ANNUAL TECHNICAL REPORT

FY 2056/2057 (1999/2000)

NEPAL AGRICULTURAL RESEARCH COUNCIL

NATIONAL CITRUS RESEARCH PROGRAMME

PARIPATLE, DHANKUTA

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FORWORD

Nepal Agricultural Research Council (NARC) officially established National Citrus Research Program (NCRP) in July 2000. This is the youngest commodity research program under NARC. However, Horticulture station, Paripatle, Dhankuta was functioning as a leading centre for citrus research and development since it's establishment in 1961 in the name of **Citrus Research Station.** In it's forty-years of history this station has undergone several changes in organizational set-up, name and mandate. Since national mandate on citrus research has been given to this station it is believed that research works on these fruit crops will be again systematized and enhanced in the years to come. This is the first annual technical report of NCRP. This report highlights the research activities and major findings of the year 2056/57 (1999/2000) when the station was operating in the name of Agriculture Research Station (Hort.), Dhankuta.

I would like to extend my sincere gratitude to Mr. Dhruva Joshi, Executive Director of NARC and other Directors for their keen interest and support for the creation of National Citrus Research Program.

I also gratefully acknowledge the valuable work and effort of Scientists, Technical Officers, Technicians and other administrative and support staff for their contributions to accomplish the research and management activities.

I believe that this report will be useful to all concerned with research, production and extension of citrus fruit crops in Nepal. Constructive comments and suggestions on this publication will be highly appreciated.

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Coordinator
NCRP, Dhankuta

ACRONYMS AND ABBREVIATION

C.	=	Citrus
cm	=	Centimeter
FYM	=	Farm yard manure
GA	=	Gibberellic acid
gm	=	Gram
Ha	=	Hectare
HMG/N	=	His majesty's government of Nepal
IBA	=	Indole Butyric Acid
Kg.	=	Kilogram
LSD	=	List Significant Difference
M	=	Meter
MS	=	Murashige and Skoog
N	=	North
NAA	=	Napthal Acetic Acid
NARC	=	Nepal Agricultural Research Council
NCDP	=	National Citrus Development Programme
NCRP	=	National Citrus Research Programme
NPK	=	Nitrogen, Phosphorous and Potash
^{0} C	=	Degree Celsius
RCB	=	Randomize Complete Block Design
SEAN	=	Seed Entrepreneurs Association of Nepal
t	=	Ton
TA	=	Titratable Acidity
T/ha	=	Ton per hectare
TSS	=	Total Soluble Solids
VDC	=	Vegetable Development Division
@	=	At the rate of
ZI	=	Indigenous ginger Germplasm
%	=	Percent

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1. INTRODUCTION

1.1 Background and History

Citrus fruits are cultivated all over the world in tropical region where there are suitable soil and climatic condition. In Nepal, the climatic condition of mid-hill region stretching right from the east to the west is favorable for citrus cultivation specially for mandarin, sweet orange, lime and lemon. Particularly the geographical areas between 26.5^0 to 28^0 N latitude having an altitude range of 750 to 1400 m are considered suitable locations for the cultivation of almost all citrus species and varieties of commercial importance. Pummelo, lime and lemon can also be cultivated in Terai region (< 500 m). The three most important species on which Nepal's citrus industry is based are mandarin (*Citrus reticulata*), sweet orange (*C. sinensis*) and lime (*C. aurantifolia*). These species are also potential exportable items particularly to India and Bangladesh. National Citrus Research Program (previously ARS, Hort. Dhankuta) has been involved in research and development of citrus fruit crops since its establishment in 1961.

The nomenclature and mandate of present-day Citrus Research Program has undergone several changes in the past. Firstly, it was born in the name of "**Citrus Research Station**" in 1961 with the objectives to generate the technologies on *Citrus species* and to boost the citrus cultivation in mid-hills of Nepal. In 1966, the name of this station was changed to "**Horticulture Research Station**" and mandate was given to work on other horticultural commodities too although major emphasis was on citrus fruits. Chungbang farm established in 1967 as an independent farm to conduct research on cereal crops was also later annexed to Paripatle farm and consequently programs on cereal crops were stopped and horticultural activities mainly on citrus fruits were initiated. This satellite farm is situated at a distance of 10 km from Paripatle farm. After the establishment of NARC, HMG/N decided to keep this station under Nepal Agriculture Research Council. However, HMG again transferred this station from NARC to the then Department of Horticulture in 1991 shifting its mandate from research to production. Lastly, in 1993, this station was again transferred back to NARC. In line with the directives of Agriculture perspective Plan, Nepal Agriculture Research Council up-graded this station as **National Citrus Research Programme** (NCRP) from Shrawan 2057 and provided national mandate to develop technologies on citrus fruit crops. It is believed that research programs on citrus fruits will be greatly strengthened and systematized after the re-establishment of this program.

1.2 Location

The main research farm of National Citrus Research Program is located in Belhara VDC ward No. 1, Paripatele of Dhankuta district. Geographically it is situated at $27^0 1'$ North latitude and $87^0 18'$ East longitude. The altitude of the farm ranges from 1250 to 1390 meter. It is situated 3.75 km west of Kagate, a spot situated on Dharan-Dhankuta-Hile high-way and is connected by motorable road. The satellite farm, Chungbang is located at Chungbang VDC at a distance of 10 km from Paripatele farm.

1.3 Soil and Climate

The soil texture varies from sandy to sandy loam along with gravel in different terraces. The pH of soil is acidic ranging from 4.5 to 6.2 with low (0.044%) to medium (3.33%) organic matter. Phosphorus and potash content of the soil vary from 15 to 50 kg/ha and 2.14 to 3.50 kg/ha respectively. The land of Paripatle farm is east faced of the hill where as Chungbang farm is north faced with sub-tropical type of climate. Paripatle farm receives average annual minimum and maximum temperature of 12.4^0 C and 26.78^0 C respectively. Monthly average meteorological data are presented in Appendix 5.

1.4 Land Utilization

National Citrus Research Program has a total of 26 hectare of land. Of the total land 20.0 hectare is in Paripatle farm and rest is in Chungbang farm. Land utilization statistics of both the stations has been presented in Table 1. From the table it is obvious that nearly 30% of the land is still covered by forest or is fallow which can be utilized for cardamom or coffee.

Table 1. Land utilization pattern of Citrus Research Program (Paripatle and Chungbang farm)

S.No.	Utilization pattern	Area (ha)		
		Paripatle Farm	Chungbang Farm	Total
1.	Orchard	8.0	3.0	11.0
2.	Fruit nursery	1.0	0.50	1.5
3.	Vegetable seed production	2.0	0.50	3.5
4.	Building, canal and road	2.3	0.50	2.8
5.	Forest and fallow	6.7	1.50	7.2
	Total	20.0	6.0	26.0

1.5 Objectives of NCRP

The long term goal of NCRP is to increase productivity and quality of citrus fruit crops in Nepal with especial emphasis in mid-hill region of the country. The short term goal (objective) of the program is to solve the production constraints of citrus fruit crops. To achieve above mentioned goal and objective NCRP performs the following activities on citrus fruit crops:

- Identify production constraints faced by growers, traders and processing industries.
- Develop appropriate technologies to solve the problems faced by these clients.
- Disseminate proven technologies to the clients (farmers, traders and processing industries) through out-reach research and publication of research findings.
- Coordinate with other national and international organizations in order to develop low-cost technologies efficiently.

- Compilation of research findings and other information related to citrus fruit crops from national and international sources.
- Serve as the source of expertise in citrus fruit crops.
- Production and supply of healthy mother stocks to nursery owner and farmers.

2. PAST ACHIEVEMENTS

Since its establishment NCRP has been involved in technology generation, testing, dissemination, farmers' training and production of foundation stocks of citrus species. Some of the major achievements (technologies) of the past are given below:

2.1 Germplasm collection and evaluation

NCRP collected various varieties and land-races of citrus germplasm. These germplasm are being established in the field gene bank of its farm for evaluation. Collected germplasm include local mandarins (land races from 10 different districts of Nepal), introduced mandarin varieties (Unshu, Murkott, Kinnow and Fruetrele early), sweet orange (12 varieties) Lime (two varieties) and citrus rootstocks (10 different types). A total of 132 pummelo trees grown in farmers' field were also evaluated *in situ*.

2.2 Variety Selection

A number of varieties have been recommended to the farmers as a result of germplasm evaluation work carried out in the past. Recommended varieties include (i) mandarin: Khoku local for eastern hill, (ii) sweet orange: Washington Naval for early harvest, Dhankuta Local for mid season harvest and Valencia late for late season harvest (iii) lime : Eureka for early season and Terathum local for late season harvest. In a farmers' participatory survey carried out in Terai and mid-hills of Nepal revealed very high level of diversity in pummelo population with respect to fruit quality. Terai area has been found more suitable for quality pummelo production. From 132 pummelo trees evaluated, five trees (4 from Terai & one from mid hill) are identified as elite types.

2.3 Standardization of nursery system

Studies carried out to standardized the vegetative propagation of citrus showed that veneer method of grafting should be performed in the months of November and December in mid-hill climate. Maintenance of grafted plants under plastic tunnel for three months produces up to 95 percent success. Trifoliate orange is suitable rootstocks for mandarin and sweet orange. Grafted saplings packed in moistened moss and jute sheet can survive up to 12 days during transportation.

