EFFECT OF FOLIAR APPLICATION OF CHEMICALS ON FRUIT RIPENING AND QUALITY IN WINTER GUAVA

Thesis

Submitted to the Punjab Agricultural University
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
in
HORTICULTURE (POMOLOGY)
(Minor Subject : Botany)

By
Gaganpreet Kour
(L-2002-A-56-M)

Department of Horticulture
College of Agriculture
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA - 141 004
2005

EFFECT OF FOLIAR APPLICATION OF CHEMICALS ON FRUIT RIPENING AND QUALITY IN WINTER GUAVA

Thesis

Submitted to the Punjab Agricultural University
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
in
HORTICULTURE (POMOLOGY)
(Minor Subject : Botany)

By
Gaganpreet Kour
(L-2002-A-56-M)

Department of Horticulture
College of Agriculture
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA - 141 004
2005

Is there, anything I can say
Anything I can give
Or do for you?
Because all that I'm
All what I have
I owe to you.....
Affectionately Dedicated to
My parents
And
Loving Brother

CERTIFICATE-I

This is to certify that the thesis entitled, **"Effect of foliar application of chemicals on fruit ripening and quality in winter guava"** submitted for the degree of M.Sc., in the subject of **Horticulture (Pomology)** (Minor subject : **Botany**) of Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Gaganpreet Kour** (L-2002-A-56-M) under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

Major Advisor
Dr. W.S. Dhillon
Associate Professor of Horticulture
Deptt. of Horticulture
College of Agriculture
Punjab Agricultural University
Ludhiana - 141 004

CERTIFICATE-II

This is to certify that the thesis entitled, **"Effect of foliar application of chemicals on fruit ripening and quality in winter guava"** submitted by **Gaganpreet Kour** (L-2002-A-56-M) to the Punjab Agricultural University, Ludhiana, in partial fulfillment of the requirements for the degree of M.Sc., in the subject of **Horticulture (Pomology)** (Minor subject : **Botany**) has been approved by the Student's Advisory Committee along with Head of the Department, after an oral examination on the same.

11.3.05

Head of the Department
(Dr. Y.R. Chanana)

11/3/05

Major Advisor
(Dr. W.S. Dhillon)

24/3

Dean, Postgraduate studies
(Dr. Darshan Singh)

ACKNOWLEDGEMENT

Foremost of all, I bow my head to him, the merciful 'WAHEGURU' for his benign blessing hand out bestowing a creative and healthy environment throughout my academic and research work.

It is proud privilege to express my sincere and whole-hearted sense of gratitude and indebteness to my Major Advisor ***Dr WS Dhillon****, Associate Professor of Horticulture, Department of Horticulture, PAU, Ludhiana for his scholarly guidance, generous in lending his intellectual ideas, everwilling help continuous and unexcelled interest, constructive criticism and parental affection through out the period of my studies.*

My thanks go spontaneously to my retired advisor, ***Dr GS Dhaliwal****, Professor of Horticulture, Department of Horticulture, PAU for his timely help, guidance and critical assessment during my research work.*

I accord my deep sense of gratitude to the members of my advisory committee ***Dr JS Bal****, Professor of Horticulture,* ***Dr Harminder Singh****, Horticulturist,* ***Dr DS Gill****, Professor of Botany for their valuable suggestions and uninterrupted help and also for the critical appraisal of the manuscript.*

I extend my sincere thanks to ***Dr Yog Raj Chanana****, Head, Department of Horticulture for providing necessary facilities during the tenure of my studies.*

It is beyond my access to acknowledge in words the infinite love, affectionate, care, silent prayers and selfless sacrifices of my revered parents ***S. Manjit Singh*** *and* ***Mrs. Virinder Kour*** *and loving relatives that always help me in high spirits.*

My vocabulary falls short of adequate words to convey my innermost feelings of gratitude to my Brother, ***Jatinderpal Singh Reen,*** *whose deep affection, constant encouragement, moral support and attention enables me to persue my studies.*

It also express my gratitude for the blessings of my sister ***Mrs Taranjeet Kaur****, My Jeeju (****Dr Kuldeep Singh****), Associate Professor of Biotechnology for their everlasting love and best wishes that remain indelible ion my life.*

No appropriate words could be traced in the present lexion to convey my profound thanks to my Friend ***Datar Singh Lo*** *for his affection, endless cooperation, care, inspiration and untiring help during each and every moment of this investigation.*

It gives me immense pleasure to accord my sincere feelings of gratitude to my respectable senior, ***Ms Jaspreet Kaur*** *for assiduous help and valuable suggestions.*

Words are inadequate to acknowledge my friends ***Nitika, Ruby, Shikha, Karan, Gurmeet, GGV Shyamli*** *for their care and everhelping hand and to make my stay at university memorable.*

I fully acknowledge the help and cooperation rendered by field and laboratory staff specially ***Malkit Raj****.*

I must also thanks to ***Beer Bahadur*** *and* ***Deepak Kumar*** *(Ekta Computer Centre) for typing this manuscript meticulously.*

Gagan preet

(Gagan preet Kour)

Title of the thesis	:	"Effect of foliar application of chemicals on fruit ripening and quality in winter guava"
Name of the Student	:	Gaganpreet Kour
and Admission No.	:	L-2002-A-56-M
Name and Designation of Major Advisor	:	Dr. W. S. Dhillon Professor Deptt. of Horticulture
Major Subject	:	Horticulture (Pomology)
Minor Subject	:	Botany
Degree to be Awarded	:	M.Sc.
Year of award of degree	:	2005
Total pages in thesis	:	64
Name of University	:	Punjab Agricultural University Ludhiana

ABSTRACT

The present investigation was undertaken to study the "Effect of foliar application of chemicals on fruit ripening and quality in winter guava" at the New Orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana, during 2003-04. Foliar application of growth regulators i.e. Urea (2, 3 and 4%), potassium sulphate (1, 2 and 3%) and ethephon (200, 300 and 400 ppm) were made on 10 years old guava trees cv. Allahabad Sufeda at the time when fruit size was slightly bigger than the walnut. K_2SO_4 and ethephon increased the fruit weight, whereas urea reduced it. The yield was maximum (73.30 kg per tree) with K_2SO_4 3% and minimum in ethephon 400 ppm. The fruit pressure was minimum (5.01 kg/cm^2) with urea 4%. The organoleptic rating out of 9 points was the highest (7.0) with K_2SO_4 at 3%. The total soluble solids was more with K_2SO_4, followed by ethephon and ascorbic acid was found maximum (127.91 mg/100g) with K_2SO_4 3%.

Key words : Growth regulators, Allahabad Sufeda, Organoleptic rating

Signature of the major advisor

Gaganpreet

Signature of the student

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter - I

INTRODUCTION

Guava is one of the most delicious and popular fruits and is widely grown in tropical and sub-tropical regions of the country. It is hardy, prolific bearer and highly remunerative fruit crop. The fruits are rich in vitamin-C, pectin and potassium. Guava is one such fruit which is 100 per cent edible. The common guava is indigenous to tropical America and is reported to be the most important cultivated species of the myrtaceae family. Guava has been thoroughly naturalized throughout the tropics and sub-tropics because of its wider adaptability and of commercial importance in USA (Florida and Hawaii states), India, Egypt, Africa, Brazil, Columbia and the West Indies (Popenoe 1920, Wilson 1980, Mitra and Bose 1985).

In India, guava has been cultivated since 17^{th} century in many states but the best quality guava are produced in Uttar Pradesh. The district of Allahabad has a reputation of growing the best guava in the country as well as in the world. In Punjab, guava is cultivated on large scale in all the districts. It ranks third in cultivation after citrus and mango and occupies an area of 6690 ha with an annual production of 117075 mt (Anon 2004).

The trees of guava produce as many as three crops in a year under tropical regions, whereas under northern region, it flowers twice a year i.e. once in April - May and again in August - September. The crop

from spring flowering ripens during the rainy season but fruits are heavily infested with the attack of fruit fly. The second crop is ready in winter and is commercially important because of better quality and being free from fruit fly attack.

Apart from the fact that fruits of winter season crop is better, but the fruits of this crop lacks ripening due to low temperature. Under this situation, if the maturity of the fruit coincides with the low temperature, the fruit remains hard and do not ripe well particularly in December and January. The fruits also remain small in size and proper ripening is not achieved and sometimes the fruit becomes too hard to eat. The degree of hardness of fruit varies with the prevailing minimum temperature at the time of fruit maturity. Moreover, the maturity also varies with the early or late flushes which are common in guava.

Some workers (Sunderajan *et al* 1969, Singh *et al* 1978, Bhatia *et al* 2001 and Yadev *et al* 2001) improved fruit quality of winter season guavas of cv. Sardar with the use of chemicals such as urea, K_2SO_4, NAA, etherel and GA but still there is a need of more work in general and on winter guava of cv. Allahabad Sufeda in particular, on this aspect to achieve the desired results. Keeping in view the above problems/ facts, the present studies were therefore, planned to minimize the fruit hardness and to bring the softness and proper ripening with the foliar application of some chemicals/growth regulators such as urea, K_2SO_4 and

ethephon at varied concentrations in cv. Allahabad Sufeda with the following objectives :

1. To find the best chemical and its concentration to minimize the fruit hardness and to bring proper ripening.
2. To ascertain the effects of chemicals on fruit quality and yield.

Chapter - II

REVIEW OF LITERATURE

The research work carried out in India and abroad on the related aspect of present investigation entitled "Effect of foliar application of chemicals on fruit ripening and quality in winter guava" is reviewed under the following sub heads :

2.1. Physical fruit characters

2.2. Chemical fruit characters

2.1. PHYSICAL FRUIT CHARACTERS

2.1.1 Fruit weight

Singh *et al* (1977) studied the effect of GA on the size and quality of mango fruit at Horticultural Experiment and Teaching Centre, Basti (U.P.) and reported that fruits of cultivar 'Banarsi Langra', when sprayed at 0-250 ppm 3 times at weekly interval in early March significantly increased the weight of the fruit. Likewise, Masheva *et al* (1978) advocated that application of GA_3, IAA and kinetin markedly increased the bunch and berry weight in the seedless cv. 'Kishmisi kishmis' of grapes. An increase in fruit weight of papaya cv. CO-2 was recorded with etherel at 300 ppm, while CCC and TIBA has the opposite effect, when applied at brown stigma stage and then 15-days interval (Battacharya and Rao 1981).

Ghosh (1986) observed an increase in fruit weight of guava with 0.3 per cent zinc sulphate spray. Zinc sulphate at 0.4 per cent improved fruit weight of guava (Pandey *et al* 1988). Wang (1989), while conducting the studies on the methodology of harvesting in processing guava, advocated that urea sprays at 6.25 per cent gave the best results with the highest fruit yield and mean fruit weight of 94.8 g. Likewise, Ogata and Saito in (1989) studied the effect of N-phenyl-N'-(4-Pyridyl) Urea (4-PU) on grapevine and reported that application of 5-10 ppm 4-PU increased the berry weight (1.82 g) significantly. On the other hand, Sharma and Azad (1991) reported the maximum mean fruit weight of "Kinnow" fruits (147 g) with $N_2P_1K_1$ treatment producing 28 per cent more yield than $N_0P_0K_0$. Study done by Munish Makhija and Atul Chandra (1992) reported that foliar spray of zinc sulphate (0.5%) produced maximum berry weight in grapes. However, foliar spray done twice on the vines further improved this parameter.

It was recorded that 1.5 per cent urea spray was the most effective for increasing the bunch weight, berry characteristics and yield in grapes (Beniwal *et al* 1992). Singh *et al* (1992) reported that the average bunch weight of 'Perlette' (379-383 gms) and 'Beauty Seedless' (372-378 gms) were recorded under different treatments of ethephon. Likewise, Dwivedi *et al* (1993) also obtained increased fruit weight with urea sprays in guava fruits. Dhillon and Bindra (1995) recorded that $ZnSO_4$ (0.4%) was

found to be most effective in increasing the bunch and berry weight of the five year old 'Perlette' vines. Josan *et al* (1995), while working on ten year old plants of lemon cv. Baramasi advocated that maximum fruit weight was recorded under 10 per cent K_2SO_4 treatment, followed by borax and $CaCl_2$ treatments. The spray application of NAA and 2, 4-D at 100 ppm markedly increased the average weight of the guava fruits (Kandu and Mitra 1997).

Bhatia *et al* (2001) studied the effect of foliar applications of some nutrients on the quality of guava (Winter season) at walnut size and reported that the application of potassium sulphate (0.5, 1.0 and 1.5%), zinc sulphate (0.5, 0.75 and 1.0%), H_3BO_3 (0.3, 0.5 and 1.0%) increased fruit weight and yield. Similarly Yadav *et al* (2001) studied the effect of foliar application of growth regulators NAA (20, 40, 60 ppm), GA (50, 100, 150 ppm) and etherel (50, 75, 100 ppm) on 15 years old guava trees cv. L-49, when the fruit size was bigger than walnut. They found that NAA and GA increased the fruit weight, while etherel reduced it. Yadav (2002) also suggested that the application of 3 per cent Urea resulted in the greatest fresh fruit weight (96.6 g) and flesh weight (19.1 g) in guava fruits. Also NAA at 10 ppm resulted in the greatest fruit diameter (5.03 cm) and fruit yield (56.9 kg). Usha *et al* (2002) recorded that the macro and the micro-nutrients spray resulted in the highest berry weight with the application of boron and magnesium, but in case of iron, it was related to an increase in number of berries.

2.1.2 Fruit volume

Bhattacharya and Rao (1981) reported that all applications of CCC reduced the fruit volume, while etherel at 300 ppm recorded a fruit volume of 1313.41 cc as against 1253.75 cc recorded in the control fruits in papaya cv. CO-2. They further noted that there was concomitant reduction in fruit volume with the increase in concentration of TIBA. However, Sainji *et al* (1988) advocated that the application of 40 ppm GA_3 significantly increased the volume of the berries in 'Thompson Seedless' grapes. Beniwal *et al* (1992) studied the foliar application of urea and K_2SO_4 on grapes cv. Perlette and reported that 1.5 per cent urea was effective for increasing bunch volume and yield. Sharma *et al* (2002) noted that the volume of fruit (44.60 ml) increased with the application of 0.5 per cent $ZnSO_4$ and 2, 4, 5-T in Kagzi lime with foliar spray of $ZnSO_4$.

