (most of which fall off), and produce small, irregularly shaped fruit with a thick, pale peel that remains green at the bottom and tastes very bitter. Common symptoms can often be mistaken for nutrient deficiencies; however, the distinguishing factor between nutrient deficiencies is the pattern of symmetry. Nutrient deficiencies tend to be symmetrical along the leaf vein margin, while HLB has an asymmetrical yellowing around the vein. The most noticeable symptom of HLB is greening and stunting of the fruit, especially after ripening.

In Nepal, citrus decline was recorded first time in Pokhara valley during 1968. Later the disease has been confirmed as the greening disease (HLB) and it was suspected to be introduced from Sharanpur, India with the planting materials. For time being, several

studies and surveys were carried out in other parts of country to explore the distribution of the greening disease and its vector. The studies revealed that HLB has already distributed across the country, but the extent of citrus decline due to this disease was found maximum in western region than eastern region. But now the disease is spreading rapidly in eastern region too.

NCRP has been doing research from past 3 years for not spreading the disease in new and healthy orchard by intercropping guava in mandarin orchards. Thus, this study was carried out in Ilam district, Godak area since fiscal year 2073/74 to prevent the transmission of disease from infected orchard to newly established healthy mandarin orchard. It could be due to some volatiles of guava that plays a role in the psyllid reduction by functioning as repellents against the psyllids.

Methodology

In the 1st year 20 guava were planted. In 2nd year 20 mandarin saplings were intercropped in field. Planting distance of 3 m * 3 m was maintained. Then the number of psyllid was monitored in research field during the month of Falgun-Bhadra at weekly interval with the help of yellow sticky trap. Disease incidence was also taken.

Result

In the 3st year after mandarin plantation, no any citrus psylla vector was recorded from the research plot. Similarly, there was no any incidence of citrus greening disease too. Four years after mandarin plantation, neither citrus psylla nor incidence of citrus greening disease was observed.

This research activity should be continued for further few years because normally greening disease generally appears after 3-4 years of planting and in this case also greening disease may appear after 3-4 years of plantation.

3.7 Multi-locations (Collaborative) Trial

3.7.1 Coordinated Varietal Trial on Ginger

Introduction

The family Zingiberaceae comprises of five genera that are commercially important, namely *Amomum*, *Curcuma*, *Elettaria* and *Zingeber*. Ginger belongs to the gens *Zingeber* and turmeric to *Curcuma*. In both plant, the underground stem (rhizome) is commercial product. Zingiberaceous spices are known for their properties in the traditional systems of medicine in Asia. There are several pharmaceutical applications for these spices. Ginger contains about 1.5-2.5% volatile oil, namely Zingiberine that

contributes the aroma. The oleoresin content varies from 4-10% known as gingerol that contributes to the taste and smell.

Methodology

Eight genotypes of ginger including 'Local Check' were obtained from National Ginger Research Program (NGRP), Salyan in 2020. They were included in CVT, and evaluated in the field of NCRP, Dhankuta with three replications in RCBD. Thirty tones of FYM/ha were incorporated into soil in the first week of May, 2020: 70 kg Nitrogen, 50 kg Phosphorus and 50 Kg Potassium/ha were recommended doses of fertilizer/ha. Full dose of phosphorus and half dose of potash were applied as basal dose prior to planting rhizome in the last week of May. Rhizomes were planted in the intra row spacing of 30 cm and inter-row spacing of 30 cm. Immediately after rhizome planting, dry forest leaves @ 16 tones/ha were applied as mulching. The whole recommended nitrogen dose was split into two doses: first at 30 days after planting and remaining half dose of nitrogen and half dose of potash were applied at 60 days after planting. Weeding was done twice: first in 45 days after rhizome planting and second in 70 days after rhizome planting. Earthing up was given in 140 days after rhizome planting. Fresh rhizomes were harvested in 232 days later than planting day. Experimental data *viz.*, plant height, number of tillers per clump, length of primary and secondary fingers, fresh rhizome yield and Dry Ginger Recovery (DGR %) were recorded.

Result and discussion

Plant height

The plant height varied from 61.37 cm to 80.10 cm with mean plant height of 70.12 cm. The highest plant was recorded from genotype KKA-1 (80.10 cm) followed by genotype ZI 1007 (76.77 cm). The lowest plant height was recorded from genotype ZI 1027 (61.37 cm) (Table 47).

Number of tillers per clump

The number of tillers per clump was found ranging from 5.50 to 6.53 with mean value of 5.93. The highest number of tillers per clump was found in genotype ZI 1010 (6.53) followed by ZI 1303 (6.27). The lowest number of tillers per clump was found in genotypes ZI 1025 (5.50) (Table 47).

Length of primary finger

The length of primary finger ranged from 3.82 cm to 4.33 cm with mean value of 4.17 cm. The highest length of primary finger was recorded from genotype ZI 1025 (4.33 cm). The lowest length of primary finger was recorded from ZI 1027 (3.82 cm) (Table 47).

Length of secondary finger

The length of secondary finger ranged from 8.00 cm to 9.50 cm with mean value of 8.93 cm. The highest length of secondary finger was recorded from local genotype (9.50 cm) followed by genotype ZI 1010 (9.27 cm). The lowest length of secondary finger was recorded from genotype ZI 1303 (8.00 cm) (Table 47).

Total rhizome yield

The total rhizome yield per hectare ranged from 15.70 t/ha to 24.04 t/ha with mean total rhizome yield of 20.63 t/ha. The highest fresh rhizome yield was recorded from genotype ZI 1302 (24.04 t/ha) followed by ZI 1010 (23.52 t/ha). The lowest fresh rhizome yield was recorded from genotype ZI 1027 (15.70 t/ha) (Table 47).

Dry ginger weight

The dry ginger weight was found significantly different varying from 191.97 g to 246.79 g with mean value of 214.15 g. The highest dry ginger weight was recorded from genotype ZI 1010 (246.79 g). The lowest dry ginger weight was recorded from genotype ZI 1302 (191.97 g) (Table 47).

Dry ginger recovery %

The dry ginger recovery % was found significantly different varying from 19.20 % to 24.68 % with mean value of 21.42 %. The highest dry ginger recovery % was recorded from genotype ZI 1010 (24.68 %). The lowest dry ginger recovery % was recorded from genotype ZI 13.02 (19.20 %) (Table 47).