2.4 Control of fruit fly

For the control of citrus fruit flies recommendations are (i) soil treatment with malathion dust during Feb. - March (Before flowering) (ii) collection and destruction (burying into soil or boiling in water) of infected fruits within half an hour of their drop from the tree (iii) spraying of trees with sugar + malathion solution during July - August (iv) use of Feromin trap from March to September (5 ml malathion + 5 ml methyl eugenal per trap; one trap per 10 trees)

2.5 Control of scale insects

Spray of mineral oil @ 5 ml/litre of water just after the harvest of fruit and pruning of infected branches

2.6 Control of green sting bug

Spray of Malathion 1ml/lit + Rogor 0.5 ml/ lit during July - August

2.7 Rejuvenation of declining trees due to root-rot

Approach grafting with trifoliate rootstocks during May - June can revert the declining trees

2.8 Storage of mandarin in cellar store

Matured mandarin fruits with fruit stalk can be stored for three months at room temperature of 10^0 C. and nearly 95% relative humidity inside cellar store.

3. RESEARCH REPORTS

3.1 On-farm Verification of Improved Technology on Mandarin Orange

Abstract

To demonstrate the possibility of increasing productivity and quality of mandarin fruits in poorly managed orchards an on-farm study was carried out at three locations of Dhankuta district. In each location, 18 plants (15 years old) were selected. Recommended package of technology (pruning, mulching, irrigation, fertilizer, pest control) was given in 9 plants whereas 9 plants were left for farmers to apply their practices. On an average there was 40 percent increase in yield of mandarin trees when improved technology was applied in poorly managed trees for two consecutive years. The results suggest that extension should give further attention to educate citrus growers and to demonstrate the economic viability of presently available technology in order to increase the productivity.

Introduction

Citrus species are the most important fruit crops of Nepal. At present mandarin, sweet orange and lime are grown in more than 400 pockets of 49 districts in mid-hill of Nepal. Mandarin has covered nearly 60 percent of citrus area of the country. It is widely cultivated in the hills from 600 to 1400 m elevations and is the most important crop commodity among citrus species in Nepal. Mandarin trees can be seen around almost each and every household in the villages of hills from east to west of the country. Over 100 years old seedling mandarin trees are found in bearing condition in some districts such as Dhanging, Dhankuta and Sankhuwasava. It indicates that mandarin is a traditional crop of Nepal. In the last 20 years area under mandarin cultivation has been increased by 18 folds but productivity has remained stagnant at 10 tons per hectare level. The low productivity of this crop is mainly attributed to the poor management of trees with respect to training, pruning, nutrition, diseases and insects in most of the orchards. Therefore, a field study in farmers' orchards has been under taken since last two years with the objective to rejuvenate and improve the productivity of poorly managed orchards.

Production period of mandarin orange in Nepal is very narrow (Kartik to Poush). Nearly 15 years ago a new mandarin variety: Kinnow was introduced to Nepal from Pakistan. In India and Pakistan this variety has been grown in warmer areas such as Delhi and Punjab and supplied in the market in late season. In Nepal, initially it was planted at various research stations including in Terai areas. But all trees died before their potentiality of production in lower altitude and Terai regions was properly evaluated. From this year, saplings of this variety are being planted in two locations of eastern Terai namely Damak (Jhapa) and Lahan (Siraha) in varietal evaluation plots to evaluate the production potentiality of this variety in warmer climate.

Materials and Methods

For the verification of improved management practices on mandarin orchard, three poorly managed orchards at farmers' field one each from Dhankuta municipality, Khoku V.D.C. and Chhingtang V.D.C. were selected. Name of the orchard owner and address are given in Table 3. A total of 18 plants of about 15 years of age were selected from each selected orchard. Information on orchard management practices adopted by collaborative farmers on these trees was collected through interview. Before the application of treatments, selected plants were grouped into two groups, comprising nine trees in each group. The plants of each group were numbered from 1-9 so that their individual performance can be monitored later. In one group of plants (nine plants) recommended package of technology (IP) was applied while in other group farmers' practice was applied (FP). Inputs used and cultural practices adopted by collaborative farmers (FP) were based on the information provided by them during interview. Detailed of two types of treatments (FP and IP) applied on these trees is given in Table 2. Data on growth pattern on vegetative parts and yield were recorded after fruit harvest.

Table 2 Description of improved technology (IP) and farmers' practice (FP) applied in the experimental trees.

SN	Operation	Treatment type	
		IP	FP
1	Pruning	Once in Magh	No pruning
2.	Basin making	Done in Magh	No basin preparation
3.	Compost application	@ 50 kg/plant in Magh	@ About 30 kg/plant in Magh - Phalgun
4.	Chemical fertilizer application	DAP @ 1 kg/plant Ist week of Phalgun and Urea @ 500 gm /plant after first rainfall	No chemical fertilizer application
5.	Bordeaux paste	Applied	Not applied
6.	Insect control	Spraying of Roger @ 1 ml/lit of water before flowering, in Jestha and in Bhadra	Insecticide was not applied
5.	Disease control	Spraying of Kerathion @ 1/2 ml/lit of water Jestha, Asar and Bhadra	No fungicide application

To evaluate the performance of Kinnow mandarin in Terai area grafted plants on trifoliate orange rootstocks were planted in two sites namely Damak and Lahan. In Damak (Jhapa), 52 plants are planted in farmer's field at a distance of 3 meters covering an area of two ropanies. In Lahan, same numbers of plants were planted in the production field of Technical School. The saplings were produced in CRP, Dhankuta. At the time of planting, pit digging and other operations were carried out as per recommendation to other mandarin varieties. Similarly, recommended inputs were also applied. Data on survival rate and growth patterns in vegetative parts were recorded annually.

Results and Discussion

Table 3 presents the data of 3 locations and two years on growth and yield increment achieved as the result of application of improved technology in farmers' orchard. It is apparent from the table that fruit yield in the plants that received improved production technological packages increased by 15 to 89 percent over those plants, which were managed following the farmers' practices. On an average there was 40 percent increase in yield of mandarin trees when improved technology was applied in poorly managed trees for two consecutive years. Average yield of a tree in farmer's practice (FP) was 33.4 kg, which is equivalent to national average productivity (10 tons/ha). On the other hand, when recommended package of technology (IP) was applied for two years on these plants, average fruit yield of a tree increase to 45.2 kg. This productivity level is equivalent to 13.56 tons in a hectare (calculation is based on 300 trees/ha). This productivity is 35 percent higher than national average productivity.

Table 3 Effect of improved technology on growth and yield of mandarin at farmers' field after two years of treatment application.

Locations	Year	Mean girth increase (cm)		Volume increase (Cubic m)		Yield (Kg)		Yield increase in IP over FP
		IP	FP	IP	FP	IP	FP	
Dhankuta municipality W. N. 7 (B. Guragai)	1998/99	2.90	2.47	3.03	2.30	31.3	23.2	34.7
	1999/00	3.03	2.56	3.10	2.41	46.0	24.3	22.3
	Average	2.96	2.51	3.06	2.35	38.7	23.8	89.3
Khoku V.D.C. W.N. 5 (K. B. Rai)	1998/99	2.40	1.77	2.95	2.12	49.8	42.4	15.4
	1999/00	2.60	1.84	3.15	2.15	58.2	43.6	33.5
	Average	2.50	1.80	2.13	2.13	54.0	43.4	24.5
Chhintang V.D.C. W.N. 3 (B. B. Rai)	1998/99	1.72	1.18	1.83	1.83	39.7	33.4	18.9
	1999/00	1.80	1.20	1.85	1.85	46.2	32.6	41.7
	Average	1.76	1.19	1.84	1.84	43.0	33.0	30.3
Average of 3 locations		2.46	1.83	2.10	2.10	45.2	33.4	36.9

The hills of Nepal, which support nearly half of the nation's population has been facing environment degradation due to increasing population pressure as well as expanding cultivation of cereals and overgrazing. In this context, rapid incorporation of high value fruit trees such as mandarin into farming system could be an alternative to improve the welfare of small farmers without impairing the resource base. As the access to urban market improves, commercial demand of mandarin orange is likely to increase. Nepalese mandarin can also enter Indian and Bangladeshi market if we can increase the volume of production and assure supply in terms of

time, quantity and quality. Therefore, to meet increasing demand of mandarin fruits, Nepal has to increase its productivity rather than focusing only on area expansion. This study showed that presently significant number of citrus growers do not apply recommended technology on their orchards, which is one of the major reasons for very low national productivity. Extension agents involved in citrus crops should, therefore, give due attention to educate citrus growers and demonstrate the economic viability of advanced technology.

The study carried out to explore the possibility of Kinnow mandarin cultivation in Terai area is still in initial stage. In each site (Damak and Lahan) 52 plants were plants in 2056, Asar. Presently, these plants are 18 months old and are showing vigorous vegetative growth and health. The evaluation work will be continued in the years to come in order to evaluate the yield and fruit quality parameters.

3.2 Management Study on Fruit fly and Phytophthora on *Citrus Species*.

Abstract

Fruit fly (Daccus dorsalis) is the most serious citrus insect pest of eastern hills. It is reported that more 30% sweet orange fruits are damaged by fruit fly in this region. The study carried out in farmers' fields showed that population of fruit flies starts to increase from Baisakh to Bhadra and then drops down. In most fruit fly affected orchards, fruits damaged by flies were not collected and damaged in proper time (within half an hour of fruit drop). Farmers were selling affected fruits in the market which could cause further spreading of this pest in new areas. There was lack of coordination among the growers of close vicinity in fruit fly control activity. Among the Citrus species grown in Dhankuta district hill lemon (Nibuwa), sweet orange and Bhale Junar (Sweet orange x pummelo ?) were found most severely affected by fruit flies. Other insect pests most commonly found in eastern hill were scales, aphids, leaf minor and green stink bug. Similarly major citrus diseases found in eastern hills were foot and root rot, powdery mildew, shooty mould and citrus canker.