2.1.3 Fruit size

Parker and Jones (1950) studied the effect of K-application on fruit size of oranges and reported that K-fertilizer caused greater increase in fruit size. Smith and Rasmussan (1960) reported that lower supply of K (0.43% to 0.93% in leaves) reduced the fruit size in grapefruits. While in 'Valencia' oranges, K application increased the fruit size but did not effect its grades (Reitz and Kew 1960).

Histological studies in 'Thompson Seedless' and 'Black Corianth' grapes revealed that there was a general increase in the diameter

throughout the pericarp from anthesis to a stage prior to maturity (Sachs and Weaver 1966). Similarly, Daris (1966) applied potassium salt of GA at 50 ppm to the inflorescence of 'Perlette' vines at full bloom and reported an increase in berry size.

Kumar and Hoada (1974) studied the effect of GA on growth and composition of guava and reported an increase in fruit set and fruit size with the application of GA at 100 or 200 ppm when applied twice. The foliar spray of zinc sulphate at 0.5-1.0 per cent increased fruit size in 'Kinnow' mandarin (Dixit *et al* 1977). Similarly, Nijjar and Brar (1977) suggested that zinc sulphate at 0.4 per cent increased the fruit size in 'Kinnow' mandarin. Likewise, Khera and Dhawan (1979) obtained an increase in fruit size in 'Pusa Seedless' grapes with the application of zinc sulphate at 0.4 per cent. Maurya and Singh (1979) reported an increase in fruit size, with NAA at 40 ppm sprayed at pea stage of fruits in mango.

Rath *et al* (1980) found that zinc sulphate increased fruit length and diameter in mango fruits. Likewise, Babu and Rajput (1982) reported an increase in fruit diameter of Kagzi Lime by foliar spray of zinc (0.6%). Likewise, Ghosh (1986) advocated that Borax alone or in combination with magnesium and zinc resulted in larger fruit size in guava cv. L-49. Singh and Misra (1986) reported that the application of 2, 4-D at 20 ppm mixed with the copper sulphate at 0.25 or 5.0 per cent reduced the fruit drop and significantly increased the fruit size in 'Kinnow' mandarin.

'Thompson Seedless' grapes responded to 20-50 ppm PPG-1721, whereas, 'Flame Seedless' responded to 20-25 ppm PPG-1721 for the increase in the fruit size (Taylor and Dewitt 1987). While zinc sulphate applied at 0.4 per cent improved the fruit size in 'Sardar' guava (Pandey *et al* 1988). Similarly, the fruit size of Ber cv. Umran improved with 10 ppm NAA (Bal *et al* 1988).

Shikhamany *et al* (1990) conducted a trial on five year old 'Thompson Seedless' grapevines to study the efficacy of 700 kg each of N and K_2O applied in different split combinations. They reported that the application of higher doses of N but no K_2O in April was found to increase internodal length measured just before the floral differentiation. The effect of Napthalene-acetic acid on the 'Satsuma' mandarin was studied by Ortola *et al* (1991), who reported an increase in fruit growth leading to an increase in fruit size at harvest time. Similarly, Gorakh Singh and Reddy (1997) recorded that urea 10 per cent gave the maximum fruit length (6.48 cm) and diameter (6.91 cm) in guava fruits than the control plants.

Yadav *et al* (2002) studied the effect of urea, borax and NAA on yield parameters of guava cv. L-49 and suggested that the application of 3 per cent urea resulted in the greatest fruit length (5.7 cm) and fruit diameter (5.11 cm). Spray of Borax at 0.15 per cent also resulted an increase in fruit length (5.43 cm), fruit diameter (5.05 cm) and NAA at 10 ppm resulted an increase in fruit diameter (5.03 cm) in guava cv. L-49.

Dhaliwal *et al* (2002) suggested the application of 1.5 per cent urea to increase the fruit size in winter season crop of guava cv. Allahabad Sufeda.

2.1.4 Fruit shape and surface

Balasubramanyam and Rangaswami (1959) studied the parthenocarpy in some fruit plants and reported that parthenocarpic fruits of guava were characterised by 6-8 prominent ridges on the surface and swelling on the calyx end. Likewise, Teotia (1961) also observed long shaped fruits with swollen calyx and ridges on the surface of guava fruits when sprayed with GA to induce seedlessness. Similarly, Shanmugavelu (1962) reported that parthenocarpic fruit in Allahabad Sufeda, L-49, Red Fleshed and Seedless varieties showed 6-8 prominent ridges on the surface and swelling at the calyx end. Again, Coggins and Hield (1962) conducted studies on the effect of potassium giberellate on 'Navel' oranges. These authors did not observe any change in fruit shape with 5, 9, 10, 18, 20 and 36 ppm KGA, when sprayed in July, September, November and February. In grapefruit varieties, GA at low concentrations resulted in normal shaped fruits, while at higher concentrations, fruits were oblong or pear shaped (Randhawa *et al* 1964). These were elongated and fruit surface was rough, due to ridging, whereas the normal fruits were round, smooth surface and seeded. Islam and Siddique (1972) observed a central cavity in all the seedless fruits of guava with prominent ridges on the fruit surface.

Schawabe (1973) also obtained negligible change in size and

shape of apple fruits cv. 'Cox's Orange Pippin' with GA_1, while Susanto *et al* (1973) observed elongated fruits of pummelo with the application of GA at 20 ppm and 200 ppm NAA. Comai *et al* (1981) reported that the application of Promalin (GA_4+GA_7+BA at 12.5+12.5+25 or 6.25 +6.25 + 12.5 ppm) and gibberellins (GA_4+GA_7 at 50 +50 ppm) applied at the start of petal fall favoured the fruit lengthening and lessened the average fruit size of different fruits.

2.1.5 Fruit colour

Saha (1971) observed that guava fruits treated with 2, 4-D (100 and 200 ppm) and 2, 4, 5-T (100 and 200 ppm) developed yellow colour earlier than untreated fruits. Garg *et al* (1978) reported that cycocel and MH 40 proved to be equally effective in prolonging the shelf life of guava by 3 days, followed by alar, by way of retarding colour development. Likewise, Singh *et al* (1979) applied ethephon to improve the quality of guava, reported that 600 ppm dose was most effective in the development of colour.

Ratnababu and Lavania (1986) studied the fruit maturity and colour development in lime and reported that treatments with 2,4,5-T, followed by GA greatly decreased the yellow coloured fruits at the time of harvest and on the other hand GA alone greatly increased the number of greenish yellow fruits. Similarly, calcium compounds at 1.7 g per litre used as a pre-harvest spray in ber, delayed colour development and

maintained good quality (Gupta *et al* 1987). Bal (1997) reported that flesh colour of the guava cv. L-49 (Sardar) fruits was creamy white, pulp crispy and soft flavour. Gaona *et al* (1994) reported that the application of 550 mg ethephon per litre applied on 30th September significantly improved the fruit colour of 'Jaffa' oranges.

2.1.6 Fruit maturity

Shanmugavelu (1962) studied the effect of GA_3, 2, 4-D and NAA on the maturity of grapes and found 10 ppm GA_3 to be most effective in enhancing maturity. Contrarily 250, 500, 750 and 1000 ppm GA sprayed at full bloom stage slightly delayed the maturity period in sweet lime fruits (Kumar *et al* 1975). Likewise, Kaur (1977) noted an advancement in fruit maturity in guava fruits varying from 101 to 102 days with chemical treatment as compared to 124 days in the control. Chapman *et al* (1979) advocated that harvesting period of guava was shortened from 15 weeks in control trees to 4 weeks in the trees which received spray of urea at 25 per cent.

Singla *et al* (1992) advocated that the application of ethephon @ 250, 500, 700 ppm and 100 ppm were effective in advancing the ripening and improved quality of berries of 'Early Muscat' and 'Gold' grapes. They further stated that Ethephon 750 ppm was the best treatment, followed by 1000 ppm which could advance ripening by 7 days in 'Early Muscat' and by 8 days in cv. 'Gold'. Panwar *et al* (1994) advocated that the

application of kinetin delayed the fruit ripening by 2 days, while etherel enhanced it by 4 days in 'Beauty Seedless' grapes.

Kim *et al* (2000) studied the effect of GA_3, ethephon and girdling and reported that GA_3+girdling reduced the number of days to harvesting in 'Himrod' grapes as compared with the control. Sasaki and Utssunmiya (2002) suggested that CPPU + GA_3 (10 pm and 100 ppm) caused the abnormal fruit growth and delayed the fruit maturity in 'Irwin' Mango fruits.

2.1.7 Fruit pressure

Bhatia *et al* (2001) studied the effect of foliar application of nutrients on yield and fruit quality of winter season guava cv. L-49 and reported that the minimum fruit pressure (10.11 kg/cm^2) with H_3BO_3 at 1.0 per cent when sprayed on 25th October and then again 15 days later. Yadav *et al* (2001) also studied the effect of growth regulators on the yield and quality of winter season guava cv. L-49 and recorded minimum fruit pressure (8.4 kg/cm^2) with etherel 75 or 100 ppm.

2.1.8 Fruit yield

The increase in yield of guava by 82 and 73 per cent was obtained with the spray of boron at 0.1 and 0.2 per cent concentrations, respectively, (Arora and Singh 1972). Doraipandhan and Shanmugavelu (1972) selected five year old trees of guava cv. Bangalore to study the effect of urea sprays at Coimbatore and reported that spraying the trees

with 1 and 2 per cent urea at 15 days interval during pre-bloom stage, resulted into an increment in mean fruit yield. Whereas, Dixit *et al* (1977) reported that zinc sulphate enhanced the yield in 'Kinnow' mandarin when sprayed 0.5 to 1.0 per cent in April and September.

Kundu and Mitra (1997), while working on 11-year old trees of cv. L-49 'guava' plants recorded maximum fruit yield per tree (21.7 kg) with sprays of DNOC at 10 ppm. Zinc sulphate 0.4 per cent increased yield upto 47.4 per cent in grapevine cv. Thompson Seedless (Kheddar *et al* 1978). While, Yamadagni *et al* (1979) suggested that zinc sulphate (0.2%) one week before flowering and at full-bloom stage increased the yield in 'Thompson Seedless' grapes.

The 17- year old guava trees were sprayed With urea at 2, 4 and 6 per cent in early August and February and the highest yield of 29.9 kg per tree was obtained with 2 per cent urea in the first year, while in second year, 1 per cent gave better yield (Mansour *et al* 1985). Ghosh (1986) conducted an experiment on the effect of magnesium, zinc and manganese on the yield of guava cv. L-49. He found that spraying the trees with 0.3 per cent solution of magnesium, zinc and boron improved the yield. Likewise, Singh *et al* (1989), while working on 20 year old guava cv. Allahabad Sufed at HAU, Hisar stated that a mixture of 15 per cent urea and 400 ppm NAA sprays produced highest yield during the winter season.

Tiwari *et al* (1992) conducted the trial on the 7 years old trees

of guava cv. Allahabad Sufeda and advocated that higher yield in winter season (64.8 kg) was recorded in the trees treated with 1000 ppm NAA. They further reported that both NAA and urea increased the fruit yield. Likewise, Ram and Bose (1994) conducted their study on the Mandarin orange and recorded maximum fruit yield per hectare (44.69 g) with foliar application of urea and zinc treatment. Kumar *et al* (1996) from their study recorded the maximum fruit yield (39.59 kg/tree) at 600 g N which was higher than 0-300 N level. They further reported that fruit yield increased upto 300 g during 1989 and 1990, whereas in the later years, the increase was observed upto 600 and 700 g levels.

A significant increase in fruit yield was obtained with the foliar spray of zinc at 4 g/plant per year (Lal *et al* 2000). Whereas, Ram and Bose (2000) reported that the application of magnesium + copper + zinc gave the maximum fruit yield in Mandarin orange. Again Dubey and Yadav (2001) advocated that the application of 800 g N produced the highest yield (55.37 kg/tree) of Mandarin cv. Khasi as compared to control, which was (32.11 kg/tree). Similarly, Bhatia *et al* (2001) recorded highest yield of (73.0 kg/tree) with the application of H_3BO_3 at 1.0 per cent in guava cv. L-49. Yadav *et al* (2001) recorded maximum fruit yield (71.0 kg/tree) with NAA at 60 ppm and minimum with etherel (45 kg/tree).

Otmani *et al* (2002) studied the effect of foliar application of urea at 0.8 or 1.6 per cent with ammonium nitrate supplying, 75 or 100 g

significantly increased the yield in citrus fruits. Similarly, Monga *et al* (2002) suggested that the fruit yield (no. of fruits/tree) increased with the increase in nitrogen and in combination with phosphorous and potassium and recorded maximum in receiving N at 900 g, P at 300 g and K at 300 g treatments. Singh and Singh (2002), while working on 'Allahabad Sufeda' guava fruits recorded the maximum yield (62.63 kg/tree) with 0.4 per cent copper spray and minimum in control (15.31 kg/tree).

2.1.9 Pulp percentage

Dhillon and Singh (1968) found that 75 ppm GA_3 and 15 ppm 2, 4, 5-T were most effective in increasing the pulp percentage, thickness, and pulp to stone ratio in 'Dhandhan' and 'Kaithali' cvs. of ber. But in cv. Umran, response was not so marked except 75 ppm GA_3 and 10 ppm 2, 4, 5-TP.

2.1.10 Organoleptic rating

Singh *et al* (1981) reported that treating of guava cv. L-49 fruits in calcium nitrate 1 per cent showed the organoleptic score of 70 out of 100, which was higher than the control plants. Likewise, Tandon *et al* (1984) observed that guava cv. Allahabad Sufeda fruits treated with Alar 500 ppm showed high organoleptic rating of 5.83 out of 10. On the other hand, Guava cv. Allahabad sufeda fruits treated with GA 150 ppm showed highest organoleptic score of 8.24 out of 10 (Rajput *et al* 1992).

