Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate (*Punica granatum*)

Cv. Bhagwa

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July, 2016

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A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI

(Agricultural University)
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in partial fulfillment of the requirements for the degree of

Master of Science
(POST HARVEST MANAGEMENT)

IN

FRUITS, VEGETABLES AND FLOWERS CROPS

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CERTIFICATE

*This is to certify that the thesis entitled "***Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate (*Punica granatum*) Cv. Bhagwa"** *submitted to Department of Post Harvest Management of Fruits, Vegetables and Flowers crops, Post Graduate Institute Of Post Harvest Management, Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, (Maharashtra State), in the partial fulfillment of the requirements for the degree of* **MASTER OF SCIENCE (POST HARVEST MANAGEMENT)** *in* **FRUIT, VEGETABLE AND FLOWER CROPS**, *embodies the results of a piece of bona-fide research carried out by* **Mr. Anmol Shankarrao Khemnar** *under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by him.*

Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate (*Punica granatum*) Cv. Bhagwa

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CANDIDATE'S DECLARATION

I hereby declare that the thesis or any part thereof has not been previously submitted by me orother person to any other University orInstitute for a degree

ACKNOWLEDGEMENT

At this gratifying moment of completion of my research problem, I feel obliged to record my gratitude to those who have helped me. First of all I express my infinite indebtedness and deep sense of gratitude to the God for continuously providing my spiritual energy, which has inspired me to reach at the highest excellence.

Some moments in life are cherished forever for one reason or another and this one is not exception for me. It is a moment of great pleasure in recording my fervent sence of gratitude.

Indeed the words at my command are not adequate to convey the depth of my feeling and gratitude to my honorable research guide ***Dr. K. H. Pujari,*** *Associate Dean, Post Graduate Institute of Post Harvest Management, Killa-Roha, District Raigad for his most valuable and inspiring guidance with his friendly nature, love and affection, for his attention and magnanimous attitude right from the first day, constant encouragement, enormous help and constructive criticism throughout the course of this investigation and preparation of this manuscript.*

I feel a great pleasure in getting this proud privilege offering my sincerest and devoted thanks to for their valuable guidance and co-operation throughout the course of my studies and other members of my advisory committee, ***Dr. P. P. Relekar,*** *Associate Professor, Post Graduate Institute Of Post Harvest Management, Killa-Roha, District Raigad, and* ***Dr. S.S.Prabhudesai****, Head, Dept. of Soil Science and Agriculture chemistry College of Agriculture, Dapoli for his help in analytical research study for their worthy suggestions, ever willing help and unbiased attitude throughout the course of this investigation.*

My profound and sincere thanks to all staff members viz. ***Mr. Shedge Sir, Mr. Khapre Sir, Mr. Debaje sir*** *and* ***Miss. Kashid mam*** *from the Dept. of Post Harvest management of Fruit, Vegetable and flower crops, Post Harvest Institute of Post Harvest Management for their valuable guidance and co-operation throughout the course of my studies.*

I also extend my deep sense of honour to ***Dr. T. Bhattacharay,*** *Honourable Vice Chancellor, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.*

The word like thanks should not come in between friends, but it came from the bottom of heart for my beloved, sweet friends ***Sidhesh, Shivam, Aniket, Ajinkya, Tejashree, Shobhana, Pranaykumar, Hitendra, Kiran, Prashant, Ganesh*** *and other colleagues for their helping and kind co-operation during the course of study.*

No word could do justice to express my sence of respect and gratitude to word my beloved ***Mom Mrs. Nanda Shankarrao Khemnar, Dad Mr. Shankarrao Hanumant Khemnar*** *and all my lovely family members for their everlasting love, constant encouragement, prayer support and sacrifice, without which this dream could not have become a reality.*

Last, but far from the least, I wish to express my deepest gratitude and sole full respect to 'God', who helped me on every path of life and made every step a great success.

Place*: Killa-Roha*

Date*: / / 2016*

(Anmol Shankarrao Khemnar.)

Place: Killa-Roha **(A. S. KHEMNAR)**

Date: / / 2016

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DEPARTMENT OF POST HARVEST MANAGEMENT OF FRUIT, VEGETABLE AND FLOWER CROPS

POST GRADUATE INSTITUTE OF POST HARVEST MANAGEMENT

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ABSTRACT

The present study entitled, "Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of

pomegranate (*Punica granatum*) Cv. Bhagwa" was undertaken in the pomegranate orchard At-Post-Sakur, Tal-Sangamner, Dist-Ahmednagar (M.S.) during 2015-2016.

Investigation on effect foliar application of different concentrations of CPPU with GA_3 on fruit set, fruit drop, yield and physico-chemical parameters was conducted by using randomized block design (RBD).