Introduction

More than 825 different species of insects and mites are known to feed on citrus throughout the world. According to Rajput and Haribabu (1995) citrus trees in India are attacked by more than 250 inswect pests at all stages of growth right from seedling till the plant exists. It is reported that more than 30 types of insects are causing economic loss in citrus in Nepal (Cokkes, 1995). One or other species of insect pests attacks roots, trunks, stems, leaves, flowers as well as the fruits. Fruit fly (*Daccus dorsalis*) is most serious citrus insect pest of eastern hills. The insect was first reported from Bhojpur district about 20 years ago. Presently, it is distributed in most hill districts of eastern development region. Integrated techniques to control this pest has been already recommended and extension people in Dhankuta district are using this technique. Therefore, to monitor the effectiveness (adoption by farmers) of the technique and population dynamic of fruit fly a field study was carried out in Dhankuta district.

Foot-rot caused by *Phytophthora spp* is another problem of mandarin. Other terms used for foot-rot are gummosis, brown rot, collar rot, trunk rot. More than one species of Phytophthora are associated with this disease. When fungus attacks near the soil, the disease first spreads to the main roots and then around the base of trunk. Mandarin trees specially the seedling trees are very susceptible to Phytophthora fungus. Since majorities of mandarin trees of eastern hills are seedling origin, phytophthora problem is also wide spread. Therefore, a management study of foot-rot disease on mandarin was undertaken. Similarly citrus diseases and insect pests of eastern hills were monitored through field visit and visual observation.

Materials and Methods

Study on fruit fly management on sweet orange was conducted at CRP, Paripatele as well as in farmers' fields of Dhunkuta district. Sweet orange orchards at 4 sites were selected for the study. These sites are Chuliban, Debrebas, Belahara and Citrus Research farm, Pripatle. Fruit trees were selected during February and soil was treated with malathion @ 50-100 gm per tree depending upon tree size. After this, feromone traps were installed in the selected orchards. A total of 8 traps were installed in Chuliban, 10 traps in Debrebas, 5 traps in Belahara and 22 traps in CRP, farm. In the trap, methyl eugenol was used as an attractant and malathion as poison. Both chemicals were used @ 5 ml/trap. The male flies entrapped in the lure assembly were observed at weekly interval and old lures were replaced with new ones at 15 days interval. Two foliar cover spray of malathion (50% E.C.) 0.05% a.e. + sugar !% was given in the month of July and August. Infected fruits were collected and buried in the soil from November to December.

For the management of Phytophthora disease 15 years old mandarin seedling trees in the orchard of CRP were used. Twenty highly infected plants were divided into two groups. In ten trees phytophthora management practices were applied while in rest of the ten trees farmers' practice was used. Details of two types of treatment is given in Table 4.

Table 4 Detailed of treatments in Phytophthora management study

SN	Phytophthora management practice	Farmers' practice (control)
1	Darainage system developed.	1. Drainage system was not developed.
2	No inter-cropping	2. Inter-cropping with maize and millet
3	Only surface soil was disturbed at time of fertilization	3. Heavy digging and plowing was done
4	Bordeaux paste applied in January	4 Bordeaux paste was not applied
5	Approach grafting done in highly infected plants with trifoliate rootstocks	5. No approach grafting
6	Infected portion of trunk scratched and Bordeaux paste applied.	6. Infected portion left as such.

For monitoring the insects and diseases of citrus fruits in eastern hills of Nepal, different production pockets of Dhankuta, Terathum, Ilam and Bhojpur were visited three times a year (March, July and September) and major diseases and insects were recorded by visual observation and interview with farmers.

Results and discussion

The data on monitoring of fruit flies in different locations and months of the year are presented in Table 5. It is clearly observed that number of male flies entrapped tended to increase gradually from Baisakh to Bhadra and then dropped down. The number of flies entrapped varied in different sites because of various reasons such as initial population density, micro-climatic condition, intercultural operations, orchard management etc.

Table 5 Average number of fruit flies entrapped in different months and locations.

Months	Locations				
	CRP, farm (1300 m)	Chuliban (1000 m)	Debrebas (1300 m)	Belahara (1200 m)	Month mean
Baisakh	35	57	81	59	58
Jestha	232	135	188	288	210
Asar	591	354	348	629	480
Shrawan	442	417	830	467	539
Bhadra	117	222	149	306	198
Aswin	3	8	3	3	4
Location average	236	198	266	292	

Despite several years of efforts the population level of flies were found very high. From the direct communication and interview with the farmers it was found that citrus growers are not educated properly about the integrated control measure of fruit fly. Most farmers do not understand the life cycle of fruit fly which is very necessary to manage it. In most fruit fly affected orchards, fruits damaged by flies were not collected and damaged in proper time (within half an hour of fruit drop). Farmers were selling affected fruits in the market, which could cause further spreading of this pest in new areas. There was also lack of coordination among the growers of close vicinity in fruit fly control activity. For example all the growers of a locality were not applying control measures. In the same manner many citrus species which are not much economically important (such as Bhale Junar) but severely affected by fruit flies were not cared for fruit fly control. The affected fruits of such trees were serving as the source of flies for next year.

Among the Citrus species grown in Dhankuta district hill lemon (Nibuwa), sweet orange and Bhale Junar (Sweet orange x pummelo ?) were found most severely affected by fruit flies. But distribution of this insect is not evenly spread in all production pockets of the district. Many isolated production pockets within a VDC were also free from such flies but these pockets may be affected by fruit flies if proper quarantine is not imposed.

The management study of Phytophthora was started in last of fiscal year (after the start of rainy season). There were not visible differences in the plants applied with phyriphthora management practices. Nevertheless, observations will be continued in next several years.

Table 6 presents the major insect pests of 4 hill districts of eastern hill observed during survey. Among the insects noted fruit fly, scales, aphids were causing more economic loss to citrus

fruits. Similarly, Foot and root rot, powdery mildew, shooty mould and nutrient deficiency were major diseases of the region (Table 7.)

Table 6 Major citrus insect pests found in eastern hill in 2056/57

Name of insects	Time of occurrence	Crop affected	Intensity of damage
1. Fruit fly	Baisakh to Bhadra	Sweet orange, lemon, Bhale Junar	High
2 Scales (red, purple, brown, soft)	Whole year	Sweet orange, mandarin, trifoliate orange	High
3. Green stink bug	Shrawan - Bhadra	All citrus	Medium
4. Aphids	Phalgun -Asar. Also causing shooty mould	All citrus	High
5. Leaf minor	Jestha-Shrawan. In third flush growth	All citrus	Medium
6. Stem Borer	Whole year	Seedling/saplings of all citrus and mature plants of eureka lemon	Medium
7. Lemon butter fly	Chaitra - Asar	Seedlings/saplings	Medium

Table 7 Major citrus diseases found in eastern hills in 2056/57

Name of disease	Time of occurrence	Crop affected	Intensity of damage
1. Foot and root rot	Whole year. Severe in rainy season	Seedling trees of mandarin	High
2. Gumosis	Whole year. Severe in rainy season	Mandarin, sweet orange	Medium
3. Powdery mildew	Rainy season in more than 1100 m altitude	All citrus	High
4. Shooty mould	Rainy season	All citrus	High
5. Citrus Canker	Whole year	Lime	Medium
6. Damping off	Rainy season	In nursery of all citrus	Medium
7. Nutrient Deficiency	Whole year	Mandarin and sweet orange	High

3.3 Multi-location Trial on Cauliflower cv. Kibo Giant for Seed Production

Abstract

Kibo Giant is the major cauliflower cultivar for late season production in Nepal. Seed production technique of this variety has not yet standardized in Nepal. Therefore, seed production study of this variety was carried out in two locations (1390 and 1500 m elevation) of Dhankuta district. Highest yield (82.2 kg/ha) was recorded in 1500 m altitude when (i) seeds were treated with Bavistin (2 gm/kg) before sowing (ii) recommended doses of compost and fertilizers were applied and (iii) Borax was applied @ 2 kg/ha.

Introduction

Cauliflower is one of the major vegetable crops of Nepal. Both hybrid and open pollinated varieties are being cultivated in Nepal in commercial scale. The open-pollinated varieties of cauliflower are classified into three groups based on their harvesting period: early, mid and late season. Kibo-Giant is one of the late season varieties and this variety is gradually replacing another late season variety "Snow Ball-16" in Nepal and consequently its seed demand is increasing. However, almost all of the seed requirement of Kibo-Giant is being met by importation mainly from the Netherlands. The price of imported seed is very high; normally more than Rs.5000 per kg. Earlier, seed production of this variety was attempted in several locations of western Nepal such as Dhadeldhura, Dolpa and Jumla' but results are not much promising for commercial production. Deficiency of micro-nutrients (boron and molybdenum) and stalk-rot due to sclerotonia are considered as the major limiting factors for the seed production of Kibo-Giant. Therefore, a multi-location study was carried out to identify the limiting factors for seed production of Kibo Giant and to explore the possibility of seed production of this variety.

Materials and Methods

The experiment was carried out at two locations namely Paripatle (1390 m) and Dhankuta Municipality W.N.1, Nigale (1500 M). A total of six treatments were applied to the experimental plants. The detailed of these treatments are as following:

1. Control = Farmers practice (FP) for the seed production of cauliflower - Compost + fertilizer applied .
2. Recommended package of practice (RPP) = Compost + fertilizer + seed treatment
3. RPP + Borax as soil application @ 20 Kg/ha (RPP + BO)
4. RPP + Molybdenum @ 2 kg/ha (RPP +MO)
5. RPP + foliar spray of carbendazim @ 2 gm/lit. of water (RPP +spray)
6. RPP + BO + MO + Spray (Rate as mentioned above).