Bhatia *et al* (2001) reported that the organoleptic rating (out

of 10) was the highest (9.0) with K_2SO_4 at 1.5 per cent spray in guava cv. L-49. Likewise, Yadav *et al* (2001) obtained the organoleptic rating of (winter guava cv. L-49) 8.1 out of 10 points with etherel 100 ppm and lowest (7.0) in control plants.

2.1.11 Seed Weight

The seed weight of the 'Kinnow' mandarin and 'Grapefruit' were increased with the application of GA_3 (Khan *et al* 2002). Similarly, Yadav (2002) studied the effect of urea, borax and NAA on yield parameters of guava cv. L-49 and recorded lowest seed weight per fruit (2.74 g) with 3.0 per cent urea. Seed weight per fruit was not significantly affected with borax, while NAA at 10 ppm gave the highest seed weight per fruit i.e. 3.06 g.

2.2 CHEMICAL CHARACTERS

2.2.1 Total soluble solids (TSS)

The experiment conducted on the effect of zinc sprays on yield and quality of 'Thompson Seedless' grapes revealed that the TSS was improved with zinc sulphate (0.2%) sprayed at one week before flowering and at full bloom (Yamdagni *et al* 1979). Likewise, Singh and Singh (1981) reported that the TSS content of fruits in 'Dancy Tangerine' mandarin was increased significantly with 0.5 per cent zinc sulphate spray. Similarity, in 'Khagzi Lime', zinc sulphate at 0.6 per cent improved fruit TSS (Babu and Rajput 1982).

Singh and Chhankar (1983) studied the effect of boron, zinc and molybdennum as foliar sprays on chemical composition of guava, fruits. They reported that the TSS content of guava fruits improved significantly with 0.4 per cent zinc sulphate. Likewise, Daulta *et al* (1983) found an increase in TSS upto 19.0 per cent in 'Beauty Seedless' grapes with zinc sulphate at 0.2 per cent concentration. The effect of magnesium, zinc and manganese was studied on guava cv. L-49 by Ghosh *et al* (1986), who reported that zinc sulphate at 0.3 per cent improved TSS in guava fruits. Similarity, Pandey *et al* (1988), stated that the foliar application of nutrients and plant growth regulators on 'Sardar' guava and significantly increased the TSS with 0.4 per cent zinc sulphate. Zinc sulphate at 1.0 per cent improved TSS content in 'Perlette' grapes when applied at the onset of berries (Yamdagni 1988).

Brahamchari *et al* (1997) found that the application of NAA enhanced the TSS and TSS/acid ratio in guava cv. Allahabad Sufeda fruits. (Kale *et al* 2000) observed that the maximum TSS in ber fruits was recorded when the plants were sprayed with 20 ppm gibberellic acid. Bhatia *et al* (2001), studied the effect of foliar application of nutrients on the yield and fruit quality of winter season guava cv. L-49 and recorded that the highest level of total soluble solids and sugars with H_3BO_3, followed by K_2SO_4 sprays.

2.2.2 Acidity

Hidalgo and Canadala (1962) reported that the application of GA to grapevines produced parthenocarpic berries which had low level of acidity in the juice than normal berries. Vaksonovic (1975) also recorded lower acidity in grape berries cultivar 'Afus Ali' with bloom application of gibberellic acid. On the other hand, Singh *et al* (1976) advocated decreased acidity in mango fruits with the application of 200 ppm GA at blooming stage. (Kumar and Hoada 1977), while conducting their study on effect of GA_3 on growth and composition of guava fruit recorded lowest acidity when emasculated flowers were sprayed with 100 and 200 ppm GA_3. Likewise, Rajput and Singh (1977) studied the effect of certain plant growth substances in guava and reported decreased acidity with GA_6 and NAA application.

Effect of magnesium, zinc and manganese on yield and fruit quality of guava cv. L-49 was studied by Ghosh (1986) and reported that the application of zinc and boron, singly, and in combination reduced the acidity of fruit which was significantly lower than the control. Chandra *et al* (1984) noted that the pre-harvest spray of calcium nitrate at 1.5 per cent on 5 year old guava trees cv. Allahabad Sufeda and then dipping the fruits in 500 and 700 alar after harvest gave the highest values of total titratable acidity (0.62%).

Singh (1985) studied the effect of foliar spray of urea on

growth, yield and quality of guava cv. Allahabad Sufeda and reported a decrease in the fruit acidity with the application of urea (4 or 6%) during January and July. Sharma *et al* (1991) observed that the acidity of fruit decreased with the foliar application of different nutrients solution like potassium, calcium and zinc. Maximum decrease in acidity (0.36%) was recorded with zinc at 0.6 per cent and potassium sprays.

Singh *et al* (1992) observed reduced acidity, minimum being (0.70%) in 'Perlette' and (0.79%) in 'Beauty Seedless' with ethephon as compared to maximum (0.89%) in 'Perlettle' and 0.94 per cent in 'Beauty Seedless' in control. A significant decrease in acidity with N application in guava was recorded by Kumar *et al* (1996). Nilnand *et al* (1996) observed lower level of acidity with 50 ppm GA_{4+7} when sprayed at full-bloom stage in grapes. Effect of controlled-release fertilizers on growth, yield and fruit quality of guava cv. Sardar in Ustochripts was studied by Ram *et al* (1999) and advocated that the acidity in fruits was not affected by different levels and sources of nitrogen.

2.2.3 Ascorbic acid

Teotia *et al* (1961) obtained the high ascorbic acid in guava fruits when subjected to GA sprays. Likewise, Doraipandhan and Muthukrishnan (1967) recorded high ascorbic acid in guava fruits when GA and maleic hydrazide were applied at full bloom stage. Doraipandhan and Shanmugavelu (1972) observed a slight increase (5-6%) in the ascorbic

acid content with 2 per cent urea (103.68 mg/100 g pulp), sprayed trees of cv. Bangalore over the control (197.2 mg/100g pulp). Ram (1979) also recorded higher amount of ascorbic acid with GA sprays in guava fruits.

Effect of foliar feeding of various chemicals viz. $Ca(NO_3)_2$, $CaCl_2$ and KNO_3 on the physio-chemical quality of 'Allahabad Sufeda' guava were studied by Singh *et al* (1981) and reported that foliar application of 3 nutrients together gave the highest content of ascorbic acid (75.93 mg/100 g pulp). Similarly, Koj *et al* (1989) obtained high ascorbic acid and total sugars in fruits which obtained 400 g N per tree applied to 8 years old 'Sardar' guava trees. Singh *et al* (1992) obtained the ascorbic acid content of 245.43 and 255.67 mg/100g pulp in the 'Allahabad Sufeda' fruits when sprayed with 4 per cent urea + 2 per cent single super phosphate and 10 ppm GA_3 treatments.

Brahamchari *et al* (1997) conducted their studies on the effect of foliar application of calcium, potassium and growth substances on the yield and quality of guava advocated that the application of GA_3 at 10 ppm gave the highest ascorbic acid in guava fruits cv. Allahabad Sufeda. Malik *et al* (2000) noticed a decrease in the ascorbic acid content in 'Kinnow' fruits with the application of urea and zinc sulphate. Bhatia *et al* (2001) studied the effect of foliar application of nutrients on the yield and fruit quality of winter season guava cv. L-49 and observed the maximum ascorbic acid content (182 mg/100 g pulp) with K_2SO_4 spray. Kanwarjit *et*

al (2001) studied the effect of growth regulators on the yield and quality of ber cv. Umran and advocated that the ascorbic acid content of ber fruits were highest (109 mg/100g pulp). Likewise, Babu and Yadav (2002) conducted the studies on the effect of 2, 4-dichlorophenoxy acetic acid on the yield and quality of 'Khasi' mandarin and reported that the application of 2, 4-D at 10, 20 and 30 ppm as foliar spray gave the maximum ascorbic acid content (32.50 mg/100 g).

Chapter - III

MATERIALS AND METHODS

The present studies on 'Effect of foliar application of chemicals on fruit ripening and quality in winter guava' were conducted in the year 2003-04.

3.1 PLANT MATERIAL

Ten year old trees of guava cv. Allahabad Sufeda planted at a distance of 6x6 m apart at the New Orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana, were sprayed at the time when the fruit size was of walnut size or little bigger during the month of October- November. Details of the experiments are as under :

Sr. No.	Name of chemicals	Concentration
1.	Urea	(2,3 and 4%)
2.	Potassium sulphate (K_2SO_4)	(1, 2 and 3%)
3.	Ethephon	(200, 300 and 400 ppm)
4.	Control (water spray)	Simple water

In all, there were 10 treatments including control (water spray) and each treatment was replicated thrice, i.e. one tree per replication in Randomized Block Design (RBD). Thus, 30 trees were taken for conducting the experiment.

3.2 PHYSICAL FRUIT CHARACTERS

3.3.1 Fruit weight

The average fruit weight of ten randomly selected fruits in each replication were determined by weighing the fruits on the pan balance and the average fruit weight was calculated.

3.2.2 Fruit volume

The average fruit volume of two fruits which were dipped in a beaker containing water was recorded in each replication.

3.2.3 Fruit size (length and breadth)

The mean fruit size (length and breadth) of ten randomly selected fruits were recorded in each replication. The size was measured by placing the fruits on one end to the end position on the measuring scale and then again placed breadth wise to measure the fruit breadth and then average fruit length and breadth was calculated.

3.2.4 Fruit shape

The fruit shape was described on the basis of visual observations in a random sample of ten fruits. The following categories were made with respect to fruit shape :

i. Round

ii. Ovate to round

iii. Ovate

3.2.5 Fruit surface

The presence/absence of ribs and smoothness/roughness of the fruit surface were examined visually in a random sample of ten fruits. The following categories were made with respect to fruit surface :

i. Smooth

ii. Slightly ribbed

iii. Rough

The fruits which were glossy, considered as smooth while others as rough.

3.2.6 Fruit colour

The colour of the fruit was described on the basis of The Royal Horticultural Colour Chart (Wilson 1938).

3.2.7 Date of fruit maturity

The day/date when the fruits were picked from the tree was noted as the date of fruit maturity.

3.2.8 Span of fruit harvest

The span of fruit harvest was calculated in number of days from the first harvest date to the last date of fruit harvest from a tree.

3.2.9 Fruit pressure

Hardness of the five randomly selected fruits was determined with pressure tester and expressed as kg/cm^2.

3.2.10 Fruit number/yield per plant

Total number of fruits on each tree were counted about 15-20 days prior to the expected date of fruit ripening. The fruit yield in kg per plant was thus worked out.

3.2.11 Seed number per fruit

Seeds of five randomly selected fruits in each replication was extracted and counted, then the average was expressed as seed number per fruit.

3.2.12 Pulp per cent

Pulp per cent of five randomly selected fruits was calculated by taking the fruit weight and then deducting the seed weight of all the replications.

3.2.13 Organoleptic rating

The fruits were tasted by a panel of five judges and organoleptic rating was done by giving the marks to the fruits according to their taste, flavour and aroma on the basis of Hedonic Scale 1-9.

3.2.14 Seed weight per fruit

The weight of the seeds of five randomly selected fruits was taken by removing all the seeds from the fruits with the help of pan balance and is expressed in gms.

3.3 CHEMICAL CHARACTERISTICS

3.3.1 Total soluble solids (T.S.S.)

The juice from five randomly selected fruits was extracted by crushing the slices in a pestal and mortar and then squeezing that through the rough muslin cloth by pressing with hands. The TSS was recorded by Bausch and Lomb (0-32 range) refractometer. The readings were adjusted with the temperature correction chart (AOAC 1985).

3.3.2 Titratable acidity

For recording the acid content, juice from the five randomly selected fruits was extracted. Then 2 ml of juice was taken in a 50 ml beaker. This was diluted to 10 ml with distilled water and then titrated against 0.1 N NaoH using phenolphthalein as an indicator. The change in the colour from yellow to light pink was noted as end point. The acid content was expressed in terms of anhydrous citric acid per 100 ml of juice, by using the following formula :

$$\text{Per cent acidity} = \frac{0.0064 \times 0.1 \text{ N NaoH used (ml)}}{\text{Juice taken (2 ml)}} \times 100$$

3.3.3 Ascorbic acid

Preparation of reagents

a. Extracting solution

15 g of glacial metaphosphoric acid pallets were dissolved in 40 ml of acetic acid and 200 ml of water. The final volume was made

500 ml.

b. Ascorbic acid standard solution

100 mg of ascorbic acid was taken and 100 ml volume was made with metaphosphoric acid i.e. extracting solution.

c. Indophenol standard solution

50 mg of dye (2,6-dichlorophenol-indophenol) was dissolved in 50 ml of water, to which 42mg of sodium bicarbonate was added and distilled to 200 ml.

d. Standardization of indophenol solution

2 ml of standard ascorbic acid solution was added in each of three volumetric flasks containing each 5 ml of extracting solution. Then it was rapidly titrated with the indophenol standard solution till rose pink colour persisted for 5 seconds. The volume of indophenol solution used for titration of standard ascorbic acid was calculated by taking the average of three readings.

e. Sample preparation and determination of vitamin C

For recording the vitamin C content of fruits, juice was extracted from ten randomly selected fruits. Then 2 ml of juice was added to each of three volumetric flasks containing 5 ml of extracting solution. The titration was done against indophenol standard solution and end point of each solution was noted. The volume of dye used for titration of juice was calculated by taking the average of three readings.

The ascorbic acid (mg/100g of pulp) of a given sample was calculated with the following formula

$$\frac{\text{Volume of standard ascorbic acid taken}}{\text{Volume of dye used for titration of standard ascorbic acid}} \times \frac{\text{Volume of dye used for titration of juice}}{\text{Volume of juice taken}} \times 100$$

3.4 STATISTICAL METHOD OF ANALYSIS

The data recorded for all the parameter were analysed according to the method of Randomised Block Design (RBD) as advocated by Panse and Sukhatme (1978).