Table 47: Performance of eight genotypes of ginger tested under Coordinated Varietal Trial in the field of NCRP, Pariptle, Dhankuta in 2020

Genotypes	Plant height (cm)	No. of Tillers per clump	Length of finger (cm)		Total rhizome yield (t/ha)	Dry ginger weight (g)	DGR %
			Primary	Secondary			
ZI 1303	67.57	6.27	4.32	8.00	19.02	218.04	21.80
ZI 1010	73.53	6.53	4.27	9.27	23.52	246.79	24.68
ZI 1302	66.77	5.57	4.07	8.87	24.04	191.97	19.20
Farmers' Local	67.63	6.10	4.08	9.50	16.36	221.59	22.16
ZI 1007	76.77	5.73	4.27	8.97	22.07	211.01	21.10
KKA-1	80.10	5.87	4.21	8.87	22.29	194.04	19.40
ZI 1025	67.23	5.50	4.33	9.02	22.03	221.59	22.16
ZI 1027	61.37	5.87	3.82	8.95	15.70	208.18	20.82
Mean	**70.12**	**5.93**	**4.17**	**8.93**	**20.63**	**214.15**	**21.42**
P-value	**	NS	NS	NS	*	NS	NS
CV%	**6.44**	**17.63**	**9.43**	**7.37**	**15.80**	**9.47**	**9.47**

3.7.2 Farmers' Field Trial on Ginger

Methodology

Five genotypes of ginger were obtained from National Ginger Research Program (NGRP), Salyan in 2020. They were included in FFT, and evaluated in the field of Farmer. Thirty tones of FYM/ha were incorporated into soil in the first week of May, 2020: 30 Kg of Nitrogen, 30 Kg of Phosphorus and 69 Kg of Potash per hectare were recommended doses of fertilizer/ha. Full dose of phosphorus and half dose of potash were applied as basal dose prior to planting rhizome in the last week of May. Rhizomes were planted in the intra-row spacing of 30 cm and inter-row spacing of 30 cm. Immediately after rhizome planting, dry forest leaves @ 16 tones/ha were used as mulching. The whole recommended nitrogen dose was split into two doses: first at 30 days after planting and remaining half dose of nitrogen and half dose of potash were applied at 60 days after planting. Weeding was done twice: first in 45 days and second in 70 days after rhizome planting. Earthing up was given in 140 days after rhizome planting. Fresh rhizomes were harvested in 240 days later than planting day. Experimental data *viz.*, Plant height, number of tillers per clump, length of primary and secondary fingers, total rhizome weight, weight of dry slice per kg sample, weight of dry powder per kg sample and Dry ginger recovery (DGR %) were recorded.

Result and discussion

Plant height

The plant height varied from 55.60 cm to 91.90 cm. The highest plant was recorded from genotype ZI 1303 (91.90 cm) followed by genotype ZI 9707 (85.30 cm). The lowest plant height was recorded from farmers' local (55.60 cm) (Table 48).

Number of tillers per clump

The number of tillers per clump was found ranging from 3.80 to 8.20. The highest number of tillers per clump was found in genotype ZI 1302 (8.20). The lowest number of tillers per clump was found in farmers' local (3.80) (Table 48).

Length of primary finger

The length of primary finger ranged from 4.00 cm to 4.40 cm. The highest length of primary finger was recorded from farmers' local (4.40 cm). The lowest length of primary finger was recorded from ZI 9707 (4.00 cm) (Table 48).

Length of secondary finger

The length of secondary finger ranged from 8.90 cm to 10.70 cm. The highest length of secondary finger was recorded from local genotype (9.50 cm) followed by genotype ZI

1303 (10.70 cm). The lowest length of secondary finger was recorded from genotype ZI 1302 (8.90 cm) (Table 48).

Total rhizome yield

The total rhizome yield per hectare ranged from 9.33 t/ha to 32.33 t/ha. The highest fresh rhizome yield was recorded from genotype ZI 1303 (32.33 t/ha) followed by ZI 1302 and ZI 9707 with yield of 25.44 t/ha each. The lowest fresh rhizome yield was recorded from farmers' local (9.33 t/ha) (Table 48).

Dry ginger weight

The dry ginger weight was found significantly different varying from 132.25 g to 254.69 g. The highest dry ginger weight was recorded from genotype KKA-1 (254.69 g). The lowest dry ginger weight was recorded from farmers' local (132.25 g) (Table 48).

Dry ginger recovery %

The dry ginger recovery % was found significantly different varying from 13.18 % to 25.32 %. The highest dry ginger recovery % was recorded from genotype KKA-1 (25.32 %). The lowest dry ginger recovery % was recorded from farmers' local (13.18 %) (Table 48).

Table 48: Performance of five genotypes of ginger tested under Farmers' field trial in Dhankuta in 2020

Genotypes	Plant height (cm)	No. of Tillers per clump	Length of finger (cm)		Total rhizome yield (t/ha)	Dry ginger weight (g)	DGR %
			Primary	Secondary			
Farmers' local	55.60	3.80	4.40	10.20	9.33	132.25	13.18
KKA-1	71.80	6.00	4.30	9.80	17.44	254.69	25.32
ZI 1303	91.90	6.70	4.25	10.70	32.33	169.56	16.93
ZI 1302	62.30	8.20	4.30	8.90	25.44	190.07	18.99
ZI 9707	85.30	6.80	4.00	9.60	25.44	134.64	13.45

3.7.3 Farmers' Field Trial on Turmeric

Introduction

The family Zingiberaceae comprises four or five genera that are commercially important, namely *Amomum*, *Curcuma*, *Elattaria* and *Zingeber*. Turmeric belongs to the genus *Curcuma*. In plant the underground stem (rhizome) is commercial product. It is a flowering plant, a perennial herb that measures about 40 inches in height and has white flowers. Zingiberaceous spices are known for their medicinal properties in the traditional systems of medicine in Asia. There are several pharmaceutical applications for these

spices. Turmeric is valued for the yellow pigment curcumin (diferulolylmethane) which varies 4-8% in the dried rhizome. Curcumin in turn contains curcumin-1 (almost 94%), curcumin-11 (6%) and curcumin-111 (0.3%). Turmeric is used in cases of biliary disorders, intestinal disorders, anorexia, cough, diabetic wounds, hepatic disorder, pain, rheumatism and sinusitis, cancer, psoriasis and Alzhemer's disease (Anandaraj, 2009).

Methodology

Five genotypes of turmeric were obtained from National Ginger Research Program (NGRP), Salyan in 2020. They were included in FFT, and evaluated in the field of Farmer. Thirty tones of FYM/ha were incorporated into soil in the first week of May, 2020: 30 Kg of Nitrogen, 30 Kg of Phosphorus and 69 Kg of Potash per hectare were recommended doses of fertilizer/ha. Full dose of phosphorus and half dose of potash were applied as basal dose prior to planting rhizome in the last week of May. Rhizomes were planted in the intra-row spacing of 30 cm and inter-row spacing of 30 cm. Immediately after rhizome planting, dry forest leaves @ 16 tones/ha were used as mulching. The whole recommended nitrogen dose was split into two doses: first at 30 days after planting and remaining half dose of nitrogen and half dose of potash were applied at 60 days after planting. Weeding was done twice: first in 45 days and second in 70 days after rhizome planting. Earthing up was given in 140 days after rhizome planting. Fresh rhizomes were harvested in 240 days later than planting day. Experimental data *viz.*, Plant height, number of tillers per clump, length of primary and secondary fingers, total rhizome weight, weight of dry slice per kg sample, weight of dry powder per kg sample and Turmeric Powder Recovery (TPR %) were recorded.