Except in control seeds used in other treatment were treated with carbendazin (Bevistin) @ 2 gm/kg seed before sowing. Each treatment was replicated four times and the experimental plots were designed in RCB method. A total of nine plants were planted in each plot of 2.70 x 2.25 m size; maintaining row to row and plant to plant distance at 90 cm and 75 cm respectively. In all treatments fertilizers were applied at the rate of 250:200: 100 kg/ha N:P:K respectively. Full dose of P & K and half of N were applied at the time of transplanting whereas 1/4 N_2 was applied two months after transplanting and next 1/4 at the time of bolting. In addition to chemical fertilizers each plant was given 1 kg compost at the time of transplanting. The seed were shown on 32 Bhardra, 2056 and seedling were transplanting after 45 days. In case of treatment number 5 and 6 carbendazine was sprayed on Magh 21, Magh 28 and Phalgun 8, 2056.

Result and Discussion

Seed yield and yield contributing parameters recorded in this study have been presented in Table 8. Flowering characters such as 50% curd formation, 50% bolting and flowering were not affected by the application of micro-nutrients (Boron and/or molybdenum) and fungicide but there traits were affected by altitude of seed production site. In lower altitude (1390 m), 50% plants produced curds after 73 days of transplanting where as in 1500 m altitude they produced curds only after 94 days. Similarly, in 1390 m altitude, 50% plants were at bolting and flowering stage after 118 and 130 days of transplanting respectively. But at the altitude of 1500 m, these events took place 131 and 153 days after transplanting respectively. Like wise pods of 75% plants reached at maturity stage after 155 days of transplanting at 1390 m altitude. On the other hand in 1500 m elevation, 75 % maturity was noticed after 198 days of transplanting. It was observed seed yield is positively correlated with number of stalks. In both altitudes, the plants applied with RPP + Boron produced highest number of stalks as well as seed yield. Highest seed yield (41.2 gm in 1390 m.; 50 gm in 1500 m) was observed in the plants applied with RPP + BO. In other treatments seed yield was very poor (less than 15 gms/plot). It indicates that boron could be on of the limiting factors for the seed production of cauliflower cv. Kibo Giant.

The highest yield (50 gms/plot) is equivalent to 82.2 kg/ha. This level of productivity is considered very low for commercial production. Such low seed yield was mainly due to two reasons. Firstly, seed crop was damaged by hailstorm and secondly, there was very good flowing and pods setting but seed formation was very poor. Therefore, further investigation is necessary to improve rate of seed formation. Manipulation of planting time and/or use of chemicals that accelerate the rate of seed formation in vegetable crops could be worth to investigate

Table 8 Seed yield and yield contributing traits of cauliflower cv Kibo Giant under various treatments conditions.

Treatments	Days to 50% curding	Days 50% bolting	Days to 50% flowering	Days to 75 % maturity	Number of normal fruiting plants/plot	Number of stalks/ plant	Seed yield/ plot	Days to harvest
1390 m FP	73	118	130	155	4.2	3.5	11.2	168
1500 m	94	131	153	198	4.0	3.0	15.0	215
1390 m RPP	73	118	130	155	3.5	3.5	10.0	168
1500 m	94	131	153	198	3.0	3.0	10.0	215
1390 m RPP + Bo	73	118	130	155	5.7	5.4	41.2	168
1500 m	94	131	153	198	7.0	5.0	50.0	215
1390 m RPP + Mo	73	118	130	155	3.6	3.3	18.2	168
1500 m	94	131	153	198	5.0	4.0	25.0	215
1390 m RPP + spray	73	118	130	155	3.0	3.0	10.0	168
1500 m	94	131	153	198	3.0	2.0	10.0	215
1390 m RPP + Bo + Mo + spray	73	118	130	155	3.0	3.0	10.0	168
1500 m	94	131	153	198	3.0	2.0	10.0	215

3.4 Coordinated Varietal Trial on Ginger

Abstract

A collaborative study with Ginger Research program was undertaken in NCRP, Dhankuta with the objective to identify high yielding ginger clones with superior quality attributes for eastern hills of Nepal. A total of eight different clones (accessions) were included in the study. Accession ZI-9721 (Salyan selection) produced highest yield (78.4 T/ha) followed by ZI-8508 (Tanahu selection) (66.0 T/ha). Accession ZI-9721 is liked by the farmers and seed demand is increasing.

Introduction

The ginger is a vegetatively propagated crop and the agro-ecological conditions play greater role in the quality attributes. The same variety grown under different conditions show marked differences in quality attributes. However, a good amount of genetic variability has been observed in the cultivars being grown in different parts of the country. Flowers are sterile, clonal selection is the most conventional and adopted variety screening method in ginger.

There is no significant increase in area and production of the ginger during the past decades. Because particularly of unavailability of quality varieties and losses due to rhizome rot. It is therefore imperative to develop high yielding along with disease resistant, low fiber content (<4.0 % and high volatile oil content (>2.0%) and oleoresin (>6.0%) contained varieties. A very little variability exist among the genotypes being grown in the same area. However a good amount of genetic variability has been reported among the cultivars grown in different states of India. In this contest some attempts have been made on collection and evaluation of indigenous ginger germplasms and performance of selected varieties in different locations of the country. In this context a collaborative study with Ginger Research Program was undertaken in this station with the objective to identify high yielding ginger clones with superior quality attributes for the eastern hills of Nepal.

Materials and Methods

A total of 8 different accessions (clones) were included in the study of which seven clones were supplied by Ginger Research Program and one (local) was collected locally. The accessions included in the study were: Salyan selection (ZI1-9721) Ilam selection (ZI 8502), Bhojpur selection (ZI 8503), Palpa selection (ZI, 8505), Tanahu selection (ZI 8508), Nawalparasi selection (ZI-8506), Syanja selection (ZI-8504), and local. Seed-rhizomes were treated twice by dipping one hour prior to storage with Indofil M-45 @ 3 and 1 gm/lit of water respectively followed by shade drying. Experimental plots were designed in RCB method and each accession was replicated three times. About 60 gm sized rhizome bits were planted in a plot size of 3.0 m x 1.2 m with the spacing of 30 cm x 30 cm. All experimental plots were supplied with 30 T/ha FYM and 75:50:50 kg N:P:K: per hectare. Full dose of FYM and P_2O_5 and 1/2 dose of K_2O were applied as basal dose. Half dose of N_2 was applied 30 days offer germination (DAG) whereas half dose of N_2 and half dose of K_2O were applied 60 days offer germination. After planting experimental plots were mulched with tender twigs of Titepati and mulch was covered with soil. All accessions were planted on 10th Chaitra, 2055 and harvested on 22nd Paush 2056 . Data recording was undertaken as per the instruction provided by Ginger Research Program.

Results and Discussion

Table 9 shows the performance of ginger accessions with respect to vegetative and yield characters. ZI-9721 (Salyan selection) produced highest yield (78.4 T/ha) followed by ZI-8508 (Tanahu selection) (66.0 T/ha). The plants of Z1-9721 were also taller as compared to others. Z1-8506 (Nawalparasi selection), and Dhakuta local (check) gave lowest yield (48 T/ha). Incidence of rhizome-rot was not noticed in any of the clones. This might be due to the reasons (i) the seed rhizomes were treated with fungicide and (ii) the field used for the experiment was free from the pathogen. Although, all the genotypes contained some fiber, Salyan-selection was found best performer in Dhankuta area.

Table 9 Performance of different ginger genotypes in Dhankuta condition (1390m).

Accession No	Tillers per clump	Plant height (cm)	Yield per clump (kg)	Yield per plot (kg)	Mother rhizome recovery per plot (kg)	Fresh Rhizome yield (t/ha)
ZI-9721 (Salyan selection)	17.0	110.3	0.73	35.3	2.1	78.4
ZI-8502 (Ilam selection)	18.3	92.0	0.61	28.5	2.0	63.3
ZI-8503 (Bhojpur selection)	17.7	93.7	0.53	25.1	1.7	55.8
ZI-8505 (Palpa selection)	20.3	84.3	0.54	25.4	2.0	56.3
ZI-8508 (Tanahu selection)	18.3	78.7	0.63	29.7	2.0	66.0
ZI-8506 (Nawalparasi selection)	20.3	80.3	0.48	22.0	1.9	48.8
ZI-8504 (Syanja selection)	22.7	83.3	0.58	27.1	2.3	60.3
Local	16.0	73.0	0.47	21.6	1.3	48.0

3.5 Management of Citrus Orchards

The research farm of NCRP was established in 2018 B.S. (1961 AD) as "Citrus Research Station" to initiate systematic research on *Citrus species*. In 2029 (1972), National Citrus Development Program (NCDP) was established. In the beginning NCDP was housed at Horticulture Research Station, Pokhara (previously Citrus Research Sub-station). In 2031 B. S. (1972), NCDP was moved to Dhankuta Agriculture Station (previously Citrus Research Station). But later NCDP was again moved to Kirtipur, Kathmnadu and this station had under-gone several changes in it's nomenclature (naming) and organizational set-up as mentioned in introduction section of this report. In spite of all these changes, this farm has been primarily involved in citrus research and development of the country since its establishment. In the initial stage of this station (2018-2035), several types of citrus and other fruit tree germplasm were collected locally and from abroad. Detailed of genetic materials of citrus species maintained in this farms of this program are given in **Table 11.** While maintaining these germplasm, recommended practices were adopted. These genetic resources are being maintained in two research farms (Paripatle and Chungbang) of this program. Paripatle has 20 hectares of farm area and Chungbang has 6 hectares. These germplasm are utilized for (i) Source of scion for sapling production for farm as well as for local nurseries (Mother stocks) (ii) research materials for superimposed study (iii) source of rootstocks (iv) field gene bank for germplasm conservation.