Chapter - IV

RESULTS AND DISCUSSION

4.1 FRUIT WEIGHT

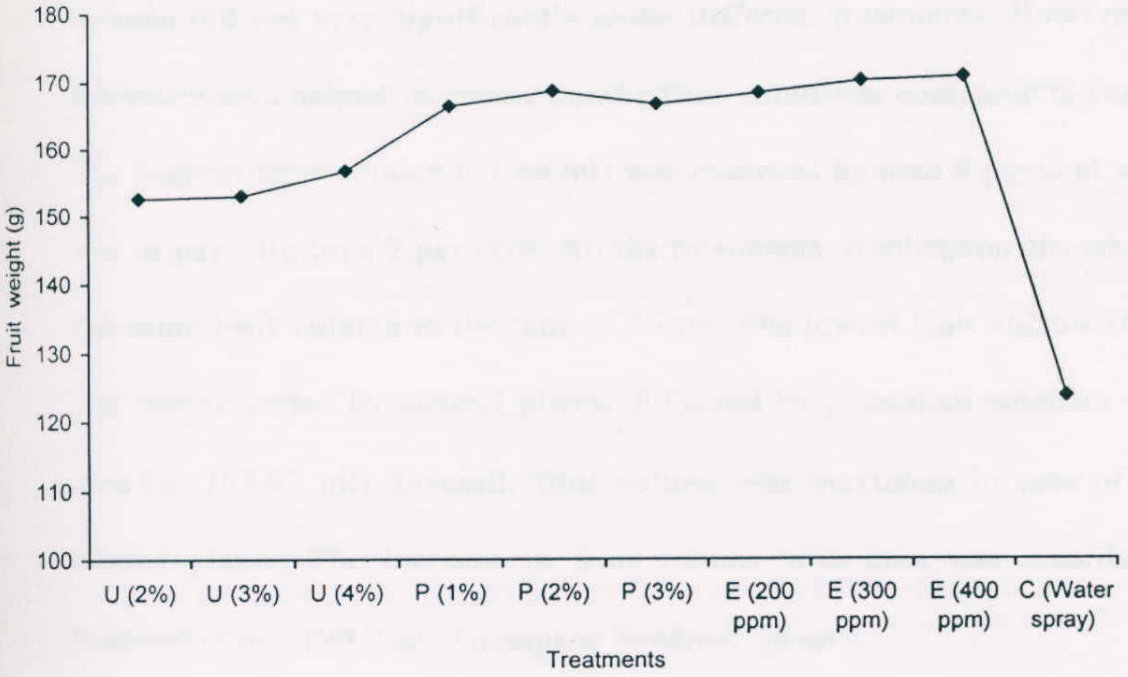
The data on the average fruit weight shows that the influence of different chemicals were significant over control. Among the chemicals, potassium sulphate and ethephon improved the fruit weight significantly as compared to urea. However, the differences were non-significant between the concentrations of different chemicals (Table 1). The maximum fruit weight (170.67 g) was recorded from the plants sprayed with 400 ppm ethephon, followed by 300 ppm ethephon (170.12 g). On the other hand, the fruit weight was 152.60 g with 2 per cent urea spray. All the treatments helped in increasing the fruit weight over control. In case of potassium sulphate, maximum fruit weight (168.67 g) was recorded with 2 per cent spray, while control plants showed the fruit weight of only 123.80 g. The increase in total weight of the fruit might be due to the increase either in the flesh or seed or in both. In the present study, increase in the fruit weight was primarily due to stimulation in the growth of the flesh.

So, the ethephon at 400 ppm was superior in increasing the weight which was higher than all other treatments. These findings are in line with those of Sandhu *et al* (1985), who reported an increase in fruit weight by ethephon in ber cv. Umran.

In case of fruit volume, (Table 1) the data indicates that the

Table 1 Effect of foliar application of chemicals on fruit weight and volume of winter guava

Treatments	Fruit weight (g)	Fruit volume (ml)
Urea (2%)	152.60	73.75
Urea (3%)	153.00	76.83
Urea (4%)	156.70	77.66
Potassium sulphate (1%)	166.40	63.33
Potassium sulphate (2%)	168.67	69.41
Potassium sulphate (3%)	166.67	75.34
Ethephon (200 ppm)	168.34	70.03
Ethephon (300 ppm)	170.12	70.20
Ethephon (400 ppm)	170.67	70.60
Control (Water spray)	123.80	61.41
CD at 5%	**6.70**	**NS**



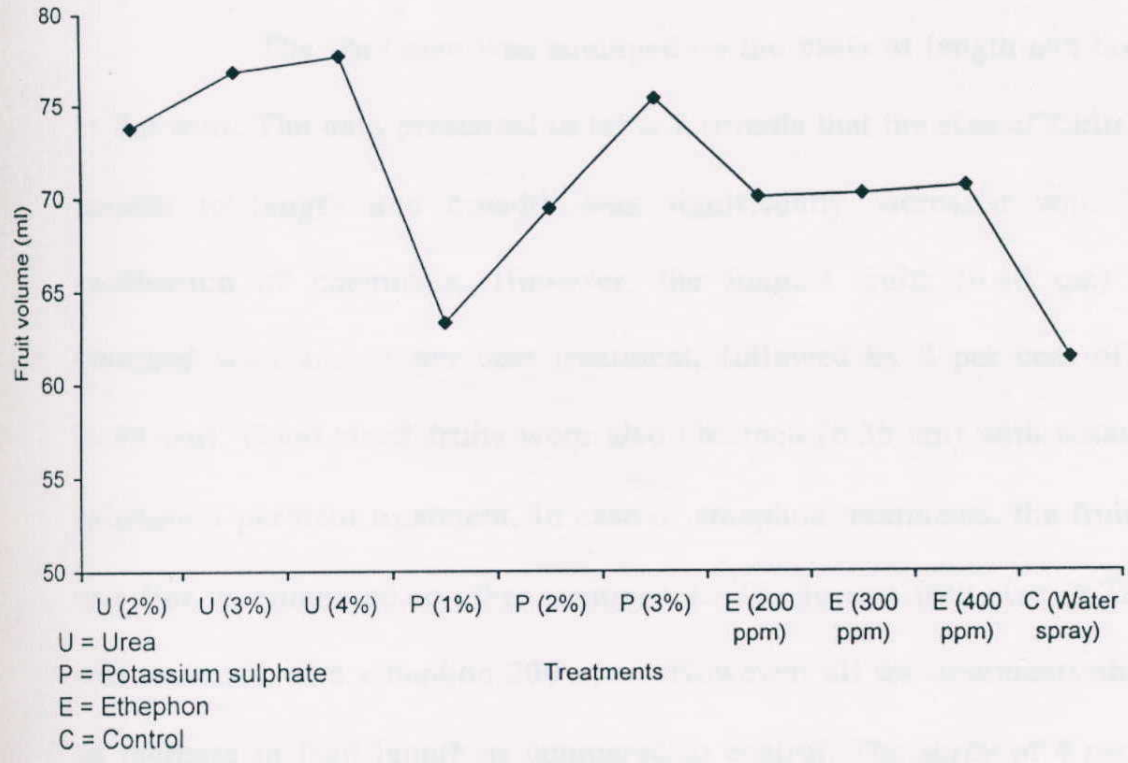


Fig. 1 Effect of foliar application of chemicals on fruit weight and volume of winter guava

volume did not vary significantly under different treatments. However, all the treatments helped in increasing the fruit volume as compared to control. The highest fruit volume (77.66 ml) was recorded by urea 4 per cent which was at par with urea 3 per cent. All the treatments of ethephon also showed the same fruit volume to the tune of 70 ml. The lowest fruit volume (61.41 ml) was recorded by control plants, followed by potassium sulphate 1 per cent i.e. (63.33 ml). Overall, fruit volume was maximum in case of urea treated plants. The increase in fruit volume with urea was recorded by Beniwal *et al* (1992) in 'Thompson Seedless' grapes.

4.2 FRUIT SIZE

The fruit size was adjudged on the basis of length and breadth of the fruit. The data presented in table 2 reveals that the size of fruits with respect to length and breadth was significantly increased with foliar application of chemicals. However, the longest fruits (6.40 cm) were obtained with urea 4 per cent treatment, followed by 3 per cent of urea (6.39 cm). Good sized fruits were also obtained (6.35 cm) with potassium sulphate 3 per cent treatment. In case of ethephon treatments, the fruit size was less as compared to other treatments. The lowest fruit size (6.23 cm) was recorded with ethephon 200 ppm. However, all the treatments showed an increase in fruit length as compared to control. The spray of 4 per cent urea and 400 ppm ethephon recorded the broadest fruits (6.20 cm). The next broadest fruits recorded (6.16 cm) were with urea 3 per cent. The

Table 2 Effect of foliar application of chemicals on fruit size of winter guava

Treatments	Length (cm)	Breadth (cm)
Urea (2%)	6.36	6.15
Urea (3%)	6.39	6.16
Urea (4%)	6.40	6.20
Potassium sulphate (1%)	6.30	6.05
Potassium sulphate (2%)	6.32	6.05
Potassium sulphate (3%)	6.35	6.13
Ethephon (200 ppm)	6.23	5.88
Ethephon (300 ppm)	6.25	5.91
Ethephon (400 ppm)	6.40	6.20
Control (Water spray)	5.30	5.43
CD at 5%	**0.38**	**0.42**

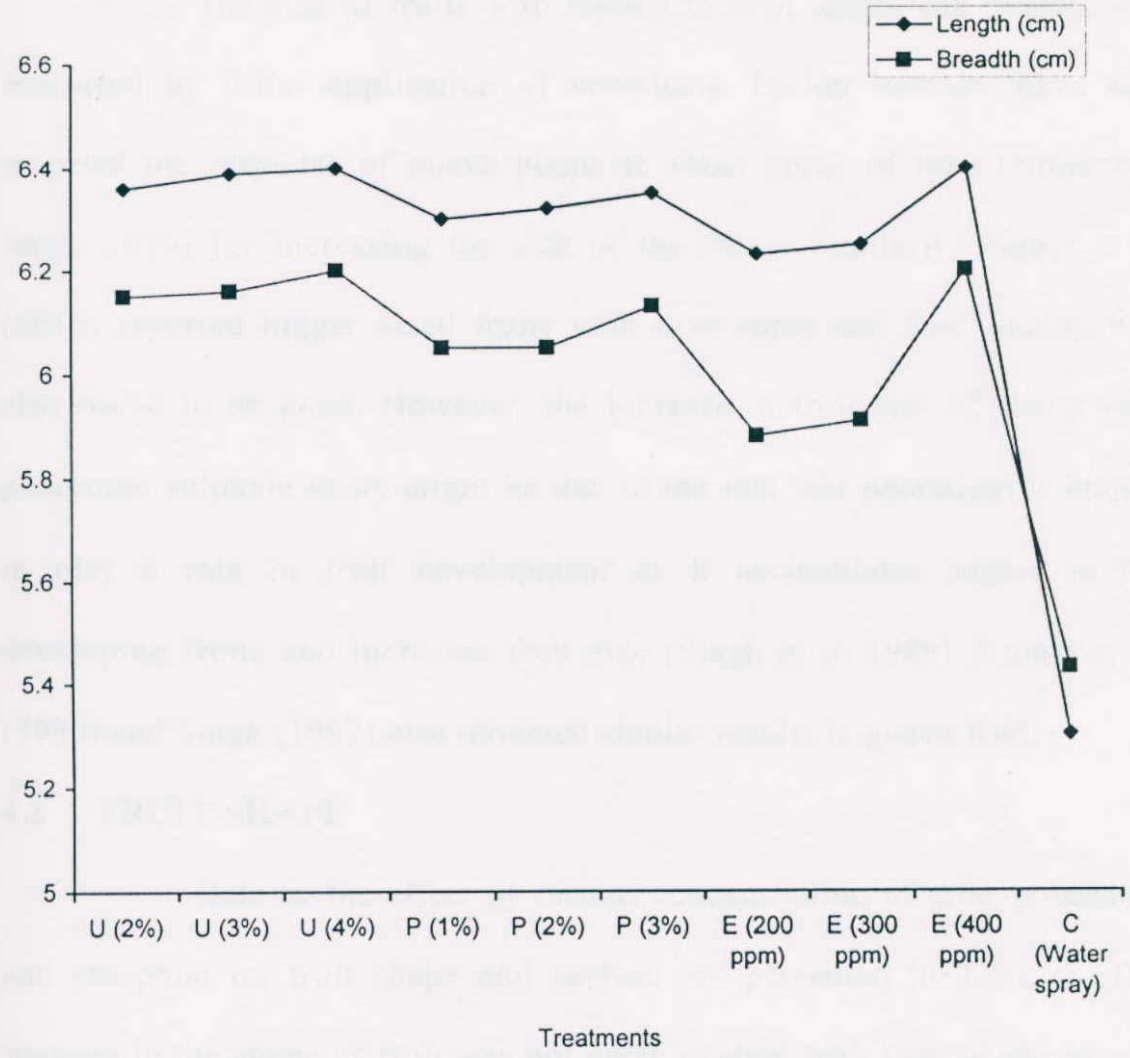


Fig. 2 Effect of foliar application of chemicals on fruit size of winter guava

U = Urea
P = Potassium sulphate
E = Ethephon
C = Control

lowest fruit breadth was recorded (5.43 cm) in control. However, the differences between chemicals and their concentrations were non-significant.

The size of fruits with respect to both length and breadth was increased by foliar application of chemicals. Earlier workers have also reported the response of guava plants to foliar spray of urea (Arora and Singh 1970) for increasing the size of the fruits. Similarly, Rajput *et al* (1986) reported bigger sized fruits with urea spray and fruit quality was also found to be good. However, the increase in fruit size of guava with potassium sulphate spray might be due to the fact that potassium is known to play a role in fruit development as it accumulates sugars in the developing fruits and increases fruit size (Singh *et al* 1989). Kumar *et al* (1996) and Singh (1997) also obtained similar results in guava fruit.