Result and discussion

Plant height

Plant height varied from 28.80 cm to 64.60 cm. The highest plant height was recorded from farrmers' local genotype (64.60 cm) followed by CI 0207 (43.00 cm). The lowest plant height was recorded from CI 9102 (28.80 cm) (Table 49).

Number of tillers per clump

The number of tillers per clump ranged from 1.00 to 2.20. The highest number of tillers per clump was obtained from Farmers' local (2.20). The lowest number of tillers per clump was recorded from genotypes CI 9102 and CI 0205 with the value of 1.00 each (Table 49).

Length of primary finger

The length of primary finger ranged from 4.20 cm to 5.06 cm. The highest length of primary finger was recorded from genotype Kapurkot haledo-1 (5.06 cm) followed by CI

9102 (4.80 cm). The lowest length of primary tillers was recorded from genotype CI 0207 (3.92 cm) (Table 49).

Length of secondary finger

The length of secondary finger ranged from 9.80 cm to 10.20 cm. The highest length of secondary finger was recorded from Kapurkot Haldo-1 (10.20 m) followed by CI 0207 (10.00 cm). The lowest length of secondary tillers was recorded from genotypes farmers' local, CI9102 and CI 0205 with the value of 9.80 cm each (Table 49).

Total rhizome yield

The total rhizome yield was found ranging from 2.44 t/ha to 12.44 t/ha. The maximum rhizome yield was obtained from genotype CI 0207 (12.44 t/ha) followed by farmers' local (11.33 t/ha). The lowest rhizome yield was obtained from genotype CI 9102 (2.44 t/ha) (Table 49).

Table 49: Performance of five genotypes of turmeric tested under Farmers' field trial in Dhankuta in 2020

Genotype	Plant height (cm)	Tillers per clump	Length of fingers (cm)		Total rhizome yield (t/ha)
			Primary	Secondary	
Farmers' local	64.60	2.20	4.20	9.80	11.33
CI 9102	28.80	1.00	4.80	9.80	2.44
CI 0205	35.20	1.00	4.50	9.80	4.67
Kapurkot haledo-1	41.60	1.20	5.06	10.20	9.11
CI 0207	43.00	1.20	3.92	10.00	12.44

Weight of dry slice per kg sample

The weight of dry slice per kg sample varied from 110.10 g to 163.20 g. The maximum weight of dry slice per kg sample was obtained from CI 0207 (163.20 g) followed by farmers' local (152.90 g). The lowest weight of dry slice per kg sample was obtained from genotype CI 9102 (110.10 g) (Table 50).

Weight of dry powder per kg sample

The weight of dry powder per kg sample varied from 110.05 g to 163.16 g. The maximum weight of dry slice/ kg sample was obtained from CI 0207 (163.16 g) followed by farmers' local (152.82 g). The lowest weight of dry slice per kg sample was obtained from genotype CI 9102 (110.05 g) (Table 50).

Turmeric powder recovery %

The TPR % was found ranging from 11.00 % to 16.31 %. The maximum TPR % was recorded from genotype CI0207 (16.31 %) followed by farmers' local (15.28 %). The lowest TPR % was recorded from genotype CI 9102 (11.00 %) (Table 50).

Table 50: Performance on quality parameters of five genotypes of turmeric tested under Farmers' field trial in Dhankuta in 2020

Genotype	Weight of dry slice (g)/ 1 kg sample	Weight of dry powder (g)/ 1 kg sample	TPR %
Farmers' local	152.90	152.82	15.28
CI 9102	110.10	110.05	11.00
CI 0205	122.70	122.64	12.26
Kapurkot haledo-1	150.16	150.10	15.01
CI 0207	163.20	163.16	16.31

4. PRODUCTION PROGRAM

NCRP has maintained production orchards of mandarin, sweet orange and acid lime for different research purposes. It spreads out in about 7 ha area. The popular local variety, which is known as Khoku local has occupied major portion of the production orchard followed by sweet orange variety Dhankuta local and different local genotypes of acid lime. This year, Rs.1.78 million revenue was collected from saplings, fruit production and other horticultural sources.

Besides, NCRP has a regular activity of sapling production of major varieties of mandarin, sweet orange and acid lime. In 2077-78, a total of 35,850 grafted saplings were produced and 19,108 saplings were sold to the farmers. The figure showed the major demand of acid lime followed by mandarin and sweet orange. The demand of acid lime saplings was high from the farmers of terai districts. The detail of fruit and sapling production is given on the Table 51.

Table 51: Production of fruits, saplings and revenue collected during 2077/78

S.N.	Particulars	Unit	Quantity	Revenue (NPR) '000
1	Mandarin saplings	No.	7650	2,32,960.00
2	Sweet orange saplings	No.	1000	7,230.00
3	Acid lime saplings	No.	27200	11,12,265.00
4	Mandarin fruits	Kg.	3800	1,46,605.00
5	Sweet orange	Kg.	94	3,560.00
5	Trifoliate orange, Citrange, Rangpur lime, Volkamerina seed	Kg.	39.20	54,080.00
	Sub-total			**15,56,700.00**
6	Other horticultural sources			59,084.75
	Sub-total			**1615784.75**
7	Administrative			1,66,350.00
	Grand Total			**17,82,134.75**

5 EXTENSION DISSEMINATION

Need of action research programs at problematic areas across the country.

Produce publication in Nepali language and provide to needy people.

Model orchard demonstration of promising technologies at different locations for larger impact.

Make availability of adequate planting saplings of promising genotypes.

6 MARKETING

Need of strengthening the citrus marketing system avoiding middleman-controlled marketing system for getting higher benefit to the farmer.

Improvement on the post-harvest practices such as harvesting, packaging, and transportation with the technology adoption to minimize the losses.

Need of cooperative marketing.

Farmers to be trained with the knowledge for increasing bargaining power in market.

Develop the citrus farming as a business enterprise.

7 CALENDAR OF OPERATION

Based on research findings and field experiences, NCRP has developed a calendar of operation for citrus orchard management (Table 52).