3.6 Collection and Evaluation of Vegetable and Citrus Germplasm

Introduction

Mid-hills of Nepal is very rich in genetic diversity of different types vegetables. The diversity exists both among and within species. Local communities of Nepal have been growing diverse genotypes (land races) for centuries and contributing towards domestication, selection and protection of valuable genetic resources in their home harden and marginal land. Diversity of such natural population is the result of evolutionary process caused by natural selection and hybridization, spontaneous mutation, migration (dispersion and geographical isolation) and genetic drift. Human activities such as artificial selection and hybridization have caused further differentiation in the domesticated plant species which developed plant types more suited to human requirements. Plant breeding begins with exploitation of variability within natural populations and therefore genetic diversity can be considered as raw materials for varietal improvement program. Since genetic diversity is exploited in breeding programs, there is a need to capture the diversity through exploration, collection, characterization, evaluation, documentation and preservation of plant resources before they disappear. Considering the importance such local genetic resources this station had collected some local germplasm of vegetable crops in past years. These germplasm were maintained in the field gene bank of the station in this year. Brief description of these germplasm is given in **Table 10.**

In addition to maintaining local germplasm some commercial cultivars of vegetables have also been maintained in this station through the process of mass selection. The crop and varieties include cauliflower (cv. Kathmandu local), radish (cv. 40 days and Mino-early), bean (cv. Trisuli and Four season), Broad Leaf Mustard (cv. Khumal Broad Leaf), Pea (Sikkime).

Table 10 List of local vegetable germplasm maintained in NCRP, Dhankuta.

S. N.	Name	Collection site	Available season	Types
1.	Pindalu (*Colacacia indicum*)	Dhading and, Bhojpur	May-Dec.	Long slender type, round type, very big size
2.	Chayote (*Sechium edule*)	Ilam and Dhankuta	June-Dec.	**Green:** Big spineless, Big spiny **White:** Big spineless, small spineless, Big spiny and small spiny.
3.	Pea (*Pisum sativum*)	Ilam	Sep-Jan.	Large-sized fiber-less pods
4.	Bean (*Dolichus lablab*)	Dhankuta	All season	Grown in four season, black seed, small sized pod; high yielding
5.	Pumpkin (*Cucurbita muschata*)	Dhankuta	July-Oct.	Big fruits with oblong, oval and round shape.
6.	Tarul (*Dioscora albate*)	Dhankuta	Dec.-Feb.	Long and tapering
7.	Cucumber (*Cucumis sativa*)	Dhankuta	June-Oct.	Long green, long white, green oblong, white oblong

Table 11 Citrus and other fruit germplasm maintained in NCRP (Paripatle and Chingbang farms).

Name of species	Variety/type	Age	No.	General characters
Mandarin (*Citrus reticulata*)	1. Khoku collection	30	1700	Commercial, mid-season
	2. Collection from 10 districts	20	400	Under evaluation
	3. Kinnow	15	250	Late season, under evaluation
	4. Frutrele early	20	10	Under evaluation
	5. Unshu	3	5	Under evaluation
	6. Murkotte	2	5	New introduction
Sweet orange (*Citrus sinensis*)	1. Dhankuta local	10-25	1135	Commercial, mid-season
	2. Washington Navel	15-25	70	Early season
	3. Mosambi	25	5	
	4. Pineapple	25	5	
	5. Samauti	25	2	
	6. Valencia late	25	3	Late season
	7. Malta Blood Red	25	3	
	8. Ruby	25	3	
	9. Jaffa	25	2	
	10. Hamling	25	2	
Lime (*Citrus aurantifolia*)	1. Terathum local	20	200	Commercial, mid-season
Lemon (*Citrus lemon*)	1. Hilll-lemon (Nibuwa)	20	5	Commercial
	2. Ureka	20	90	Late season
Citron (*Citrus medica*)	1. Local	20	2	
Calamondin (*Citrus mitis*)	-------	20	1	
Trifoliate orange (*Poncirus trifoliata*)	-------	10	150	Commercial in Nepal, dwarf.
Rangapur lime (*Citrus limonia*)		110	1	Popular in India
Rough lemon (*Citrus jambhiri*)	Local	20-25	10	Vigorous
Citrange (Carizo and Tryor)		10		Substitute of trifoliate
Boxifolia (*Severiana boxifolia*)		5-10		
Guava	L.-49, A. Safeda	25-30	100	
Pear	Bartlett, Pharping	25-30	50	
Avocado	-------	15	3	

3.7 Micro-propagation of *Citrus species.*

Abstract

Tissue culture technique can be applied in citrus species especially for the management of citrus greening disease and tristeza virus and for rapid multiplication of elite germplasm, rootstocks and indicator plants. A study was carried out at tissue culture laboratory of Citrus Research Program, Dhankuta to standardize the tissue culture technique for rapid multiplication of trifoliate orange. For shoot proliferation, actively growing shoots ca. 1 cm long (explants) were cultured in MS media supplemented with BA @ 0.5, 1.0 and 2 mg/litre in combination with NAA @ 0, 0.1 or 0.2 mg/lit. Rooting media consisted MS macro- and micro-nutrients at half strength and supplemented with IBA @ 0.5, 1.0, 1.5 or 2.0 mg/lit. After six weeks of culture highest number of shoots (5 shoots/explant) were produced in the explants cultured in the media supplemented with 1 mg BA + 0.1 mg NAA. Similarly highest number of roots (3.0 per shoot) was produced in the rooting media supplemented with BA 1.0 mg/lit. of media.

Introduction

Micro-propagation has been established as an efficient technique of propagating many plant species with the promise of increasing application. On of the major merits of this technique is elimination of pathogens including systemic viruses and virus-like organisms from desirable clones. In vitro propagation to eliminate virus has been successfully practiced on potato for over a decade in Nepal. Tissue culture technique (micro-propagation) can also be applied in Citrus species especially for the management of citrus greening disease and Tristeza virus and for rapid multiplication of elite germplasm, rootstocks and indictor plants. Citrus greening and Tristeza virus are have been found associated with severe decline of citrus orchards in some parts of Nepal. The saplings produced in an ordinary condition on the open field may harbor pests and pathogens. Therefore, a viable program of certification is an imperative so as to exclude various pests and pathogen from getting introduced to the new areas. Micro-propagation can play a vital role in such program whereby disease-free plants produced *in vitro* constitute the main form of propagules. *In vitro* produced planting materials are also very useful for international exchange of germplasm and *in vitro* conservation. Therefore, a study has been carried out at tissue culture laboratory of Citrus Research Program, Dhankuta to standardize the tissue culture protocol for rapid multiplication of trifoliate orange.

Materials and methods

Seeds collected from a healthy tree of trifoliate orange trees were germinated inside the plastic tunnel. Seedlings were transferred to glass-house after 30 days of germination and maintained there with regular spray of insecticide and fungicide. These healthy and vigorous seedlings were used as the source of explants. Actively growing shoot-tips (ca. 1 cm long) were soaked in distilled water for 30 minutes and washed three times. Shoot-tips were dipped in 70 ethanol for 1 minute after washing and then surface sterilized with 8 % sodium hypoclorite (4.25 % w/v available chlorine) for 20 minutes. Shoot-tips were then washed three times in sterile distilled water inside the laminar flow cabinet. The young leaves and basal portion of shoots injured by

sterilant were removed and ca. 0.8 cm long shoot-tip explants were prepared for culture. To investigate the rate of in *vitro* shoot multiplication these explants were cultured in MS media supplemented with 0.5, 1 or 2.0 mg/lit BA in combination with NAA @ 0, 0.1 or 0.2 mg per litre of media. The media was adjusted to pH 5.7 and solidified with 0.8 % agar. The culture was maintained at 25 ± 2 ^{0} C providing 14 hours photo-period. Data on percent shoot formation, number of shoots per explant were recorded.

Actively growing shoots produced *in vitro* were used for rooting. Rooting media consisted MS macro- and micro-nutrients at half strength supplemented with IBA at concentrations 0.5, 1.0, 1.5 or 2.0 mg per liter of media. Data were collected on percent rooting, root initiation time, and numbers of roots per shoot and survival percent in glass-house.

Results and Discussion

The explants cultured on shoot proliferation media started to produce adventitious roots after 4 weeks of culture. There was not different in shoot proliferation date with or without NAA application. After 6 weeks of culture, explants cultured in the media supplemented with 1 mg BA + 0.1 mg NAA per liter produced highest number of shoots (5 shoots/explant) In the media supplemented with NAA 0.2 mg/liter, there was higher rate of callus formation rather than shoot formation. Adventitious roots became ready for rooting after 7 weeks of culture in shoot proliferation media.

In vitro shoots were transferred to rooting media (1/2 x MS + various concentrations of IBA). Root initiation started after 3 weeks in all IBA concentrations. However, in high concentration there was more callusing and roots were shorter. Highest number of roots (3.0 per explant) was recorded in the media supplemented with IBA 1.0 mg/liter of water.

Attempts were made to transfer and to establish rooted plantlets inside glass house. But survival rate was only about 25 percent. Further efforts and study is necessary to standardize the technique for glass-house establishment. Similarly, further study to increase the rate of proliferation is also suggested.

3.8 Effect of Pre-harvest Application of GA_3 and Maturity Stage on Fruit Quality and Shelf-life of Mandarin (*Citrus reticulata Blanco*).