4.3 FRUIT SHAPE

Data on the effect of various concentrations of urea, potassium and ethephon on fruit shape and surface are presented in Table 3. The changes in the shape of fruit was not much evident with various chemicals. However, the shape of 'Allahabad Sufeda' fruits changed from ovate to round with 3 per cent potassium sulphate, followed by urea 3 per cent treatment, which also produced the fruit shape from ovate to round. The fruits sprayed with different concentrations of ethephon produced two types of fruit shapes. First oblong shape which was produced by the

Table 3 Effect of foliar application of chemicals on fruit shape and surface of winter guava

Treatments	Fruit shape	Fruit surface
Urea (2%)	Round	Slightly rough
Urea (3%)	Ovate to round	Slightly rough
Urea (4%)	Round	Slightly rough
Potassium sulphate (1%)	Ovate	Slightly rough and ribbed
Potassium sulphate (2%)	Round	Rough
Potassium sulphate (3%)	Ovate to round	Rough
Ethephon (200 ppm)	Oblong	Smooth
Ethephon (300 ppm)	Ovate	Smooth
Ethephon (400 ppm)	Ovate	Smooth
Control (Water spray)	Ovate	Smooth

application of ethephon 200 ppm treatment, while ethephon 300 ppm and 400 ppm produced ovate shape fruits. Fruit shape was changed to round with the concentration of urea 2 per cent and 4 per cent. This was closely followed by potassium sulphate 2 per cent treatment. Whereas, fruits from the control plants were ovate and had smooth surface.

The fruits with the glossy appearance and without any ribs was considered to be smooth. While the others were placed under rough category. The fruits of the 'Allahabad Sufeda', when sprayed at different concentrations of urea produced slightly rough surface as compared to the fruits of plants when sprayed with different concentrations of ethephon, which produced smooth surface. A slight change in the trees sprayed with potassium sulphate 1 per cent produced slightly rough and ribbed surface. Smooth fruits were also recorded in the control plants.

4.4 FRUIT COLOUR

A persual of the data in table 4 indicates the fruit colour which was recorded with the help of a colour chart. There was no considerable variation in the colour of the fruits. All the treatments showed the same colour yellow green but with different shades.

The data regarding the fruit maturity for 'Allahabad Sufeda' (Table 4) shows that all the fruits were picked at the same date on Nov. 11 but there was much variation in the number of days taken for the fruit to complete its span of harvest. The trees sprayed with ethephon treatments at

Table 4 **Effect of foliar application of chemicals on fruit colour, fruit maturity and span of fruit harvest of winter seasons guava**

Treatments	Fruit colour	Fruit maturity (dates)	Span of fruit harvest (days)
Urea (2%)	YGG 150 B	Nov. 11	36
Urea (3%)	YGG 150 C	Nov. 11	34
Urea (4%)	YGG 150 C	Nov. 11	33
Potassium sulphate (1%)	YGG 150 C	Nov. 11	41
Potassium sulphate (2%)	YGG 150 B	Nov. 11	43
Potassium sulphate (3%)	YGG 150 B	Nov. 11	41
Ethephon (200 ppm)	YGG 150 C	Nov. 11	24
Ethephon (300 ppm)	YGG 150 C	Nov. 11	28
Ethephon (400 ppm)	YGG 150 B	Nov. 11	28
Control (Water spray)	YGG 150 C	Nov. 11	28

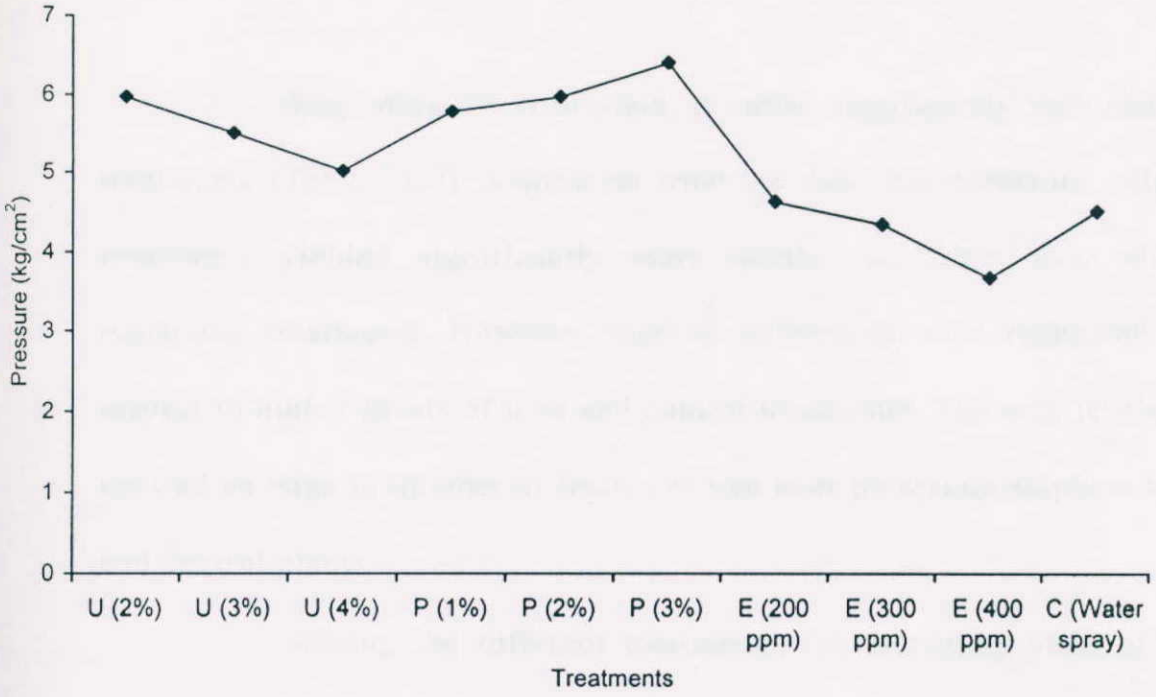
all the concentrations, were the first to mature the fruits with a marked difference of 24 and 28 days. Urea spray @ 2, 3 and 4 per cent took about 36, 34 and 33 days, respectively to mature the fruits which was slightly lower than the control plants which took about 38 days. However, the treatments of potassium sulphate took the maximum days i.e. (41, 43 and 41 days) for the fruits to mature which were slightly higher than those taken by the control trees i.e. 38 days.

4.5 FRUIT FIRMNESS

Data on the effect of various concentrations of urea, potassium sulphate and ethephon on the fruit pressure are presented in Table 5, which shows that the treatments did not vary significantly. Fruit pressure with urea 2 per cent as well as potassium sulphate 2 per cent were the same but potassium sulphate 3 per cent had the higher pressure of 6.40 kg/cm^2. The minimum fruit pressure (3.68 kg/cm^2) was recorded with ethephon 400 ppm, which was found to be much lower as compared to control (4.50 kg/cm^2). The control plants produced harder (4.50 kg/cm^2) fruits as compared to ethephon 300 and 400 ppm, which recorded the fruit pressure of 4.34 kg/cm^2 and 3.68 kg/cm^2. So, on an average, the fruit pressure was found to be minimum with ethephon treatments. The softening of the fruits with ethephon might be due to its action on cell wall hydrolysis and changes in the complex substances to simple ones. These findings are in line with the work of Yadav *et al* (2001).

Table 5 Effect of foliar application of chemicals on fruit pressure (kg/cm^2) and fruit yield of winter guava

Treatments	Pressure (kg/cm^2)	Fruit yield (kg/tree)
Urea (2%)	5.97	65.20
Urea (3%)	5.50	69.30
Urea (4%)	5.01	70.50
Potassium sulphate (1%)	5.78	69.30
Potassium sulphate (2%)	5.97	70.70
Potassium sulphate (3%)	6.40	73.30
Ethephon (200 ppm)	4.62	48.80
Ethephon (300 ppm)	4.34	46.32
Ethephon (400 ppm)	3.68	44.32
Control (Water spray)	4.50	61.67
CD at 5%	**NS**	**2.38**



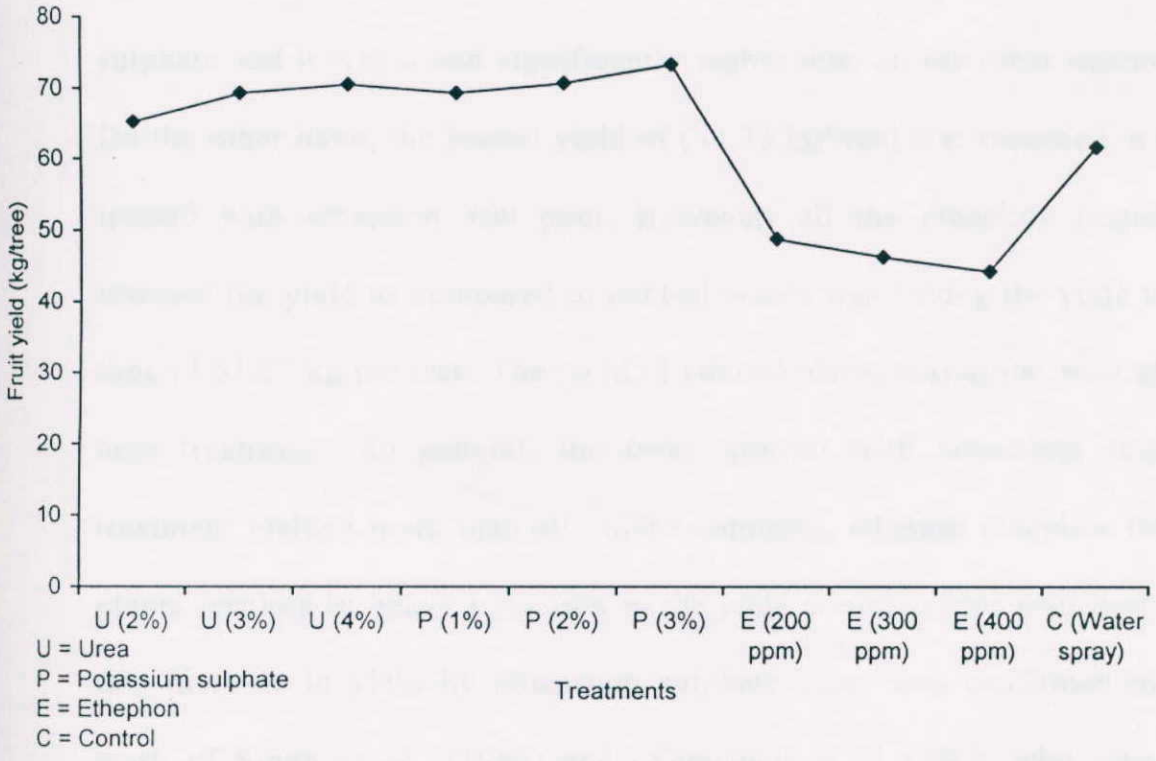


Fig. 3 Effect of foliar application of chemicals on fruit pressure (kg/cm^2) and fruit yield of winter guava

Regarding the fruit yield, it varied significantly with different treatments (Table 5). It is apparent from the data that potassium sulphate treatments yielded significantly more number of fruits over all the remaining treatments. However, marked differences were registered with respect to higher levels of urea and control treatments. The urea levels also showed an edge in number of fruits per tree over potassium sulphate levels and control plants.

Among the different treatments, the maximum yield of 73.3 kg/tree was obtained from the trees treated with 3 per cent potassium sulphate and it was found significantly higher than all the other treatments. On the other hand, the lowest yield of (44.32 kg/tree) was recorded in trees treated with ethephon 400 ppm. However, all the ethephon treatments lowered the yield as compared to control which was having the yield to the tone of 61.67 kg per tree. The yield of control plants was at par with all the urea treatments. In general, the trees sprayed with potassium sulphate treatment yielded more than all other treatments, whereas ethephon treated plants resulted in heavy reduction in the yield due to severe fruit drop. So, this increase in yield by potassium sulphate spray was confirmed by the work of Singh *et al* (1986) and (Yamdagni *et al* 1980), who found an increase in the yield by potassium sulphate in ber fruits. Ahlawat and Yamdagni (1981) and Ghosh (1986) also found an increase in yield by potassium sulphate in guava fruits.

Table 6 Effect of foliar application of chemicals on seed number and seed weight of winter guava

Treatments	Seed (no./fruit)	Seed weight (g)
Urea (2%)	198.04	2.39
Urea (3%)	201.34	2.13
Urea (4%)	209.34	1.90
Potassium sulphate (1%)	212.67	2.70
Potassium sulphate (2%)	230.67	2.32
Potassium sulphate (3%)	244.67	1.95
Ethephon (200 ppm)	217.34	2.76
Ethephon (300 ppm)	223.67	2.54
Ethephon (400 ppm)	226.67	2.41
Control (Water spray)	201.00	1.96
CD at 5%	**75.70**	**0.59**

4.6 SEED NUMBER PER FRUIT

Data regarding the seed number and seed weight per fruit are presented in Table 6 for winter season crop of guava. The values regarding the seed number and seed weight per fruit varied significantly among different treatments. The maximum number of seeds (244.67) were recorded with potassium sulphate 3 per cent, which were found to be at par with (230.67) potassium sulphate 2 per cent. While the lowest number of seeds (198.04) were recorded with urea 2 per cent spray. The control plants produced (201.00) seeds per fruit which was at par with the (201.34) treatment of urea 3 per cent. The seed number per fruit were also found more in all the ethephon treatments.

In case of seed weight, it was found highest with ethephon 200 ppm (2.76 g) which showed significant edge over the fruits sprayed with potassium sulphate 1 per cent. On the other hand, seed weight (1.90 g) was recorded with urea 4 per cent, which was lower than control (1.96 g). Overall, all the treatments decreased the seed weight per fruit.