Table 52: Calendar of operations adopted at NCRP, Paripatle for orchard management

Month	Operations
Baishak	New flush attracts insects like psylla, white black fly and leaf miner Irrigate the orchard and nursery bed at 8-12 days interval. Budding has to be done at the height of 9"-12" above the ground level. Integrated disease and insect management strategies should be adopted considering environmental protection and biodiversity conservation. Uproot the diseased and very old trees and prepare pits for new plantation. Start protein trap (4/ropani) to monitor fruit fly (*Bactrocera minax*) on sweet orange orchard. Note: spraying any sort of fungicide, antibiotic and insecticide must be discontinued during flowering period.
Jestha	Increase the frequency of irrigation from earlier schedule of 8-12 days to 5-7 days interval in case of absence of pre-monsoon showers. The most critical period is during heat spells. To be more accurate, check to moisture level 12" deep under trees to determine dryness and water accordingly. Keep water away from the trunk. Grafted/budded rootstock in winter months requires checking, thereafter, the tops of successfully intake grafting/budding are to be cut. Any fertilizer should be applied if there is sufficient moisture in soil. Recommended prophylactic measures need to be followed to the plants infected with *Phytophthora.* Make a drainage system in the orchard. Prepare the nursery bed for rootstock transplant. Prepare compost for next year. Continue protein trap (4/ropani) to monitor fruit fly (*Bactrocera minax*) on sweet orange orchard. Initiate area wide fruit fly control program with bait of protein at weekly interval (Great fruit fly bait) to control fruit drop caused by Chinese fruit fly in afffected area in consultation with Agricultural Knowledge Center and or Zone and super zone of prime minister agriculture modernization program.
Ashad	The trunk of citrus trees that are infected with fungal diseases need to be applied with Bordeaux paste as prophylactic measure against the collar rot and gummosis caused by *Phytophthora*. In case of water stagnation near the trunk of tree, 'V' shaped furrows are to dug in between the rows across the slope to drain out excess of water on the orchard. Incidence of citrus *Psylla* and leaf miner is common on new flushes. Recommended measures are to be followed by spraying insecticides at bud burst stage. Spray is to be repeated after 15 days in the event of noticeable infestation. Cankerous leaves and branches should be pruned and brunt and copper oxychloride should be sprayed before the onset of rainy season. Later than the onset of rainfall, copper oxychloride mixed with Streptocycline ought

Month	Operations
	to be sprayed at monthly intervals. Spraying with sulfur containing fungicide to control powdery mildew. Transplant rootstocks for next year sapling. Distribution of healthy saplings to farmers. Continue the area wide fruit fly bait spray as suggested in Jestha month.
Shrawan	Stagnated water should be disposed by providing trenches along with the slope. Weeding in citrus orchard. Doses of N, P and K fertilizers have to be applied depending upon the age of the trees in the later period of rainy season. If fruit drop is observed due to pathological and hormonal factors NAA or 2,4-D @ 8-15 ppm with urea @ 5 g and bavistin @1.5 g/ LW should be sprayed to reduce the intensity of fruit drop. Transplanting of rootstock seedling (Trifoliate) in main nursery block. Remove diseased, new suckers and dry branches. Spray insuf @ 2 g/l of water for the control of powdery mildew. If there is the incidence of fruit sucking moth, and puncturing, predisposing fruits to fungal infection which result in fruit drop. Light trap needs to be installed, and fallen fruits should be destroyed and buried in order to avoid its multiplication in soil. Continue the area wide fruit fly bait spray as suggested in Jestha month.
Bhadra	Weeding in citrus orchards and nurseries. Application of Servo agro sprays mineral oil @ 15 ml/l of water to control scale insects. Management of citrus canker should be followed as per recommendation. Application of systemic insecticides for the control of green stink bug. Drenching of the root with 1% Bordeaux mixture infected by root rot disease. Harvesting of trifoliate fruit should be taken up at right stage of maturity. Sow the trifoliate rootstock seed in primary nursery for better growth of seedlings. Earthing up of basins to break the crust formed that facilitates aeration in root zone.
Ashoj	Basins should be kept ready for irrigation. New flush should be sprayed with insecticides against citrus psylla and leaf miner. Likewise, recommended dose of insecticide should be sprayed to control green stink bug. Weeding and mulching in the orchards. Stacking of heavily fruiting branches. Harvesting of citrange fruit should be taken up at right stage of maturity. Sow the citrange rootstock seed in primary nursery for better growth of seedlings. Apply Bordeaux paste after the withdrawal of monsoon. Collect fruit fly infected sweet orange fruits, and immerse them into big bucket full of water.
Kartik	Collect fruit fly infected sweet orange fruits and bury them into deep pits. Prepare new nursery bed and sow trifoliate seed for next year production. Excess leaf fall could be an indication of disease infestation. Suitable control

Month	Operations
	measures are to be taken up. Harvesting of early maturing species of citrus fruits for rootstock should be taken up at right stage of maturity. Harvesting of early maturing varieties.
Mangsir	Harvesting of mid-season varieties. Grafting for sapling production.
Poush	Harvesting of mid-season varieties. Grafting for sapling production. Farm yard manure should be applied to facilitate decomposition. Its mobilization starts after 3-4 months.
Magh	Irrigate the orchard at 7-10 days intervals. Harvesting of late season varieties. Pruning and training should be carried out. Fertilizer application and Servo agro spray to control scale insects. If zinc deficiency symptoms are notices, apply zinc sulphate.
Falgun	Servo agro spray to control scale insects; fertilizer application. Foliar spray of micronutrients. Insecticides spray in nursery plants to control leaf miner. Irrigation in orchards and nursery. In the case of zinc deficiency symptoms, zinc sulphate is to be mixed with adequate quantity of farm yard manure, and then applied to the plants by spreading uniformly on the entire root zone.
Chaitra	Irrigate the orchard and nursery bed. Uproot the diseased and very old unproductive trees and prepare pits for new plantation.

8 INFORMATION DISSEMINATION

Information regarding citrus research programs and technologies was shared with the visitors that altogether 1,500 visitors made their presence in NCRP. The visitors were mainly from farmers group, cooperatives, extension officials, entrepreneurs, NGOs/INGOs officials and others. They were acquainted with the field knowledge and experience of citrus cultivation.

9 TRAINING

3 days long online training for 26 agriculture technicians of prime minister agriculture modernization project from whole nation on "Citrus crop management" was organized. The detail information on list of training participants is given in annex 10. Similarly, 3 days long online training for 31 agriculture technicians of agriculture knowledge center from province no. 1 on "Improved citrus cultivation technology" was organized. The detail information on list of training participants is given in annex 11. One day long training was given to 28 farmers of Sankhuwasabha district on "Citrus fruit fly identification and its management". The detail information on list of training participants is given in annex 12.

10 SERVICES

In fiscal year 2077/78, NCRP supplied 19,108 grafted saplings of different citrus species to the farmers. The grafted saplings made available to the farmers comprised of Khoku local mandarin, Okitsuwase unshiu, Miyagawase unshiu, three acid lime varieties; Sunkatagi-1, Sunkagati-2 and Tehrathum local and sweet orange. In addition, the scion source from the mother plant of mandarin and acid lime varieties were provided to the nearby nursery entrepreneurs in Dhankuta district. Technical service/advice on commercial citrus cultivation was provided to more than 2500 farmers from all round the nation.

11 BUDGET STATEMENT

Budget and expenditure of regular program as well as beruju of the program has been presented in Annex 5 and 6 respectively. Similarly, budget and expenditure of PMAMP, KOIKCA-UNDP and ACIAR are shown in annex 7, 8 and 9 respectively.