Abstract

Mandarin cv. Khoku is the well known mid-season commercial cultivar having excellent fruit quality grown in eastern hills of Nepal. In this investigation, an attempt has been made to examine the quality of fruits of this variety at different maturity stages as well as post harvest shelf life of fruits with GA_3 application. The experiment was carried out on 29 years old plants. Four levels of GA_3 were applied at the rate of 0, 15, 30 and 45 PPM along with five maturity stages (240, 255, 270, 285 and 300 days after full bloom. The experiment was laid out in two factors RCBD replicated thrice. Observations on Total Soluble Solids (TSS), Titratable Acidity (TA), TSS/TA ratio, physiological loss in weight, spoilage loss, shriveling and taste were recorded 60 days after storage at room temperature (13.5 ± 3.5 ^{0} C and 70-85% RH). There was a decrease in TA, increase in total juice volume, TSS/TA ration, delayed peel color development at harvest of the fruits by GA_3 treatment. GA_3 had been found effective in reducing shriveling, physiological loss in weight, spoilage loss, titratable acidity and maintained acceptable taste after 60 days of storage.

Introduction

Farmers of Nepal keep mandarin fruits on the trees from late October to the end of January as the substitute of storage. These fruits can face the danger of frost or chilling injury. The fruits left on the tree may drop or may be deteriorate due to physiological disorders. Besides, the rind of easy peelers may puff and result in a reduction of fruit quality. On of the most important and probably less understood factors that play an important role in determining shelf life is selecting the proper time of harvest Besides genetic, environmental and cultural factors the internal quality and shelf life of citrus fruits are mainly interfered by the picking date. Late picked fruits have a good internal quality but are shorter shelf life on the other hand early picked fruits have a better shelf life but poor eating quality.

Various efforts have been made to extend the shelf life of citrus fruit. Plant growth regulators have been used to extend shelf life in developed countries. Gibberellic acid (GA_3) is one of the commonly used chemicals to extend shelf life of fruits. Pre-harvest application of GA_3 maintains fruit peel quality on the tree and in storage and reduces post-harvest fruit decay. It has been reported that GA_3 also delays the senescence of fruits and extends the post harvest life with maintaining optimum eating quality. However, the effect of the pre-harvest application of GA_3 on the shelf life of mandarin has not yet been studied in Nepal. This study, therefore, was undertaken with the objectives (i) to investigate an effect of maturity stage on fruit quality as well as shelf-life and (ii) to find out the effect of pre-harvest application of GA3 on fruit quality and their shelf life.

Materials and Methods

The experiment was carried out on 29 years old trees of mandarin cv Khoku local at Citrus Research Program, Paripatle, Dhankuta (1380 m). The experimental trees were propagated by seed and were planted at the spacing of 6 m apart These trees were uniform in respect of size, vigor, age and productivity and had received uniform cultural operations during the field trial except the treatments imposed.

The experiment was laid out in two-factor factorial RCBD design with three replications. The first factor consisted different concentrations of GA_3 namely 15ppm, 30ppm, 45ppm and Control (water spray). The second factor was different harvesting dates. Detailed of harvesting dates is presented in **Table 12.** A single tree was considered as an experimental unit.

GA_3 solution was applied as aqueous foliar sprays. Distilled water was used as solvent for making spray solutions of GA_3. Six liters of solutions of each concentration were used for spraying one plant. All the experimental plants were sprayed to runoff condition with the desired GA3 solutions early in the morning, when dew had evaporated. Only one spraying was done approximately 202 days after fruit set.

Table 12. Different harvesting dates used in the experiment.

Harvesting	Days after Flowering	Date of Harvesting
First	240	24th Nov 1999
Second	255	9th Dec. 1999
Third	270	23rd Dec.1999
Fourth	285	7th Jan. 2000
Fifth	300	22nd Jan. 2000

Immediately after harvesting data on fruit weight, volume of juice, total soluble solids (TSS), total acids (TA), TSS/TA ratio were recorded on fresh fruits. A total of 10 random fruits from each tree were used for the analysis of these parameters. TSS of juice was determined with the help of hand refractometer. TA content was determined by titrating 2 ml juice with 0.1 N NaOH solution to phenolphthalein end point.

The effect of pre-harvest application of GA_3 on self-life of mandarin fruits during storage was also determined. For this, 60 fruits of uniform size, firm as well as free from any pests and diseases, injuries, blemishes and bruises were randomly selected from each treatment. The selected fruits were washed and air-dried before storing in room. The fruits were stored at ambient room temperature at 13.5^0 C and 85-90 percent relative humidity in a concrete room with rooftop of galvanized zinc plate. Before storing fruits, room as well as bedding material (rice straw) was disinfected with 1000 ppm Benomyl. Fruits were placed on bedding material at 2-3 cm apart. Each replication was bordered by bamboo stick. Fifteen fruits were taken for periodical observations. Rice straw was used as bedding material. Fruits were lining without touching each other. During storage following observations were made at fortnight intervals:

Physiological losses in weight (PLW): Three fruits were taken at random on each time of observation was loss was computed in terms of percentage on initial weight using the formula.

$$PLW\% = \frac{\text{Intial weight-Final weight x100}}{\text{Initial weight}}$$

Spoilage Loss: The spoiled fruits were separated out treatment wise from all the replications and weighed separately. The loss in weight was calculated in terms of percentage of original fruit weight

TSS, TA and TSS/TA ratio: Recorded as mentioned above

Shriveling: Shriveling was evaluated in terms of wrinkled appearances using 1-5 scale (higher the scale higher the shriveling)

Results and Discussion

1. **Effect of Pre-harvest GA_3 Application and Harvesting Period on Fruit Quality of Mandarin at Harvesting Time**

TSS, TA and Ratio: Total soluble solids content in the juice increased with delayed harvesting period. But there was not different in TSS content in the fruits harvested after 285 and 300 days of full bloom (**Table 13**). On the other hand total acids in juice decreased with prolonged harvesting dated. The lowest TA content was observed in the fruits harvested at 285 and 300 days after full bloom (**Table 14**). As the result of increased TSS and decreased TA content in late harvested fruits, the TSS/TA ratio was found significantly higher in the fruits harvested at 285 and 300 days after full bloom. Based on the values of TSS, TA and TSS/TA ratio, it can be concluded that mandarin fruits at 1300 m altitude can be harvested after 285 days of full bloom for fresh consumption.

***Peel color*:** Peel color of the fruit changes from green to yellow along with increased maturity. Slight change in color was noticed after 255 days of full bloom. After 300 days of full bloom, fruits developed yellow color in the plants that were not treated with GA (control) but in GA3 treated plants full color development was slightly delayed. Peel color development is mainly influenced by the day and night temperature of the growing area. Citrus fruit require cool night and hot day for yellow color development in the peel. Thus citrus grown in tropical climate do not exhibit yellow color.

***Weight of Fruits*:** The weight of fruits under different treatments was recorded at harvested time and their respective mean values are presented in **(Table 16)**. After analyzing the data statistically, it was found that application of GA3 increased the weight of fruit. There were bigger fruits (96.84 gm) in the trees sprayed with 45 ppm GA3 whereas fruit weight was only 87.97 gm in control. Maturity stages did not affect weight of fruits significantly.

***Juice Content*:** Total juice content in the fruit was maximum (34.6 ml /fruit) at 255 days of maturity (**Table 17**). Slight decrease in total juice was noticed along with increased maturity

stages. But it was not affected by GA3 application. The decreased volume juice at later stages of might be due to dehydration.

2. **Effects of pre-harvest application of GA3 and maturity stages on the post harvest shelf-life and quality of mandarin fruits:**

Total Soluble Solids (TSS): Total soluble solid level at harvesting time is presented in (**Table 13**). There is increase in TSS during storage in all treatments (**Table 18**). Total soluble solids after 60 days of storage was significantly influenced by the maturity stages and pre-harvest GA3 application. Matured fruits exhibited higher level of TSS after 60 days storage. TSS ranged in between 11.3 (^{0} Brix) in 240 days to 15.9 () in 300 days. Irrespective of the maturity stages higher level of TSS (13.0 to 13.4 ^{0} Brix) was noticed in GA treated fruits as compared to control (12.6). These results indicated that the retention of fruit quality during storage is better in matured fruits. Lower TSS in immature fruits after storage might be possibly due to higher metabolic activity of immature fruits. Slightly higher TSS content in GA3 treated fruit could be due to delayed senescence.

***Titrable Acidity*:** Titrable acidity of the fruit at harvest is presented in (**Table 14**). There was drastic change in titratable acidity during the storage (**Table 19**). In all the treatment there was a decline in content of titrable acidity. The level of the TA with respect to maturity stage ranged from 0.42 to 0.83%. While comparing these values with initial ones, there was a loss in TA content. Irrespective of maturity stage TA level was decreased by 45 ppm GA3 application (0.53) as compared to the control (0.94). However, slightly higher TA (0.71 to 0.72) was noticed in the fruit treated with 15 and 30 ppm GA3. The effect of GA3 did not give consistent results in this study.

***Spoilage loss*:**. Spoilage loss was influenced by the stage of maturity. Fruits harvested at 255 and 270 days of maturity had lowest level of spoilage loss (5.4 and 5.0 percent respectively.). Spoilage loss was higher both in pre- and over-matured fruits. GA3 application significantly reduced spoilage loss during storage. As the concentration increased there was decrease in spoilage. About 50% spoilage loss was minimized by pre-harvest GA3 spraying on plants at 45 ppm concentration (4.5 % loss) in comparison to unsprayed plants (8.3% loss). The interaction effect between maturity stage and GA3 application on the spoilage loss was also significant. Although in all maturity stages GA3 minimized storage loss, the lowest level of storage loss was observed in trees treated with 45 ppm GA3 and harvested at 270 days after flowering (**Table 20**).