4.7 FRUIT PULP

The effect of urea, ethephon and potassium sulphate on the pulp percentage was found to be non-significant. The highest and the lowest pulp percentage was recorded under the treatments of potassium sulphate 3 per cent and ethephon 400 ppm, respectively. However, in potassium sulphate treatments, all the concentrations increased the pulp

Table 7 **Effect of foliar application of chemicals on pulp (%) and organoleptic rating (out of 9) of winter guava**

Treatments	Pulp (%)	Organopleptic rating (9)
Urea (2%)	98.42	6.00
Urea (3%)	98.56	5.35
Urea (4%)	98.59	5.16
Potassium sulphate (1%)	98.68	5.34
Potassium sulphate (2%)	98.68	5.50
Potassium sulphate (3%)	98.69	7.00
Ethephon (200 ppm)	98.46	6.00
Ethephon (300 ppm)	98.44	5.16
Ethephon (400 ppm)	98.14	5.13
Control (Water spray)	98.38	5.16
CD at 5%	**NS**	**NS**

Fig. 4 Effect of foliar application of chemicals on pulp (%) of winter guava

U = Urea
P = Potassium sulphate
E = Ethephon
C = Control

percentage. In case of urea, it was again increased by all the treatments. However, urea 4 per cent gave the better pulp percentage to the tune of 98.59, whereas the ethephon treatments (200 and 300 ppm) recorded an increase in pulp percentage. The ethephon 400 ppm recorded the pulp percentage of 98.14, which was lower than that of control (98.38%). So, overall, all the treatments helped in increasing the pulp percentage, except ethephon 400 ppm as compared to control treated plants.

Regarding the organoleptic rating, it did not differ significantly under different treatments. However, minimum organoleptic rating out of 9 was recorded 5.13 in case of trees sprayed with ethephon at 400 ppm. The organoleptic rating of the trees sprayed with urea 3 per cent and potassium sulphate 1 per cent did not vary significantly but the highest rating was recorded to be 7.00 in case of the trees sprayed with potassium sulphate 3 per cent. The work in the present investigation were in line with the work of Bhatia *et al* (2001), who recorded maximum organoleptic rating with potassium sulphate treatment. Same was recorded in case of guava fruits by Yadav *et al* (2001). The organoleptic rating of control plants was recorded to be 5.16, which was same as that of urea 4 per cent as well as ethephon 300 ppm.

4.8 TSS

The data pertaining to the changes in total soluble solids are presented in Table 8, which shows significant differences with regard to

different treatments. Highest soluble solids (10.04%) were recorded with 3 per cent potassium sulphate, which was at par (10.01%) with ethephon 400 ppm. The lowest total soluble solids to the tune of 8.70 per cent were obtained with 2 per cent of urea treatment, which was same with regard to 8.70 per cent in control. The application of all the treatments helped significantly in increasing the total soluble solids of fruits over control.

Acidity

The effect of urea, potassium sulphate and ethephon on acidity of the fruits for winter season crop showed maximum (0.33%) in fruits produced with urea 4 per cent treatment, which was significantly higher than other treatments. Higher acidity to the level of 0.31 per cent was estimated from the fruits produced by the trees, which received urea at 3 per cent. Rest of the treatments have the same level of acidity. Production of higher acidity with the urea treatments may be attributed to the reason that it might have increased the translocation of acids from leaves to fruits. Large part of organic acids in the fruits are translocated from the leaves to fruits of the tree, because the photosynthesis from which the organic material originate is not very active in fruits. The results of the present investigation are in agreement with the work of Bal *et al* (1986), Grewal *et al* (1993), Masalkar and Wavhal (1991) in ber fruits. Whereas, acidity was found to be decreased with the application of ethephon treatment.

Table 8 Effect of foliar application of chemicals on TSS (%) and acidity (%) in fruits of winter guava

Treatments	TSS (%)	Acidity (%)
Urea (2%)	8.70	0.29
Urea (3%)	8.79	0.31
Urea (4%)	9.50	0.33
Potassium sulphate (1%)	9.23	0.25
Potassium sulphate (2%)	9.71	0.24
Potassium sulphate (3%)	10.04	0.23
Ethephon (200 ppm)	9.08	0.27
Ethephon (300 ppm)	9.09	0.26
Ethephon (400 ppm)	10.01	0.25
Control (Water spray)	8.70	0.38
CD at 5%	**1.21**	**0.16**

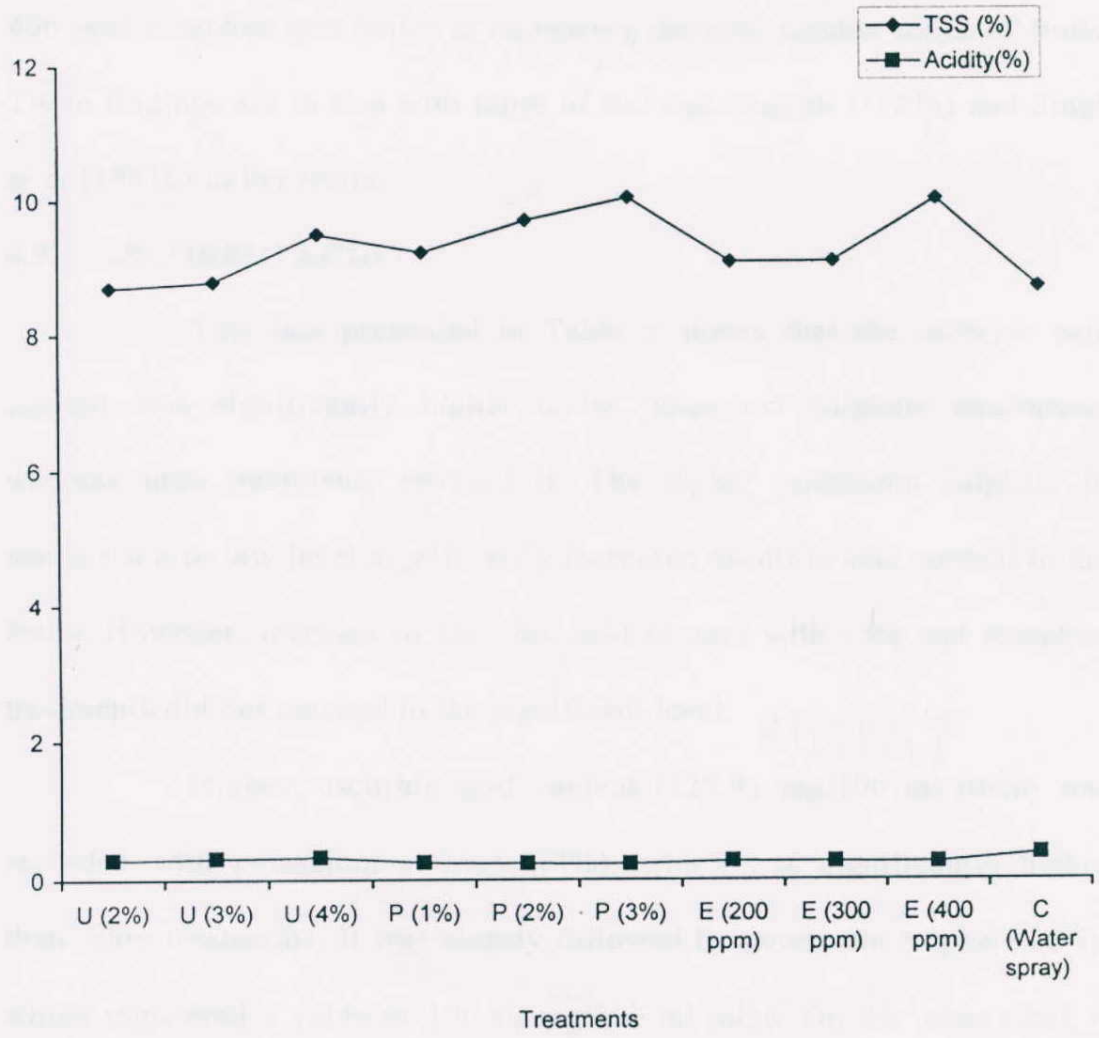


Fig. 5 Effect of foliar application of chemicals on TSS (%) and acidity (%) in fruits of winter guava

U = Urea
P = Potassium sulphate
E = Ethephon
C = Control

The total soluble solids increased, whereas titrable acidity of fruits decreased with all the concentration of ethephon treatment. However, 400 ppm ethephon was better in increasing the total soluble solids of fruits. These findings are in line with those of Bal and Chohan (1981a) and Singh *et al* (1981b) in ber fruits.

4.9 ASCORBIC ACID

The data presented in Table 9 shows that the ascorbic acid content was significantly higher under potassium sulphate treatments, whereas urea treatments reduced it. The higher potassium sulphate in comparison to low level significantly increased ascorbic acid content in the fruits. However, increase in ascorbic acid content with urea and ethephon treatments did not reached to the significant level.

Highest ascorbic acid content (127.91 mg/100 ml juice) was recorded with potassium sulphate (3%), which was significantly higher than other treatments. It was closely followed by potassium sulphate (2%), which registered a value of 120.80 mg/100 ml juice. On the other hand, 4 per cent urea recorded the lowest value (104.88 mg/100 ml juice), but in control, the ascorbic acid content was estimated to little higher scale i.e. 105.58 mg/100 ml juice, while ascorbic acid content increased significantly in all ethephon treatments. The increase in the ascorbic acid content will be attributed to the higher synthesis of some metabolites of some intermediate

Table 9 **Effect of foliar application of chemicals on ascorbic acid (mg/100 ml juice) of winter guava**

Treatments	Ascorbic acid (mg/100 ml juice)
Urea (2%)	111.88
Urea (3%)	108.10
Urea (4%)	104.67
Potassium sulphate (1%)	110.01
Potassium sulphate (2%)	120.80
Potassium sulphate (3%)	127.91
Ethephon (200 ppm)	109.63
Ethephon (300 ppm)	110.01
Ethephon (400 ppm)	110.41
Control (Water spray)	105.58
CD at 5%	**7.36**

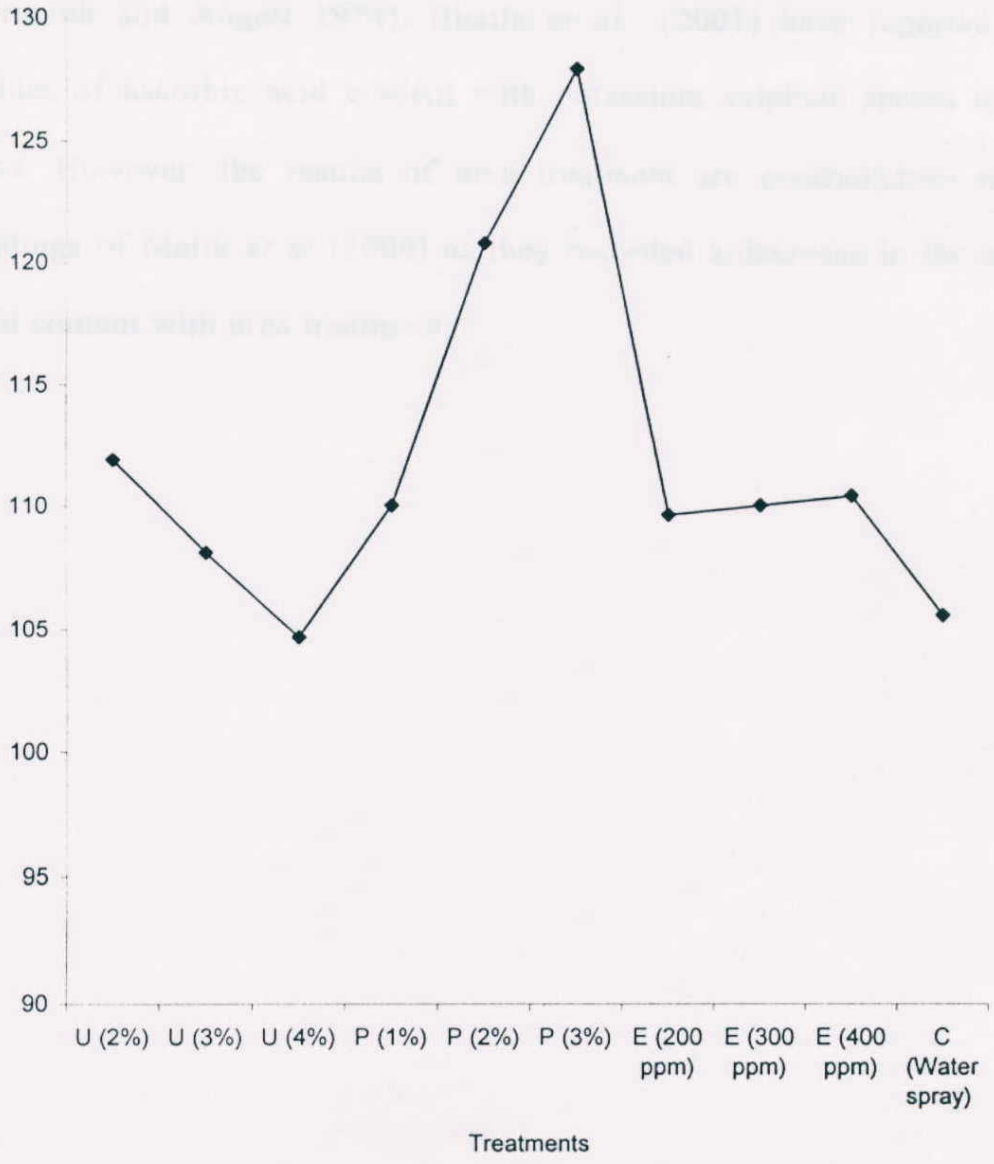


Fig. 6 Effect of foliar application of chemicals on ascorbic acid (mg/100 ml juice) of winter guava

U = Urea
P = Potassium sulphate
E = Ethephon
C = Control

substances which promoted the synthesis of the precursor of ascorbic acid (Orzorek and Angell 1974). Bhatia *et al* (2001) have reported higher values of ascorbic acid content with potassium sulphate sprays in guava fruit. However, the results of urea treatment are contradictory with the findings of Malik *et al* (2000) as they recorded a decrease in the ascorbic acid content with urea treatments.