12 MAJOR PROBLEMS

The major problems of citrus industry in Nepal are summarized as following:

a) Lack of variety diversity- short crop harvest period,
b) Small production scale,
c) Poor orchard management,
d) Lack of efficient irrigation,

e) Fruit drop due to entomological, pathological and hormonal factors.
f) Incidence of insects and different diseases.
g) Presence of hard pan.
h) Limited availability of disease free planting materials.
i) Acidic soil condition including zinc, calcium and magnesium deficiency in most of the citrus orchards particularly in mid-hills of west Nepal.
j) Macro and micro-nutrient deficiency.
k) No information about the nutrient content of citrus orchard.
l) Poor institutional mechanisms and coordination for marketing, and
m) Lack of entrepreneurship

Regarding management aspect, NCRP is lacking human resources for several years. Currently, a total of 11 staffs are working in the Program although there are 37 approved positions allocated by the NARC. Among the working staffs, only three scientists are there for research execution.

14 FUTURE STRATEGIES

At present, government of Nepal has recognized citrus sector as the national important and prioritized commodity. Because of appropriate geography and climate, citrus is widely grown throughout the mid hills from east to west across the country. In addition to, acid lime could be grown in upland condition of terai. Moreover, the demand of mandarin and acid lime in the domestic markets is escalating very high in recent years. Thus, it has an enormous potential to generate income and employment including nutrition to rural farmers in the country.

However, citrus industry is still in traditional level that needs to be transformed into commercial production. Therefore, NCRP has future strategies to address the problems of short production period of existing varieties, low productivity and production, inferior fruit quality, citrus decline due to disease and pests including management factors. Similarly, problems in institutional mechanism and coordination for marketing and entrepreneurship for this crop should be adequately dealt with by the research and development. Moreover, the research focus shall be on citrus based farming system utilizing available resources and socio-economic condition of the farmers.

Therefore, NCRP has prioritized following research areas for the upcoming years:

i) Virus indexing program should be made compulsory by law with bud wood certification program, and it should be followed timely across citrus growing areas.

ii) The quality planting materials free from pathogens and resistant to various insect pest and diseases ought to be made available to the citrus growers.

iii) The private nurseries should be inspected routinely since the uncertified nursery plants produced from bud wood of unknown mother tree decide the future of the orchard.

iv) Developing disease resistant rootstock as well as identifying new dwarfing rootstocks for high density planting.

v) Excessive use of fertilizers, chemical pesticides should be checked and organic citrus farming should be encouraged especially with the judicious use of bio-fertilizers and bio-control of pests with bio-pesticides.

vi) Postharvest processing and value addition,

vii) Marketing and export business,

viii) Cost effective and eco-friendly production technologies,

ix) Integrated nutrient management,

x) Breeding new varieties for extended harvest period,

xi) Biological pest and disease management,

xii) Water use efficiency,

xiii) In-vitro technology for healthy propagation,

xiv) Citrus based farming system, and

xv) Socio-economic studies

13. ANNEX

Annex 1: Citrus genotypes maintained at the field gene-bank of NCRP, Dhankuta

S.N.	Accession No	Identification/Common Name	Source
	A. Kumquat (Citrus japonica):		
1	NCRP-105	Fortunella (oval)	Unknown
2	NCRP-106	Fortunella (rounded)	Unknown
3	NCRP-115	Fortunella (Indian Muntala)	Unknown
	B. Mandarin (C. reticulata)		
4	NCRP-01	Khoku Suntala	Khoku, Dhankuta
5	NCRP-02	Kinnow	Pakistan
6	NCRP-03	Frutrel early	Unknown
	C. *Mandarin (C. unshiu)*		
7	NCRP-04	Unshiu	JICA, Japan
8	NCRP-05	Miyagawawase- Unshiu	JICA, Japan
9	NCRP-06	Okitsuwase- Unshiu	JICA, Japan
10	NCRP-08	Pongan, Tangerine	ICIMOD
11	NCRP-09	Kamala	Dhankuta
12	NCRP-10	Baskharka local (Parbat)	LAC, Lumle
13	NCRP-11	Sikkime suntala	Tehrathum
14	NCRP-12	Calamandarin	Unknown
15	NCRP-80	Satsumawase	INRA-CIRAD, France
16	NCRP-81	Satsuma Mino	INRA-CIRAD, France
17	NCRP-82	Satsuma URSS	INRA-CIRAD, France
18	NCRP-88	Fortune	INRA-CIRAD, France
19	NCRP-89	Kara	INRA-CIRAD, France
20	NCRP-90	Nova	INRA-CIRAD, France
21	NCRP-91	Pixie	INRA-CIRAD, France
22	NCRP-92	Dancy	INRA-CIRAD, France
23	NCRP-93	Avana	INRA-CIRAD, France
24	NCRP-94	Page	INRA-CIRAD, France
25	NCRP 95	Satsuma Okitsu	INRA-CIRAD, France
26	NCRP-97	Clamentine Mandarine Hernandina	INRA-CIRAD, France
27	NCRP-98	Clamentine Mandarine Oroval	INRA-CIRAD, France
28	NCRP-99	Clamentine Mandarine Commune	INRA-CIRAD, France
29	NCRP-100	Clamentine Mandarine Marisol	INRA-CIRAD, France
30	NCRP-101	Clamentine Mandarine Nules	INRA-CIRAD, France
31	NCRP-112	Gorkhali Suntala	Gorkha, Nareswor
32	NCRP-114	Khoku muted mandarin	NCRP, Dhankuta
33	NCRP-121	Daisy	Australia
34	NCRP-122	Avana-Aprino	Australia
35	NCRP-123	Imperial	Australia

S.N.	Accession No	Identification/Common Name	Source
36	NCRP-124	Markat	Kirtipur
37	NCRP-125	Oota Pongan	Kirtipur
38	NCRP-126	Yashida Pongan	Kirtipur
39	NCRP-127	Selection-79	Kirtipur
40	NCRP-128	Selection-04	Kirtipur
	Tangor		
41	NCRP 102	Ellendale	INRA_CIRAD, France
42	NCRP 103	Murkott	INRA_CIRAD, France
43	NCRP 72	Ortanique	INRA_CIRAD, France
44	NCRP-07	Tangor, Murkotte	JICA, Japan
	Tangelo		
45	NCRP 73	Minneola	INRA_CIRAD, France
46	NCRP 74	Oriando	INRA_CIRAD, France
47	NCRP 75	Seminole	INRA_CIRAD, France
	D. Sweet orange (C. sinensis)		
48	NCRP-13	Valencia late	ICAR, India
49	NCRP-14	Sevelle common	ICAR, India
50	NCRP-15	Navelencia	ICAR, India
51	NCRP 16	Malta Blood Red	ICAR, India
52	NCRP 17	Samauti	ICAR, India
53	NCRP 18	Masambi	ICAR, India
54	NCRP-19	Vanelle	ICAR, India
55	NCRP-20	Ruby	ICAR, India
56	NCRP 21	White Tanker	ICAR, India
57	NCRP-22	Washington novel	ICAR, India
58	NCRP 23	Hamlin	ICAR, India
59	NCRP 24	Pine Apple	ICAR, India
60	NCRP-25	Yashida navel	FDC, , Kirtipur
61	NCRP-26	Madam vanous	GRESCO, Kathmandu
62	NCRP-27	Delicious seedless	ICIMOD
63	NCRP-28	Skages Bonanja	ICIMOD
64	NCRP-29	Blood red	ICIMOD
65	NCRP-30	New Hall Navel	ICIMOD
66	NCRP-31	Succari	ICIMOD
67	NCRP-32	Meisheu-9	ICIMOD
68	NCRP 33	Dhankuta Local	Dhankuta
69	NCRP 34	LueGim Gong	ICAR, India
70	NCRP 83	Cara Cara Novel	INRACIRAD, France
71	NCRP 84	Lane Late	INRACIRAD, France
72	NCRP 85	Pine Apple	INRACIRAD, France
73	NCRP 86	Valencia Late	INRACIRAD, France