***Physiological loss in weight (PLW)*:** The PLW during 60 days storage ranged in between 3.5 to 6.6 %. As the fruits maturity advanced the physiological loss in weight also increased (**Table 21**). Physiological loss in weight during storage significantly affected by GA3 application. Irrespective of the maturity stage, lower level of physiological loss in weight was recorded in GA treated fruits (3.5 to 4.6). The higher PLW in matured fruits might be due to the fact that the late harvested fruits might have exposed to relatively higher temperature during storage. The harvesting was started on 24th November 1999 for 240 days matured and ended 22nd January 2000 for 300 days matured fruits.

Shriveling: Shriveling was slightly higher in fruits harvested at 300 DAF as compared to other fruits. Shriveling was affected by pre-harvest application of GA3. Shriveling was less in GA treated fruit as compared to control (**Table 22**). Lowest shriveling was noticed in the fruits treated with 45 ppm GA3 (2.3). Interaction effect of both GA3 and maturity stage did not show any significant variation. Higher rate of shriveling in late harvested fruit could be due to the fact that fruits were exhausted and could have higher rate of catabolic reaction.

TSS/TA ratio: After 60 days of storage there was increase in TSS/TA ratio in all the fruits (Table 9) as compared to harvesting period (**Table 23**). TSS/TA ratio was significantly higher in the fruits, which were harvested at 240 and 270 DAF (27.2 and 24.6). TSS/TA ratio decreased with increasing maturity stage of the fruits. However, a slight increase was observed in the fruits, which were harvested at 300 DAF. TSS/TA ratio was also significantly affected by pre-harvest GA3 treatment. Highest TSS/TA ratio was noticed in 45 ppm GA treated fruits (26.7) followed by 30 ppm (20.1) and 15ppm (20.2) and lowest in the control (19.6). Higher level of TSS/TA ratio after 60 days of storage was primarily due to slight increase in TSS as a result of dehydration as well as reduced level of total acids during storage. The higher level of TSS/TA ratio in GA treated fruits was primarily due to lower level of TA in GA treated fruit.

Taste: In general, most of the fruits after 60 days of storage were inferior in taste as compared to the taste of these fruits at the time of harvest. After 60 days of storage, the fruit harvested at 270 days and 285 days were slightly superior in taste as compared to earlier and delayed harvested fruits. Taste was better and fruits were in acceptable condition under 45ppm and in lower concentration of GA3 treatment. Pre-harvest treatment of fruits with GA probably reduced the rate of various metabolic activities and this retains better taste after 60 days of storage.

Table 13 Effect of pre-harvest application of GA_3 and maturity stages on TSS content during harvesting of mandarin.

Harvesting Days (after full bloom)	**GA_3 concentration**				**Mean (Harvesting Days)**
	15 ppm	**30 ppm**	**45 ppm**	**Control**	
240 days	9.8	9.5	10.9	9.9	10.0 c
255 days	10.6	10.0	10.4	10.7	10.4 bc
270 days	11.2	10.9	11.0	10.7	10.9b
285 days	11.2	12.0	12.6	11.7	11.9a
300 days	11.2	11.5	12.0	12.5	11.8a
GA_3 Mean	10.8	10.8	11.4	11.1	

CV (%) = 6.34 Means are separated at 5% level of LSD

Table 14 Effect of pre-harvest application of GA_3 and maturity stages on TA content during harvesting of mandarin.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	1.34	1.41	1.47	1.89	1.53a
255 days	1.21	1.55	1.38	1.63	1.44ab
270 days	1.03	1.41	1.26	1.47	1.29b
285 days	0.92	1.05	0.85	1.06	0.97c
300 days	0.91	0.89	0.90	0.96	0.92c
GA_3 Mean	1.08c	1.26ab	1.17bc	1.40a	

CV (%) = 19.04 Means are separated at 5% level of LSD

Table 15 Effect of pre-harvest application of GA_3 and maturity stages on TSS/TA ratio during harvesting of mandarin.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	7.8	5.5	7.4	5.2	6.5c
255 days	9.2	6.5	7.5	6.6	7.4c
270 days	11.0	7.8	8.7	7.3	8.7b
285 days	12.2	11.5	15.8	11.0	12.6a
300 days	12.3	12.9	13.3	12.9	12.8a
GA_3 Mean	10.5a	8.8b	10.5a	8.6b	

CV (%) = 17.54 Means are separated at 5% level of LSD

Table 16 Effect of pre-harvest application of GA_3 and maturity stages on fruit weight (gm) during harvesting of mandarin.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	86.3	99.5	87.3	84.0	89.3
255 days	96.6	92.5	99.9	84.7	93.4
270 days	94.2	93.5	96.2	95.4	94.5
285 days	94.6	94.0	94.9	94.2	95.2
300 days	95.6	101.3	105.8	81.7	96.1
GA_3 Mean	93.4	96.3	96.8	88.0	

CV (%) = 14.44 Means are separated at 5% level of LSD

Table 17 Effect of pre-harvest application of GA_3 and maturity stages on juice volume during harvesting of mandarin.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	26.3	33.0	26.3	24.0	27.4b
255 days	42.7	30.6	37.0	28.0	34.6a
270 days	33.3	31.7	31.7	32.3	32.3ab
285 days	28.3	30.7	28.7	31.3	29.7ab
300 days	27.3	30.0	31.7	25.7	28.7b
GA_3 Mean	31.6	31.2	31.0	28.3	

CV (%) = 19.7 7 Means are separated at 5% level of LSD

Table 18 Effect of pre-harvest application of GA_3 and maturity stages on TSS content after sixty days storage at room temperature.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	11.0	12.0	11.5	10.5	11.3d
255 days	15.5	13.3	13.2	12.5	12.5c
270 days	15.5	13.3	13.2	12.0	13.5b
285 days	13.0	12.4	12.3	13.2	12.7bc
300 days	16.5	17.2	15.2	14.7	15.9
GA_3 Mean	13.7a	ab13.4	13.0	12.6a	

CV (%) = 8.85 Means are separated at 5% level of LSD

Table 19 Effect of pre-harvest application of GA_3 and maturity stages on TA content after sixty days storage at room temperaturee content during harvesting.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	0.43 hi	0.46ghi	0.36i	0.43 hi	0.42d
255 days	0.63efg	0.54fgh	0.40hi	0.54fgh	0.52c
270 days	0.78 bcde	0.71de	0.46ef	0.82abcd	0.69b
285 days	0.76cde	0.95a	0.65hi	0.66def	0.75ab
300 days	0.93ab	0.91abc	0.76bcde	0.74de	0.83a
GA_3 Mean	0.70abghi	0.71ajh	0.52c	0.94b	

CV (%) = 15.51 Means are separated at 5% level of LSD

Table 20 Effect of pre-harvest application of GA_3 and maturity stages on spoilage loss (%) after sixty days storage in room temperature.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	5.66	4.66	4.33	9.66	6.08b
255 days	5.66	5.00	3.66	7.33	5.41bc
270 days	5.33	4.33	3.33	7.00	5.00c
285 days	6.33	6.00	5.00	8.00	6.33b
300 days	7.33	8.33	6.00	9.66	7.83a
GA_3 Mean	6.06b	5.66b	4.46a	8.33c	

CV (%) = 21.01 Means are separated at 5% level of LSD

Table 21 Effect of pre-harvest application of GA_3 and maturity stages on physiological loss in weight after sixty days of storage at room temperature.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	2.66	3.66	2.50	5.20	3.50c
255 days	2.33	4.06	3.00	5.73	4.03c
270 days	3.43	4.03	3.26	5.66	4.10bc
285 days	3.66	4.86	3.66	7.16	4.84b
300 days	5.40	5.66	4.96	9.43	6.36b
GA_3 Mean	3.70c	4.46b	3.84c	6.64a	

CV (%) = 20.74 Means are separated at 5% level of LSD

Table 22 Effect of pre-harvest application of GA_3 and maturity stages on shriveling of fruits after sixty days of storage at room temperature.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	3.66	3.00	2.00	3.66b	3.08b
255 days	3.00	2.83	2.16	3.00b	3.00b
270 days	3.33	2.83	2.16	2.95b	2.95b
285 days	3.00	2.83	2.33	3.00b	3.00b
300 days	3.66	3.33	2.83	3.50a	3.50a
GA_3 Mean	3.33b	2.96c	2.30d	3.83a	

CV (%) = 11.80 Means are separated at 5% level of LSD

Table 23 Effect of pre-harvest application of GA_3 and maturity stages on TSS/TA ratio after sixty days of storage at room temperature.

Harvesting Days (after full bloom)	GA_3 concentration				Mean (Harvesting Days)
	15 ppm	30 ppm	45 ppm	Control	
240 days	25.4	26.2	32.5	24.8	27.2a
255 days	20.5	22.0	32.2	23.1	24.6a
270 days	19.9	18.7	28.9	24.6a	20.5b
285 days	17.1	13.1	19.0	20.5b	17.3c
300 days	18.2	19.5	20.7	17.4c	19.6bc
GA_3 Mean	20.2b	20.1b	26.7a	19.6bc	

CV (%) = 15.64 Means are separated at 5% level of LSD

4. PRODUCTION PROGRAMME OF HORTICULTURAL COMMODITIES

Private sector is not yet capable to meet the national demand of quality vegetable seeds (Foundation seed) and healthy saplings of citrus species to implement the production program of Department of Agriculture. Therefore, NCRP has been involved in production of foundation seeds of vegetable crops and healthy planting materials of citrus species since its establishment. Production saplings of new germplasm to increase their mother stocks are essential. Although after annexation of this farm to NARC, other production program has been reduced substantially, some production program is needed as per the demand of DOA and private entrepreneurs. Department of Agriculture is implementing special program on citrus fruit crops so as to meet the target set by APP. Similarly, Seed Entrepreneurs' Association of Nepal (SEAN) mainly depends on NARC farms for foundation seed of vegetable crops. The major objective of production program is to supply foundation seeds of vegetable crops and healthy citrus saplings to the clients.