Chapter - V

SUMMARY AND CONCLUSIONS

The present investigations on "Effect of foliar application of chemicals on fruits ripening and quality in winter guava" were conducted on four year old trees of cv. Allahabad Sufeda planted at a distance of 6 x 6m in the New Orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana. The trees were sprayed when the fruits attained walnut size or little bigger during the months of October-November. The salient achievements of these studies are summarized below :

- Among the different treatments, ethephon @ 400 ppm helped in increasing the fruit weight, which was higher than all other treatments.

  . Fruit volume on the other side was increased with urea 4 per cent treatment.
- Fruit length was significantly higher with urea 4 per cent, which was at par with ethephon 400 ppm. The same treatment recorded the broadest fruits.
- Different shapes of fruits like oblong, ovate, round were found in all treatments. Ovate fruits were found maximum with different treatments. Rough surface on the fruits was found with urea and potassium sulphate, while all treatments of ethephon produce smooth

surface. Control treated plants also produced smooth fruits.

- All the fruits were picked at the same date i.e. Nov. 11 but there was much variation in the number of days taken for fruits to complete its span of harvest. The maturity period was shortened by 28 days with ethephon 200 ppm. Potassium sulphate treatments took maximum days for the fruits to mature. All the fruits have same colour of yellow green but with different shades.
- Fruit hardness was significantly lowered with ethephon 400 ppm, while potassium sulphate treatments helped in producing more hard fruits. The control plants produced soft fruits.
- Potassium sulphate significantly increased fruit yield followed by urea sprays.
- Seed number per fruit were significantly increased by potassium sulphate @ 3 per cent, while it was reduced with urea 2 per cent, which was little lower as compared to control. The seed weight was highest in potassium sulphate treatment and the lowest in control.
- Pulp percentage was increased with all the treatments, while in case of organoleptic rating, potassium sulphate @ 3 per cent produced better quality fruits as compared to other treatments. All other treatments showed almost the same results.
- Potassium sulphate @ 3 per cent helped in increasing the total soluble solids of the fruits, followed by ethephon 400 ppm. The

lowest total soluble solids were recorded with urea treatments.

- In case of acidity, control fruits recorded the highest acidity as compared to all other treatments. Acidity was also found highest with urea treatment, while it was reduced with ethephon and potassium sulphate.
- The vitamin C, was maximum in fruits treated potassium sulphate and ethephon treatments. Potassium sulphate 3 per cent produced the maximum vitamin C content.

The results of the experiment indicated that the potassium sulphate 3 per cent and urea 4 per cent treatments were the best for increasing the yield and quality of winter guava fruits cv. Allahabad sufeda.

REFERENCES

Ahlawat V P and Yamdagni R (1981) Effect of potassium sprays on quality of guava. *Agric Science Digest* **1** : 213-14.

Anon (2004) Area and production of fruits in Punjab, Directorate of Horticulture Punjab, Chandigarh.

AOAC (1985) Official Method of Analysis. Association of Agricultural Chemists. Benjamen Franklin Station, Washington DC.

Arora J S and Singh J K (1970) Effect of nitrogen, phosphorous and potassium sprays on guava (*Psidium guajava* L.). *J Jap Soc Hort Sci* **39** : 55-62.

Arora J S and Singh J R (1972) Response of guava (*Psidium guajava* L.) to boron spray. *J Jap Soc Hort Sci* **41** : 239-44.

Babu K D, Yadav D S (2002) Effect of 2,4-Dichlorophenoxy acetic acid on yield and quality of Khasi Mandarin (*Citrus reticulata* Blanco). *South Indian Hort* **50** : 31-35.

Babu R S H, Rajput C B S (1982) Effect of zinc, 2, 4, 5-D and GA_3 on flowering in Kagzi lime. *Punjab Hort J* **22** : 140-44.

Bal J S (1997) Fruit growing. Kalyani Publishers, New Delhi.

Bal J S and Chohan G S (1981) Effect of ethephon on ripening and quality of ber. *Punjab Hort J* **21**: 188-91.

Bal J S, Randhawa J S and Singh S N (1988) Effect of NAA on fruitset and quality of Ber cv. Umran. *Haryana J hort Sci* **17**: 20-23.

Bal J S, Singh S N and Randhawa J S (1986) Response of Naphthalene acetic acid spray at fruit set and slow growth phase on ber fruit (*Z. mauritiana* Lamk.). *J Res Punjab agric Univ* **23** : 569-72.

Balasubramanyam V R and Rangaswami G (1959) Parthenocarpy in guava induced by pollen 'harmone'. *Curr Sci* **28** : 413-15.

Beniwal B S, Gupta D P, Ahlawat V P (1992) Effect of foliar application of urea and potassium sulphate on physico chemical attributes of grapes (*Vitis vinifera* L) cv. Perlette. *Haryana J hort Sci* **21** : 161-65.

Bhatia S K, Yadav S, Ahlawat V P and Dahiya S S (2001) Effect of foliar application fo nutrients on the yield and fruit quality of winter season guava cv. L-49. *Haryana J hort Sci* **30** : 6-7.

Bhattacharya R K and Rao V N M (1981) Effect of growth regulants on duration of maturation, physical characters and chemical constituents of CO-2. Papaya (*Carica papaya* L.) fruit. *South Indian Hort* **29** : 27-34.

Brahamchari V S, Naresh K and Rajesh K (1997) Effect of foliar feeding of calcium, phosphorous and growth substances on yield and quality of guava (*Psidium guajava* L.). *Haryana J hort* **26** : 169-73.

Chandra R, Govind S and Basuchandhari P (1984) Pre harvest spray of calcium nitrate and Alar on the quality and post-harvest behaviour of guava fruits. *Indian J Hill Farming* **7** : 51-56.

Chapman K R, Saranah J and Paxton B (1979) Induction of early cropping guava seedlings in a closely planted orchard using urea as a defoliant. *Aust J Exp Agric An Husb* **19** : 382-84.

Coggins C W and Jr Hield Hil (1962) The influence of potassium giberellate in navel oranges trees and fruit. *Proc Amer Soc Hort Sci* **76**: 199-206.

Comai M, Widmann L, Gianotl G (1981) The effect of gibberellins and promalins on fruit shape and quality. Esperienze-e-Ricrche-Stazione-Sperimentale-Agraria-Forestate-di-S-Michelle-add 'Adige **11** : 47-61.

Daris B T (1966) The effect of Giberellin on the vine variety 'Perlette' Delt. Inst Ampel Lycovrissi, Ahters (MA 37 : 2546).

Daulta B S, Kumar R and Ahlawat U P (1983) A note on effect of micronutrient spray on quality of Beauty Seedless grapes (*V. vinifera* L.). *Haryana H hort Sci* **12** : 198-99.

Dhaliwal G S, Nanra N K and Rattanpal H S (2002) Effect of chemicals on flower drop, fruit set and yield on rainy and winter season crops of guava. *Indian J Hort* **59** : 31-33.

Dhillon D S and Singh K K (1968) Effect of some plant regulators on fruit set and fruit drop in ber (*Zizyphus mauritiana* Linn.). *J Res Punjab agric Uni* **5** : 392-94.

Dhillon W S and Bindra A S (1995) Effect of micronutrient sprays on the yield and quality of perlette grapes. *Indian J Hort* **52**(1) : 27-30.

Dixit C K, Pyamdagni R and Jindal P C (1977) A note on the effect of micro-nutrient sprays on chlorosis and yield of Kinnow - A mandarin hybrid. *Haryana J hort Sci* **6** : 153-54.

Doraipandhan A and Muthukrishnam C R (1967) Effect of gibberellic acid and maleic hydrazide on seeded and seedless guava (*Psidium guajava* L.) varieties. *South Indian Hort* issue no. 24-29.

Doraipandhan A and Shanmugavelu K G (1972) Effect of foliar spray of urea on the yield of guava (*Psidium guajava* L.). *South Indian Hort* **20** : 80-81.

Dubey A K, Yadav D S (2001) Effect of nitrogen and phosphorus on yield and quality of mandarin orange (*Citrus reticulata* Blanco). var. Khasi Mandarin. *Orissa J Hort* **29** : 79-82.

Dwivedi R, Pathank R K and Pandey S D (1993) Effect of various concentrations of urea on crop regulation in guava (*Psidium guajava* L.) cv. Sardar. *Prog Hort* **22** : 134-39.

Gaona-Ponee M, Almaguer V G, Carrales J (1994) Pre-harvest application of ethephon on 'Jaffa' oranges' (*Citrus sinensis* L. Osbeck) in Martinez de Latorne, Ver, Mexico. *Revista Chapingo Serie Horticulturae* **1** : 183-86.

Garg R C, Rani H B and Singh S K (1978) A note on the effect of certain plant growth regulators on the ripening and storage behaviour of guava (*Psidium guajava* L.) cv. L-49. *Prog Hort* **9** : 48-57.

Ghosh J N (1986) Effect of magnesium, zinc and molybdenum on yield and fruit quality of guava cv. L-49. *South Indian Hort* **34** : 327-30.

Grewal S S, Singh S and Dhillon W S (1993) Effect of growth regulators on fruit drop and quality of fruit in ber (*Z. mauritiana* Lamk.). *Punjab Hort J* **33**: 76-83.

Gupta O P, Siddiqui S and Chauhan K S (1987) Evaluation of various calcium compounds for increasing the shelf life of ber. *Indian J Agric Res* **21** : 65-70.

Hidalgo L and Candala M R (1962) A contribution to study the effects of giberellic acid on vines. *Bot Inst. Invest Agron Madrid* **22**: 1-61 (Original not seen. Abstract in Horticultural Abstracts 33 : Entry No. 2588, 1963.

Islam M M and Siddique M A (1972) A study on the induction of parthenocarpic guava by gibberellic acid. *Bangladesh Hort* **1** : 31-36.

Josan J S, Sandhu A S, Singh R and Monga P K (1995) Effect of various nutrient sprays on the fruit quality of lemon. *Indian J Hort* **52**(4) : 288-90.

Kale V S, Dod V N, Adpawar R M, Bharad S G (2000) Effect of plant growth regulators on fruit characters and quality of ber. *Crop Res* **20** : 327-35.

Kandu S and Mitra S K (1997) Regulation of cropping on guava. *Indian J Hort* **54**: 139-45.

Kanwarjit S, Randhawa J S, Singh K (2001) Effect of growth regulators and fungicides on fruits drop, yield and quality of fruits in ber cv. Umran. *Res Punjab agric Univ* **38** : 181-85.

Kaur N (1977) Crop regulation in Sardar guava by Chemicals. M.Sc. Thesis, Punjab Agricultural university, Ludhiana.

Khan M M, Muhammadi V, Rashid W, Ali M A (2002) Role of Gibberellic acid on citrus seed germination and study of some morphological characteristics. *Pakistan J Agric Sci* **39**: 113-18.

Kheddar A A, Mougheith M G and Abbram N E I (1978) Influence of foliar application of some nutrients elements on growth, yield and fruit quality and leaf mineral composition of Washington Navel orange trees. *Annals of Agricultural Sci Mashtohor* **9** : 138-58.

Khera A P and Dhawan S S (1979) Effect of micronutrient sprays on the quality of 'Thompson Seedless' grapes. *Haryana J hort Sci* **8** : 33-36.

Kim W S and Chung S J (2000) Effect of GA_3, ethephon, girdling and wiring treatment on the berry enlargement and maturity of 'Himrod' grapes. *Journal of Korean Soc Hort Sci* **41**: 75-77.

Koj T, Tiwari J P and Lal S (1989) Effect of different levels of potassium and leaf nutrient status, fruit yield and quality of guava cv. Sardar. *Prog Hort* **21** : 51-55.

Kumar R and Hoada M N (1974) The effect of GA on growth and composition of guava (*Psidium guajava* Linn.) fruit. *Proceedings of the Bihar Academy of Agricultural Sciences* pp 79-83.

Kumar R and Hoada M N (1977) The effect of GA_3 on growth and composition of guava fruit. *Proc Bihar Acad Agric Soc* **22** : 79-83.

Kumar R, Kotour S C and Singh H P (1996) Effect of nitrogen on growth, fruit yield and quality of guava under rainfed conditions of Bihar Plateau. *Indian J Hort* **53** : 109-13.

Kumar R, Kotur S C and Singh H P (1996) Chemical composition of guava with urea and NAA. *Prog Hort* **21** : 49*50.

Kumar R, Kotur S C and Singh H P (1996) Response of guava cv. Allahabad Sufeda to Potassium. *J Potassium Research* **12** : 59-64.

Kumar R, Singh J P and Gupta O P (1975) Effect of growth regulators on fruit set, fruit drop and quality of sweet lime (*Citrus limeteoides tanaka*). *Haryana J hort Sci* **4** : 123-29.

Lal G, Sen N L, Jat R G (2000) Yield and leafnutrient composition of guava as influenced by nutrients. *Indian J Hort* **57** : 130-32.

Makhija M and Chandra A (1992) A note on berry quality improvement in 'Perlette' grapes by chemicals. *Haryana J hort Sci* **21** : 666-68.

Malik P P, Ahlawat V P, Nain A S (2000) Effect of foliar application of urea and zinc sulphate on yield and fruit quality of Kinnow - A mandarin hybrid. *Haryana J hort Sci* **29** : 37-38.

Mansour N M, Tarifik M and Sied E L Z A H (1985) Effect of urea spray on fruit set and yield of guava trees. *Agric Res Rev* **59** : 103-17.

Masalkar S D and Wavhal K N (1991) Effect of various growth regulators on physico-chemical properties of ber cv. Umran. *Maharashtra J Hort* **5**: 37-41.

Masheva L G (1978) Study on endogenous phytoharmons and the effect of their application on the grapevines. *Gradinassha-i-Wzarska-Nauka* **15** : 152-158.

Maurya A N, Singh J N (1979) Effect of three growth regulators on fruit retention and quality of mango (*Mangifera indica* L.) cv. Langra. *Journal of National Agricultural Society of Ceylon* **16** : 53-56.

Mitra S K and Bose T K (1985) Guava. In : *The Fruits of India-tropical and sub-tropical* (eds. Bose T K). Naya Prakash, Calcutta, pp : 227-79.