S.N.	Accession No	Identification/Common Name	Source
74	NCRP 87	Salustiana	INRACIRAD, France
75	NCRP 96	Tamango	INRACIRAD, France
76	NCRP-129	Atwood Navel	Australia
77	NCRP-130	Navelina Navel	Australia
78	NCRP-131	Valencia Seedless Delta	Australia
79	NCRP-132	Valencia Seedless McMohan	Australia
80	NCRP-133	Ramechhap local	Ramechhap
81	NCRP-134	Sindhuli local	Sindhuli
	Grape Fruit		
82	NCRP 45	Shamber	ICIMOD
83	NCRP 76	Henderson	INRA_CIRAD, France
84	NCRP 77	Star Ruby	INRA_CIRAD, France
85	NCRP 78	Reed	INRA_CIRAD, France
86	NCRP 79	Pink Rubi	INRA_CIRAD, France
87	NCRP-44	Phultrac (Pumelo)	Vietnam
88	NCRP-43	Nam Roi (Pumelo)	Vietnam
89	NCRP-42	Phodiem (Pumelo)	Vietnam
	E. Acid lime (C. aurantifolia)		
90	NCRP-108	Khursanibari local	SHARP, Chitwan
91	NCRP-107	Tehrathum local	Tehrathum
92	NCRP-117	Baitadi local	Baitadi
93	NCRP-118	Salyan local	Rojwal Takura, Salyan
94	NCRP-119	Bhojpur local	Takshor, Bhojpur
95	NCRP-120	Parwat local	Lekhpant, Parwat
96	NCRP-60	Kaptangang lamo	Sunsari
97	NCRP-59	Kaptangang golo	Sunsari
98	NCRP 58	Krishnapur kagati	Bharatpur, Chitwan
99	NCRP-57	Krishnapur kagati	Bharatpur, Chitwan
100	NCRP-56	Banarasi Kagati	Biratnagar
101	NCRP-55	Madrasi Kagati	Biratnagar
102	NCRP 54	Banarasi Kagati	Biratnagar
103	NCRP-53	Panta-1	Chitwan
104	NCRP-52	Belepur	Morang
105	NCRP-51	Sundarpur	Morang
106	NCRP-50	IAAS Acc # 71 (5)	IAAS, Rampur
107	NCRP-49	IAAS Acc # 101 (3)	IAAS, Rampur
108	NCRP-48	IAAS Acc # 101 (2)	IAAS, Rampur
109	NCRP-47	IAAS Acc # 01 (17)	IAAS, Rampur
110	NCRP-46	IAAS Acc # 01 (25)	IAAS, Rampur
111	NCRP-135	Nepalgunj local	Banke

S.N.	Accession No	Identification/Common Name	Source
112	NCRP-136	Mexican lime	
113	NCRP-137	Ranitar local	Nawalpur
114	NCRP-138	Jhapa collection	Budhabare, Jhapa
	E. Lemon		
115	NCRP 61	Ureka lemon Unkwown	Unknown
116	*NCRP 63*	Hill Lemon	Sunderpur Morang
117	*NCRP 64*	Ureka lemon Lamcho lemon	Sunderpur Morang
118	*NCRP 109*	Thimura local	SHARP Chitwan
119	*NCRP 110*	Biratnagar Local	SHARP Chitwan
120	*NCRP 111*	Prembasti local	SHARP Chitwan
	Rootstocks		
121	NCRP 65	Citrange C-35	INRA_CIRAD
122	NCRP 66	Citrange – Carrizo	INRA_CIRAD
123	NCRP 67	Poncirus– Pomeroy	INRA_CIRAD
124	NCRP 68	Flying Dragon	INRA_CIRAD
125	NCRP 69	Citrumelo 4475	INRA_CIRAD
126	NCRP 70	Volkameriana	INRA_CIRAD
127	NCRP 71	Rangapur lime Red	INRA_CIRAD
128	NCRP 113	Citrange old	Unknown
129	*NCRP 38*	*citrange*	Unknown
130	*NCRP 35*	*Citron*	Unknown
131	*NCRP 36*	*Trifoliate*	Unknown
132	*NCRP 37*	*Rangapur lime*	Unknown
133	*NCRP 39*	*Boxifolia*	Unknown
134	*NCRP 40*	*Rough lemon*	Unknown
135	*NCRP 116*	*Rough lemon*	Paripatle Dhankuta
136	NCRP-41	Hokse	Dhankuta
137	NCRP-62	Local Bimiro (Citron)	Belahara, Dhankuta
138	NCRP-104	Sweet lime Citrus limetta	Dhankuta
139	NCRP-139	Troyer Citrange	Australia
140	NCRP-140	Rough lemon	Kathmandu

Annex 2: Human Resource Allocation in 2077/78

Designation	Approved	Fulfilled	Vacant
1. Chief Scientist (S.5) – Horticulture	1	-	1
2. Senior Scientist (S.4)- Horticulture	1	-	1
3. Senior Scientist (S.3)- Horticulture	1	1	0
4. Senior Scientist (S.3)- Plant pathology	1	-	1
5. Scientist (S.1) - Soil	1	-	1
6. Scientist (S.1) - Plant breeding (Tissue culture)	1	1 (Hort.)	0
7. Scientist (S.1) - Entomology	1	-	1
8. Scientist (S.1) - Plant Pathology	1	1	0
9. Senior Technical Officer (T.8) – Olericulture	1	-	1
10. Senior Technical Officer (T.7) – Pomology	1	-	1
11. Technical Officer (T.6) - Horticulture	1	1	0
12. Technical Officer (T.6) - Pomology	3	-	3
13. Senior Technician (T.5)	2	1	1
14. Technician (T.4)	5	0	5
15. Technician (T-1)	13	3	10
16. Account officer (A6)	1	1	0
17. Administrative Assistant (A5)	1	1	0
18. Driver (Heavy)	1	1	-
Total	37	11	26