4.1 Foundation stock production of citrus species

In the year 2056/57, a total of 17894 saplings were produced and sold from this station. Of the total production 14755 citrus fruit saplings were produced whereas rest were coffee and rose saplings. The detailed of fruit saplings production has been presented in **Table 24.**

4.2 Foundation seed production of different vegetables.

Foundation seed production of vegetable crops is another major component of production program of this farm. The detailed of crops their varieties and quantity of FY 2056/57 is presented in **Table 25.** Most of the seeds produced in this farm was supplied to SEAN.

Table 24 Fruit saplings produced and distributed from NCRP, Dhankuta in 2056/57

SN	Name fruit species/varieties	Production (number)
1.	Mandarin -grafted (Dhankuta local) Mandarin - seedling (Dhankuta local)	7386 1603
2.	Kinnow mandarin	1665
3.	Sweet orange - grafted (Dhankuta local, Washington Navel, Valencia late)	3793
4.	Lime (Terathum Local)	199
5.	Kumquat	109
6.	Others: Coffee Rose	 326 2813
	Total	**17894**

Table 25 Foundation seed production of different vegetables at NCRP, Dhankuta in 2056/57

SN	Name of Vegetable	Variety	Production (kg)
1	Bean	1. Trisuli (Kentucky Wonder) 2. 4-season	210.0 110.0
2.	Cauliflower	1. Kathmandu local	25.0
3.	Cress	1. Local	99.0
4	Turnip	1. PTWG	6.0
5.	Radish	1. 40-days 2. White neck	140.0 9.0
6.	Pea	1. Sikkime	10.0
7.	Broad leaf mustard	1. Khumal Broad leaf	6.0
8.	Sweet pepper	1. California Wonder	2.3
9.	Chilli	1. Chinese	1.0
		Total	**618.3**

5. APPENDICES

Appendix 1 Name of the Scientific, Technical and Administrative staff working in NCRP, Dhankuta (2056/57).

S.N.	Name	Position	Rank	Remark
1.	Mr. Upen Lal Chaudhari	Chief/Senior scientist	S3	
2.	Mr. Madhusudhan Ghale	Senior scientist	S3	Study leave
3.	Mr. Bharat Mishra	Senior scientist	S3	
4.	Mr. Ram Bahadur K.C.	Senior scientist	S3	Study leave
5.	Rit Raj Bhattarai	Technical Officer	T6	
6.	Bhim Bdr. Tamang	Technical Officer	T6	
7.	Mr. Nabin Kumar Lal	Technical Officer	T6	Temporary and deputation from HRD
8.	Mr. Deep Narayan Chaudhari	Technician	T5	
9.	Mr. Dal Bahadur Ale	Technician	T5	Chungbang farm
10.	Uttam Bahadur Singh	Accountant	A5	Temporary
11.	Kumar Koirala	Typist	A5	
12.	Tara Nath Khatri	Driver	A5	
13.	Mr. Bishnu Prasad Adhikari	Technician	T4	Chungbang farm
14.	Mr. Tulasi Raj Osti	Administation	A4	
15.	Mr.Man Bdr. Biswakarma	Technician	T3	
16.	Mr. Yagya Bdr. Karki	Technician	T3	
17.	Mr. Nara Bdr. Tamang	Technician	T3	
18.	Mr. Ram Bdr. Darji	Technician	T2	
19.	Mr. Amar Bdr. Shrestha	Technician	T2	
20.	Mr. Purna Bdr. Darji	Technician	T2	
21.	Mr. Tanka Prasad Timilsina	Technician	T2	Chungbang
22.	Mr. Ser Bahadur Tamang	Technician	T2	
23.	Mr. Ram Bahadur Basnet	Technician	T2	
24.	Mr. R. Bahadur Dhangel	Technician	T2	
25.	Mr. Bhabani Prasad Phuyal	Technician	T2	Chungbang farm
26.	Mr. Jagat Bdr. Karki	Technician	T2	
27.	Mr. B. M. Darji	Technician	T2	
28.	Mr. Thir Bahadur Ale	Technician	T2	
29.	Mr. Tej Bahadur Darji	Technician	T2	
30.	Mr. Hem Bahadur Dahal	Technician	T2	
31.	Mr. M. B. Tamang	Technician	T2	
32.	Mr. S. B. Tamang	Technician	T2	
33.	Mr. R. P. Timilsina	Technician	T2	Chungbang farm
34.	Mrs. Suntali Ghising	Technician	T1	
35.	Mr. Kavindra Adhikari	Technician	T1	Temporary
36.	Mr. Lekhanath Mishra	Technician	T1	Temporary
37.	Mr. Surya Kumar Thapa	Technician	T1	Temporary

Appendix 2. Total budget and expenditure of NCRP in F. Y. 2056/57

Budget code	Budget Heading	Budget allocated	Released	Expenditure	Balance
40 JK	**Staff Expenses**				
4000	Staff Basic Salary	1675000	1675000	1481104.52	193895.48
4010	Staff Allowances	250000	250000	248195.32	1804.68
4020	Provident Fund	170000	170000	130049.50	39950.50
4030	Medical	-	-	-	-
4040	Uniform	20000	20000	19500.00	500.00
4050	Dasain Kharcha	145000	145000	115305.00	29695.00
4060	Overtime	20000	20000	2595.00	17405.00
4070	Pension/gratuity	-	-	-	-
4080	Insurance	-	-	-	-
Total Staff budget		*2280000*	*2280000*	*1996749.34*	*283250.66*
41 JK	**Operational Expenses**				
4100	Travel expenses	191000	191000	190660.00	340.00
4110	Vehicle fuel, lubrication	144000	144000	141498.00	2502.00
4120	Wages to labor	390000	390000	386810.00	3190.00
4130	Laboratory research supply	155000	155000	154248.80	751.20
4140	Farm supplies	436400	436400	435861.50	538.50
4150	Books, newspaper, periodicals	80000	80000	79716.00	284.00
4180	Repair	178600	178600	174622.00	3978.00
Total Operational budget		*1575000*	*1575000*	*1563416.30*	*11583.70*
42 JK	**Administrative Expenses**				
4200	Rent, utilities and other services	150000	150000	135849.98	14150.02
4210	Communication expenses	70000	70000	61350.08	8649.92
4220	Repair and maintenance	200000	200000	197896.34	2103.66
4230	Stationary, printing and office supplies	66000	66000	65829.50	170.50
4240	Board and panel meeting	-	-	-	-
4260	Contingency expenses	15000	15000	15000.00	-
Total administrative budget		*501000*	*501000*	*475925.90*	*25074.10*
43 JK	**Capital expenses**				
4310	Land	500000	500000	493075.38	6924.62
4320	Building and other construction	1500000	1500000	1469933.49	30066.51
4330	Furniture and fixture	--	-	-	-
4340	Equipment, machinery and tools	30000	30000	30000	-
4350	Vehicle	-	-	-	-
4360	Computer and computer software	-	-	-	-
4370	Other fixed assets	-	-	-	-
Total capital budget		2030000	2030000	1993008.87	36991.13
Grand Total		***6386000***	***6386000***	***60291000.41***	***356899.59***

Appendix 3 Man-power situation of Citrus Research Programme, Dhankuta (2056/57)

SN	Name of the post	Approved post (No.)	Fulfilled (No.)	Vacant (No.)	Remark
1.	Senior Scientist (S3) -Horticulture	4	3	1	2 in study leave
2.	Senior Scientist (S3)-Plant Pathology	1	1	0	-
3.	Scientist (S1) - Soil	1	0	1	
4.	Technical Officer (T6) - Horticulture	3	2	1	
5.	Senior Technician (T5)	3	2	1	
6.	Technician (T4)	3	2	1	
7.	Technician (T3)	3	3	0	
8.	Technician (T2)	16	16	0	
9.	Technician (T1)	6	5	1	4 temporary
10.	Typist (A5)	1	1	0	
11.	Accountant (A5)	1	1	0	
12.	Administration Assistant (A4)	1	1	0	
13.	Driver(A5)	1	1	0	
	Total	44	34	5	

Appendix 4 Revenue collection at National Citrus Research (2056/57).

S.N.	Source of Revenue	Total revenue
1.	Fruit saplings	212138.00
2.	Fresh fruits	207981.25
3.	Vegetable seeds	29152.90
4.	Fresh Vegetable	13656.50
5.	Vegetable seedlings	1549.35
6.	Miscellaneous	75274.00
	Total	**539752.00**

Appendix 5. Meteorological data of NCRP (Paripatle farm, 1300 m)

Months	Temperature (^{0} C)		Rainfall (mm)
	Maximum	Minimum	
January	19.5	6.9	1.4
February	23.2	11.6	0.0
March	25.4	13.3	0.0
April	28.5	18.3	4.2
May	26.5	18.6	150.4
June	27.2	20.3	299.5
July	26.9	21.1	321.6
August	26.7	20.9	192.3
September	27.4	19.6	132.2
October	26.5	17.7	1.8
November	23.7	12.0	35.6
December	20.9	8.8	0.0