Monga P K, Kumar H, Vij V K and Aulakh P S (2002) Effect of N P K on yield and fruit quality of sweet orange cv. Jaffa. *Indian J Hort* **59** : 378-81.

Nijjar G S and Brar S S (1977) Comparison of soil and foliar applied Zn in Kinnow. *Indian J Hort* **34** : 130-35.

Nilnand S, Yuwaniri R, Sukumotanandana C, Kaumana P, Sarasak N, Paweewan Y, Chooponz S and Prasat K (1996) Effect of giberellic acid on seed and berry development in 6 white Malaga grape at Dar. *Inthahon Chiang-Mai Province Kasetsart J Nat Sci* **30**: 157-62 (Original not seen. Abstr in Horticultural Abstracts CD-ROM AN : 980301734).

Ogata R and Saito T (1989) Effect of N-phenyl N'-(4-Pyridyl) urea (4-PV) on fruit size of apple, Japaneese pear, grapevine and kiwi fruit. *Acta Horticulturae* **239** : 395-97.

Ortola A G, Monessi C, Guardiota J L (1991) The use of Naphthalene acetic acid as a fruit growth enhances in satsuma mandarin : a comparison with the fruit thinning effect. *Scientia Horticulturae* **47** : 15-25.

Orzorek and Angell F F (1974) Effect of ethephon on ascorbic acid and soluble solids in processing tomato cultivars. *Hort Sci* **9** : 306.

Otmani E I I, Ait Outafou A, Tarbi F Z, Lovatt C J, Tagliavthi M (ed), Toselli M (ed), Bertschinger Z (ed), Brown P (ed), Neilson D (ed.), Thalheimer M (2002) Efficiency of foliar urea as an N source in sustainable trees production systems. *Acta Horticulturae* pp 611-17.

Pandey D K, Pathak R A and Pathak R K (1988) Studies on the foliar application of nutrients and plant growth regulators in Sardar guava (*Psidium guajava* L.). I. Effect on yield and quality. *Indian J Hort* **45** : 197-202.

Panse V G and Sukhatme P V (1978) Statistical methods for Agricultural Research Workers. *Indian Council of Agricultural Research,* New Delhi.

Panwar K S, Suneel S and Schrawat S K (1994) Effect of plant growth regulators on uneven ripening of 'Beauty Seedless' grapes (*Vitis vinifera* L.) II. Fruit Characters and maturity time. *Inter J Trop Agric* **12** : 163-66.

Parker E R and Jones W W (1950) Orange fruit size in relation to K fertilization in a long term experiment in California. *Proc Amer Soc Hort Sci* **55** : 101-13.

Popenoe W (1920) Fruits of Myrth family. *Manual of Tropical and Sub-tropical fruits.* pp 272-79. McMillan and Co., New York.

Rajput C B S, Singh G and Mishra J S (1986) Crop regulation in guava by urea sprays. *Indian J Hort* **43** : 41-47.

Rajput C B S, Singh S N (1977) Effect of certain plant growth substances in guava. *Haryana J hort Sci* **6** : 117-19.

Rajput C B S, Singh S P and Rani B P (1992) Effect of GA, ferrous sulphate and ascorbic acid on the shelf life of guava (*Psidium guajava* L.) fruits cv. Allahabad Sufeda. *Prog Hort* **24** : 128-34.

Ram M (1979) Effects of giberellic acid on physico-chemical composition of guava (*Psidium guajava* L.). *Res Bull of Marathwada Agricultural University* **3** : 63-64.

Ram R A and Bose T K (1994) Effect of foliar spray of urea and zinc on growth and yield of mandarin orange (*Citrus reticulata* Blanco). *Indian J Hort* **51** : 266-71.

Ram R A, Rajput N S, Bhriguvanshi S R (1999) Effect of controlled-release fertilizers on growth, yield and fruit quality of guava cv. Sardar in Ustochrepts. *Indian J Hort* **56** : 104-11.

Ram R K and Bose T K (2000) Effect of foliar application of magnesium and micro-nutrients on growth, yield and fruit quality of mandarin orange (*Citrus reitculata* Blanco). *Indian J Hort* **57** : 215-20.

Randhawa G S, Dhuria H S and Nair P K (1964) A note on induced parthenocarpy in citrus. *Indian J Hort* **19**: 128-29.

Rath S, Singh R L, Singh B and Singh D B (1980) Effect of boron and zinc sprays on the physico-chemical composition of mango fruits. *Punjab Hort J* **20** : 33-35.

Ratnababu B G H V and Lavania M L (1986) A note on fruit maturity and colour development in lemon as affected by plant growth regulators sprays. *Haryana J hort Sci* **15** : 59-61.

Reitz H J and Kew R C J (1960) Effect of N and K fertilization on yield, fruit quality of leaf analysis of valencia orange. *Proc Amer Soc Hort Sci* **75** : 244-52.

Sachs R M, and Weaver R (1966) Gibberellin and auxin induced expension of grape berry. *Pl Physio* **41** : 9-61.

Saha A K (1971) Effect of post-harvest treatment with growth regulators on ripening and chemical composition of guava fruits. *Indian Hort* **28**: 11.

Sainji B R, Singh K and Jindal P C (1988) Studies on the effect of GA_3 on growth and development of berries in 'Thompson Seedless' grapes (*V. vinifera* L.). *Haryana J hort Sci* **17** : 56-59.

Sandhu S S, Thind S S, Ball J S (1985) Effect of preharvest spray of ethephon on size, quality and ripening of Ber (*Zizyphus mauritiana* Lamk) cv.-Umran. *Indian Hort* pp 23-27.

Sasaki K, Utssunmiya N (2002) Effect of combined application of CPPV and GA_3 on the growth of 'Irwin' Mango fruits. *Japaneese J Tropical Agric* **46** : 224-29.

Schawabe W N (1973) The induction of parthenocarpy in cox's orange pippin. *Acta Hort* **34**: 311-13.

Shanmugavelu K G (1962) Preliminary study on the induction of parthenocarpic guava by gibberellic acid. *Indian J Hort* **19** : 128-29.

Sharma A K, Singh K, Mishra S P (2002) Effect of foliar spray of zinc sulphate, 2, 4, 5-T and GA_3 on quality of kagzi lime (*Citrus aurentifolia* Swingle). *Orissa J Hort* **30** : 115-18.

Sharma R C and Azad A S (1991) Effect of different levels of NPK on growth, yield and quality of mandarin. *Indian J Hort* **48** : 116-20.

Sharma R K, Kumar R and Thakur S (1991) Effect of foliar feeding of potassium, calcium and zinc on yield and quality of guava. *Indian J Hort* **48** : 312-14.

Shikhamany S D, Chittiraj C R and Chadla K L (1990) Variation in vine growth, fruit yield and quality of 'Thompson Seedless' grape as influenced by split application of nitrogen and potash. *Indian J Hort* **47** : 359-64.

Singh A S (1997) Effect of N P K fertilizers on Sardar guava (*Psidium guajava* L.). M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Singh B P, Singh H K and Chauhan K S (1981) Effect of post harvest calcium treatments on the storage life of guava fruits. *Indian J Agric Sci* **51** : 44-47.

Singh D S, Singh S P, Maurya A N (1992) Effect of N, P_2O_5 and GA_3 on yield and chemical composition of guava cv. Allahabad Sufeda. *Hort J* **5** : 15-18.

Singh G and Reddy Y T N (1997) Regulation of cropping in guava. *Indian J Hort* **54** : 44-49.

Singh G, Rao O P and Mishra J S (1989) Chemical composition of guava with urea and NAA. *Prog Hort* **21** : 49-50.

Singh H K, Singh B P and Chauhan K S (1981) Effect of foliar feeding of various chemicals on physico-chemical quality of guava fruits. *Haryana Agric J Res* **11** : 411-14.

Singh H K, Singh I S and Chauhan K S (1978) Effect of pre-harvest application of ethephon on ripening and quality of guava (*Psidium guajava* L. cv. Sardar). *Udyanka* **2** : 17-20.

Singh I S, Singh H K and Gupta A K (1979) Effect of post harvest application of ethephon on quality of guava (*Psidium guajava* L.) cv. L-49. *Haryana J hort Sci* **8** : 12-16.

Singh P N and Chhankar V S (1983) Effect of zinc, born and molybdenum as foliar sprays on chemical composition of guava fruits. *Punjab Hort J* **23** : 34-37.

Singh R and Singh R (1981) Effect of various sprays of zinc on granulation and fruit quality of Dancy Tangerine mandarin. *Scientia Hort* **14** : 235-44.

Singh R R, Chauhan K S and Singh H K (1986) Effect of various doses of N, P and K on physico-chemical composition of ber fruits cv. Gola. *Progressive Hort* **18** : 35-48.

Singh S B, Misra R S (!986) Effect of plant growth regulators and micro-nutrients on the fruit drop, size and quality of Kinnow orange. *Prog Hor* **18** : 260-64.

Singh S P and Singh A (2002) Effect of copper sprays on fruit development, yield and quality of 'Allahabad Sufeda' Guava (*Psidium guajava* L.). *Prog Hort* **34** : 260-62.

Singh S, Bal J S, Dhillon B S (1981) Effect of pre-harvest application of ethephon on ripening and quality of Umran ber. *Crop Improvement* **8** : 68-70.

Singh S, Singh I S and Pathak P K (1992) A note on the effect of vine parts treatment with ethephon on ripening and quality of grape (*Vitis vinifera* L.).

Singh U R, Tripathi J S, Tripathi B M (1977) Effect of Gibberelic acid on fruit size and quality of mango fruit. *Punjab Hort J* **17** : 3-4, 120-21.

Singh V (1985) Effect of foliar spray of urea on growth, yield and quality of guava (*Psidium guajava* L.) cv. Sufeda. *Ujyamika* **5** : 11-16.

Singh V R, Tripathi J S and Tripathi B M (1976) Effect of giberellic acid on size and quality of mango fruit. *Haryana J hort Sci* **15** : 120-21.

Singla R K, Chharia A S and Kumar S (1992) Effect of Ethephon on ripening and quality of grape cultivars Early Muscat and Gold. *Haryana J hort Sci* **21** : 39-42.

Smith P F and Rasmussan G K (1960) Relationship of fruit size, yield and quality of Marsh seedless grapefruit to Potash fertilization. *Proc Fla Sci Hort Sco* **73** : 42-49.

Sunderajan S, Shanmugavelu K G and Muthuswami S (1969) A note on effect of GA on fruit set, size and quality of certain varieties of guava (*Psidum guayava* L.). *South Indian Hort* **17** : 14-42.

Susanto S, Nakajima J and Hasigawa K (!973) Effect of growth harmone application on the development of parthenocarpic fruits of Pummelo trees grown in plastic house. *Japaneese J Trop Agric* **37** : 84-89.

Tandon D K, Adsule P G and Kalra S K (1984) Effect of certain post-harvest treatments on the shelf life of guava fruits. *Indian J Hort* **41** : 88-92.

Taylor F R and Dewitt T C (1987) Effect of PPG-1721 on peaches, almonds and grapes. *Proc Plant Growth Regulator Soc America* pp 328-29.

Teotia S S, Pandey K and Mathur R S (1961) Giberellin induced parthenocarpy in guava (*Psidium guajava* L.). *Curr Sci* **30** : 312.

Tiwari R B, Tiwari J P, Shantlal (1992) Effect of shoot pruning, NAA and urea on cropping pattern of guava. *Indian J Hort* **49** : 305-08.

Usha K, Singh B, Tagliavani M, Toselli M (2002) Effect of macro and micro nutrients spray on fruit yield and quality of grapes (*Vitis vinifera* L.) cv. 'Perlette'. *Acta Horticulturae* pp 197-202.

Vaksonovic T, Muratovic A and Lucic P (1975) The response of certain grapevine cultivars to growth substances application. *Radovi Poljoprivrednog Fakultut Univerzitela V Sarajeva* **21** : 195-202.

Wang U G (1989) The studies on the methodology of regulation of harvesting period in processing guava. *J Agric Res China* **38** : 438-45.

Wilson (1938) *Horticultural Colour Chart.* Wilson Colour Limited. The Royal Horticultural Colour Society, London.

Wilson C W (1980) Guava. In : *Tropical and Sub-tropical* fruits. (eds. Nagy S and Shaw P E). AVI Publishing Inc. West Part, Connectial.

Yadav P K (2002) Effect of urea, borax and NAA on yield parameters of guava var. L-49 in rainy season. *Progressive Agriculture* **2** : 195-96.

Yadav S, Bhatia S K, Godara R K, Rana G S (2001) Effect of growth regulators on the yield and quality of witner season guava cv. L-49. *Haryana J hort Sci* **30** : 1-2.

Yamdagni R (1988) Note on physico-chemical characters of grape berries in cultivar 'Perlette' as influenced by foliar application of chemicals. *Curr Agri* **12** : 99-100.

Yamdagni R, Kumar R and Jindal P C (1980) Effect of graded doses of N on fruit set, fruit drop and yield of ber (*Zizyphus mauritiana* Lamk) cv. Kaithli. *Progressive Hort* **12** : 5-7.

Yamdagni R, Singh D and Jindal P C (1979) Note on the effect of zinc sprays on yield and quality of 'Thompson Seedless' grapes. *Indian J Agri Res* **13** : 117-18.

VITA

Name	:	Gaganpreet Kour Reen
Father's Name	:	S. Manjit Singh Reen
Mother's Name	:	Mrs. Virinder Kour Reen
Nationality	:	Indian
Date of Birth	:	02.02.1981
Permanent Address	:	House No. 35, Sector No. 7 Lane No. 1, Nanak Nagar Jammu

EDUCATIONAL QUALIFICATIONS

Bachelor's degree	:	B.Sc. (Agriculture)
University and year of award	:	CCS University, Meerut, 2002
%age	:	65.5%
Master's degree	:	M.Sc. (Horticulture)
University and year of award	:	Punjab Agricultural University, Ludhiana, 2005
OCPA	:	6.89/10.00
Title of Master's Thesis	:	"Effect of foliar application of chemicals on fruit ripening and quality in winter guava"
Awards/Distinction/ Fellowship/Scholarship	:	-