Annex 3: Human Resource of NCRP in 2077/78

Name	Position	Qualification	Working area
1. Dr. Umesh Kumar Acharya	Sr. Scientist (S-3)	Ph.D. (Pomology)	Horticulture
2. Dr. Sabitri Adhikari	Scientist (S-1)	Ph.D. (Hort.)	Horticulture
3. Roshan Pakka	Scientist (S. 1)	M. Sc. (Plant Pathology)	Plant Pathology
4. Dipti Adhikari	Technical officer (T-6)	M.Sc. (Plant Pathology)	Horticulture
5. Basupasa Hangsarumba	Account Officer (A.6)	Bachelors' degree	Account section
6. Shubheswor Yadav	Account Officer (A.6)	Bachelors' degree	Account section
7. Santosh Dewan	Chief Admin Officer (A-5)	B.A.	Administration and store
8. Balaram Shrestha	Chief Admin Officer (A-5)	Bachelors' degree	Administration and store
9. Hem Bahadur Dahal	TS- Fifth	Literate	Support in research and production
10. Tara Nath Khatri	Heavy driver-Fifth	S.L.C.	Driver
11. Kashi Nath Subedi	TS-First	Literate	Support in research and production
12. Dhan Kumar Rai	TS-First	Literate	Support in research and production
13. Gopal Silwal	TS-First	S.L.C.	Support in research and production
14. Tetari Devi	TS-First	Literate	Support in research and production

Annex 4: Publications in FY 2077/78

Publication	Type	Language	Published number
Annual Report (2076/77)	Book	English	100
Citrus nursery management technology	Book	Nepali	200
Citrus Fruit Farming Technology	Book	Nepali	500
Fruit Post-harvest Management Technology	Book	Nepali	200
Citrus Canker management technology	Leaflet	Nepali	1000
Citrus Phytopthora root rot disease	Leaflet	Nepali	1000

Annex 5: Regular Annual Budget and Expenditure in 2077/78

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
	Operational Expenses				
21111	Staff Salary	60,68,000.00	55,61,030.10	55,61,030.10	5,06,968.90
21131	Local Allowances	1,63,000.00	1,23,790.00	1,23,790.00	39,210.00
21132	Dearness Allowances	2,50,000.00	2,48,000.00	2,48,000.00	2,000.00
21121	Uniform	1,00,000.00	1,00,000.00	1,00,000.00	0.00
21213	Insurance Fund Expense Based on Contribution	52,000.00	51,200.00	51,200.00	800.00
22111	Water and Electricity Expenses	2.50,000.00	88,990.00	88,990.00	1,61,010.00
22112	Communication Expenses	2,01,000.00	1,42,370.00	1,42,370.00	58,630.00
22212	Fuel (Office purpose)	3,91,000.00	3,90,999.75	3,90,999.75	0.25
22214	Insurance	51,000.00	50,000.00	50,000.00	1,000.00
22221	Repair and Maintenance of Machinery and Equipments	199,000.00	1,96,845.00	1,96,845.00	2,155.00
22291	Repair and Maintenance of other Assets	85,000.00	84,933.00	84,933.00	67.00
22213	Vehicle Repair Cost	3,30,000.00	3,29,897.95	3,29,897.95	102.05
22311	Office related expenses	3,31,000.00	2,22,028.20	2,22,028.20	108971.80
22314	Fuel for Other Purposes	1,43,000.00	1,28,476.26	1,28,476.26	14523.74
22231	Repair/Maintenance of Public Assets	4,10,000.00	4,10,000.00	4,10,000.00	0.00
22512	Training and seminar expenses	17,50,000.00	1,92,059.00	1,92,059.00	1557941.00
22521	Production	1,04,52,000.0	95,30,554.01	95,30,554.01	921445.99

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
	Material Service	0			
22611	Monitoring and evaluation expenses	2,02,000.00	1,52,100.00	1,52,100.00	49900.00
22315	Newspaper, Printing and News Publication Cost	2,80,000.00	1,95,572.00	1,95,572.00	84,280.00
22413	Contract Service Cost	11,60,000.00	11,48,824.40	11,48,824.40	11,175.60
22612	Travel Expenses	13,21,000.00	9,77,486.00	9,77,486.00	343514.00
22711	Miscellaneous Expenses	1,06,000.00	1,05,935.00	1,05,935.00	65.00
28143	Vehicle & Machinery Equipment Rent Cost	1,20,000.00	73,199.00	73,199.00	46801.00
	Capital Expenses				
31123	Furniture and Fixtures	1,98,000.00	1,97,967.10	1,97,967.10	32.90
31122	Machinery Equipment	27,83,000.00	26,42,800.00	26,42,800.00	1,40,200.00
31159	Other Public Construction	57,50,000.00	46,78,386.82	46,78,386.82	10,71,613.18
31151	Road and bridge construction	10,00,000.00	6,33,872.94	6,33,872.94	3,66,127.06
31134	Making of computer software and purchase	1,50,000.00	0.00	0.00	1,50,000.00
	Grand Total	**3,42,96,000.00**	**2,86,57,317.50**	**2,86,57,317.50**	**56,38,682.47**

Annex 6: Beruju Status Till Fiscal Year 2077/78

Beruju	Amount	Remarks
Beruju till year (2077/78)	86,080.80	
Beruju in FY 2077/78	35,66,000	
Beruju cleared in this FY (2077/78)	0.00	
Remaining beruju	36,52,080.80	

Annex7: Annual Budget and Expenditure of PMAMP for 2077/78

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
	Operational Expenses				
22212	Fuel	1,00,000.00	98,531.00	98,531.00	1469.00
22311	Office related expenses	30,000.00	26,707.00	26,707.00	3,293.00
22611	Monitoring and evaluation expenses	1,50,000.00	1,49,961.00	1,49,961.00	39.00
22315	Newspaper, Printing and News Publication Cost	30 ,000.00	2,500.00	2,500.00	27,500.00
22522	Program expenses	9,25,000.00	8,66,854.00	29,965.00	58,146.00
22711	Miscellaneous Expenses	30,000.00	29,965.00	29,965.00	35.00
	Capital Expenses				
31122	Machinery Equipment	30,00,000.00	24.81,481.35	24.81,481.35	5,18,518.65
31131	Livestock and horticulture development expenses	55,00,000.00	25,53,173.00	25,53,173.00	29,46,827.00
	Grand Total	**97,65,000.00**	**62,09,172.35**	**62,09,172.35**	**35,55,827.65**

Annex 8: Annual Budget and Expenditure of KOIKCA UNDP Project in 2077/78

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
21135	Other Allowances	2,32,500.00	2,32,500.00	2,32,070.00	430.00
22212	Fuel	50,000.00	50,000.00	27,755.00	22,245.00
22315	Stationary and other expenses	1,50,000.00	1,50,000.00	1,49,838.00	162.00
22512	Production Material Service	9,00,000.00	9,00,000.00	7,69,632.67	1,30,367..33
22612	Travel Expenses	3,00,000.00	3,00,000.00	1,96,400.00	1,03,600.00
28142	House Rent	1,00,000.00	1,47,150.00	1,00,000.00	47,150.00
28143	Vehicle Rent	50,000.00	50,000.00	49,491.00	509.00
	Grand Total	**17,82,500.00**	**18.29,650.00**	**15,25,186.92**	**3,04,463.08**

Annex 9: Annual Budget and Expenditure of ACIAR Project in 2077/78

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
22521	Production Material Service	75,000.00	72,267.30.50	71,075.00	1,193.30
28143	Machinery and equipment	2,10,000.00	2,10,000.00	2,09,950.00	50.00
	Grand Total	**2,85,000.00**	**2,82,268.30**	**2,81,950.00**	**1,243.30**

Annex 10. List of online training participants entitled "Citrus Crop Management"

S.N.	Name of Farmer	Address
1	Kausila Thapa	Dailekh
2	Tanka Regmi	Dailekh
3	Sachin Bista	Gorkha
4	Taradatta Joshi	Gorkha
5	Suman Khanal	Gulmi
6	Madhukrishna Kandel	Gulmi
7	Jayhindra Harijan	Gulmi
8	Rupa B.K.	Myagdi
9	Ravikiran Adhikari	Nawalparasi
10	Shivanarayan Kumal	Nawalparasi
11	Kailashpati Chaudhari	Nawalparasi
12	Sushma Rai	Okhaldhunga
13	Kabita Magar	Okhaldhunga
14	Lila Shrestha	Okhaldhunga
15	Sarita Dahal	Okhaldhunga
16	Mishra Puri	Ramechhap
17	Bhawani Basnet	Ramechhap
18	Binod Raj Bhandari	Sindhuli
19	Laxmi Pokhrel	Sindhuli
20	Jahan B. Karki	Sindhuli
21	Indra P. Subedi	Syanja
22	Tuk B. Thapa	Sindhuli
23	Uttam Pokhrel	Udayapur
24	Ajay K. Yadav	Udayapur
25	Yagya B. Karki	Udayapur
26	Pramila Khalin	Udayapur

Annex 11. List of online training participants entitled "Improved Citrus Cultivation Technology"

S.N.	Name of Farmer	Address
1	Saraswati Shrestha	ADD,Biratnagar
2	Dipa Dev	ADD, Biratnagar
3	Balkumari Rai	Hort. Center, Faplu, Solukhumbu
4	Keshar B. Magranti	AKC, Panchthar
5	Hem Raj Panta	AKC, Ilam
6	Sumita Dahal	AKC, Jhapa
7	Prabin Lal Shrestha	AKC, Sunsari
8	Suraj Khanal	AKC, Dhankuta
9	Anu B.C.	AKC, Udayapur
10	Saroj Rai	AKC, Sankuwasabha
11	Yogendra Rai	AKC, Bhojpur
12	Sanjay Kumar Pandit	AKC, Khottang
13	Muna Basnet	AKC, Okhaldhunga
14	Bobby Basnet	AKC, SOlukhumbu
15	Binaya Maharjan	ACC, Taplejung
16	Renu Yadav	ACC, Morang
17	Abhishek K. Shah	ACC, Tehrathum
18	Darshan Neupane	Athrai Triveni R. M., Taplejung
19	Dipa Rai	Miklajung R.P., Panchthar
20	Santosh Lepcha	Rong R.P., Ilam
21	Kapita Pooudel	Mechinagar M., Jhapa
22	Karan Shrestha	Letang M., Morang
23	Nir B. Rai	Baharakshetra M., Sunsari
24	Dinendra Rai	Shahidbhumi R.M., Dhankuta
25	Him B. Thapa	Chhathar R.P., Tehrathum
26	Sonu Mishra	Katari M., Udayapur
27	Nima Rinji Sherpa	Madi M., Sankhuwasabha
28	Dipen Thapa	Kshadanand M., Bhojpur
29	Sargam Budhathoki	Diprung Churichumma R.M., Khotang
30	Birendra Tamang	Siddhicharan M., Okhaldhunga
31	Nawdhan Rai	Thulung Dhudkoshi R.M., Solukhumbu

Annex 12. List of training participants in Training entitled "Citrus Fruit fly identification and its management" organized at Sankhuwasabha

S.N.	Name of Farmer	Address
1	Ratna Bdr Rai	Khadabari, Sankhuwashabha
2	Tara Shrestha	Pa Na Pa, Sankhuwashabha
3	Chhinjik Bhote	Bhotekhola, Sankhuwashabha
4	Ramila Rai	Silinkchowk, Sankhuwashabha
5	Nima Rinji Shrepa	Madi Na Pa, Sankhuwashabha
6	Nima Futik Bhote	Bhotekhola, Sankhuwashabha
7	Chhitik Bhote	Bhotekhola, Sankhuwashabha
8	Kijulamu Bhote	Bhotekhola, Sankhuwashabha
9	Umesh Subedi	Madi Na Pa, Sankhuwashabha
10	Bishnu Subedi	Madi Na Pa, Sankhuwashabha
11	Dipak Bhandari	Chainpur, Sankhuwashabha
12	Lokendra Dangi	Chainpur, Sankhuwashabha
13	Shanti Bdr Dangi	Chainpur, Sankhuwashabha
14	Biroj Rai	Si. Ga. Pa, Sankhuwashabha
15	Ran kumar Rai	Si. Ga. Pa, Sankhuwashabha
16	Chadrakala Rai	Si. Ga. Pa, Sankhuwashabha
17	Shiba Kumar Rai	Khadabari, Sankhuwashabha
18	Purna Kumari Ale	Khadabari, Sankhuwashabha
19	Radha Koirala	Khadabari, Sankhuwashabha
20	Kedar Rai	Khadabari, Sankhuwashabha
21	Anil Gurung	Khadabari, Sankhuwashabha
22	Debendra Paudel	Pa Na Pa, Sankhuwashabha
23	Jamjuna Yakhya	Pa Na Pa, Sankhuwashabha
24	Soman Rai	Pa Na Pa, Sankhuwashabha
25	Nanda Bdr Magar	Khadabari, Sankhuwashabha
26	Rabin Rai	Khadabari, Sankhuwashabha
27	Dipendra Kafle	Khadabari, Sankhuwashabha
28	Durga Khatri	Khadabari, Sankhuwashabha
29	Madhu Maya Magar	Khadabari, Sankhuwashabha
30	Gajal Khatri	Khadabari, Sankhuwashabha
31	Bal Kumari Rai	Khadabari, Sankhuwashabha
32	Ban Kumari Rai	Khadabari, Sankhuwashabha
33	Santhosh B.K.	AKC, Khandabari Sankhuwashabha
34	Saugat Bohara	AKC, Khandabari Sankhuwashabha
35	Prabhat Swar	AKC, Khandabari Sankhuwashabha