The experiment result indicated that fruit set, fruit drop, and chemical properties of pomegranate Cv. Bhagwa were influenced by different concentrations of CPPU with GA_3 spray. Significantly higher fruit set, fruit drop, yield, TSS as well as organoleptic evaluation of pomegranate Cv. Bhagwa was observed in CPPU treated plants over control plants. However there was no significant difference was noticed in terms of acidity, reducing sugar and total sugars in CPPU treated plants over control plants.

The treatment T_3 i.e. T_1 (10ppm CPPU at flowering) + (30ppm CPPU with 10ppm GA_3) was significantly superior to all other treatment in terms of fruit set, fruit drop, yield, fruit weight, TSS and cost per quintal.

फल, सब्जी और फुल फसल कटाई पश्चात व्यवस्थापन विभाग,

कटाई पश्चात व्यवस्थापन पद्व्युत्तर संस्था, किल्ला-रोहा

डॉ. बाळासाहेब सावंत कोकण कृषि विद्यापीठ, दापोली –४१५ ७१२

जि. रत्नागिरी, (महाराष्ट्र) भारत

प्रबंध का नाम :		"अनार के फललागन और कटाई पश्चात गुणवत्ता पर सी.पी.पी.यू. (फोरक्लोरोफेन्युरॉन) और जिए$_3$(जिब्रेलिक □□□□)के प्रभाव का अध्ययन करना''
छात्र का नाम:		□□□□. अनमोल शंकरराव खेमनर
पंजीकरण क्रमांक:		पी एच एम आर एम–०१४००९८
दाखल किया गया वर्ष	:	**२०१५-२०१६**
विद्योपाधी	:	एम एस सी (पीएचएम)
संशोधन मार्गदर्शकका नामऔर पदनाम	:	डॉ. के.ह. पुजारी. प्राध्यापक व सहयोगी अधिष्ठाता कटाईपश्चातव्यवस्थापन पदव्युत्तरसंस्था, किल्ला–रोहा जि. रायगड.

प्रबंध सार

अनार की फललागन और कटाई पश्चात गुणवत्ता पर सी.पी.पी.यू. (फोरक्लोरोफेन्युरॉन)और जिब्रेलिक □□□□ (जिए$_3$) के प्रभाव का अध्ययन का संशोधन प्रकल्प साकूर, ता- संगमनेर, जि- अहमदनगर मेंसन २०१५-१६ में किया गया।

इस संशोधन□□□□□□□□□□□□ब्लॉक डिझाईन (आर.बी.डी) का इस्तेमाल कर के फललागन, फल गिरना, रासायनिक और भौतिक गुणधर्मो का अध्ययन किया गया।

इस संशोधन के बाद इस □□□□□ पर आये की फल लागन, फल गिरना और फलो के रासायनीक गुणधर्मो पर सी.पी.पी.यू. और जिए$_3$ के अलग अलग प्रमाण के बौछार का अलग अलग असर देखने को मिला। अनार के भगवा प्रजातीपर सी.पी.पी.यू और जिए$_3$ बौछार पौधोमें नियंत्रीत पौधो से फल लागन, फसल प्राप्ती,और एकूण विद्राव्य घन पदार्थ में लक्षनीय वृद्धी हुई, तथा□□□□□□ □□□□□□□□□ □□ सर्वाधिक गुण प्राप्त हुए। तथापि सी.पी.पी.यू. और जिए$_3$ बौछार पौधो में और नियंत्रीत पौधो के फल में आम्लता, सापेक्ष शर्कराऔर शर्करा में □□□□□□□ फरक नही दिखाया।

फल लागन, फल गिरना, फल का वजन, एकूण विद्राव्य घन पदार्थ और प्रती □□□□□□□ कीमत के लिये टी$_3$ (१० पीपीएम सी.पी.पी.यु फुलधारण के समय) + (३० सी.पी.पी.यु आणि १० पीपीएम जीए$_3$) □□ उपचार □□□□ उपचारो □□□□□□□ में उत्कृष्ट है।

फळे,भाजीपाला आणि फुल पिके काढणी पश्चात व्यवस्थापन विभाग,

काढणी पश्चात व्यवस्थापन पदव्युत्तर संस्था,किल्ला-रोहा

डॉ. बाळासाहेब सावंत कोकण कृषि विद्यापीठ, दापोली – ४१५ ७१२

जि.रत्नागिरी,(महाराष्ट्र) भारत

प्रबंधशिर्षक	**:**	"डाळिंबावरील फळधारणा व काढणी पश्चात गुणवत्ता यावर सी.पी.पी.यू. (फोरक्लोरोफेन्युरॉन) आणि जिए$_3$(जिब्रेलिक □□□□) यांच्या परिणामाचा अभ्यास करणे"
विद्यार्थ्याचे नाव	**:**	□□□□. अनमोल शंकरराव खेमनर
नोंदणी क्रमांक	**:**	पी एच एम आर एम–०१४००९८
शैक्षणिक वर्ष	**:**	**२०१५-२०१६**
अभ्यासक्रम	**:**	एम एस सी (पीएचएम)
संशोधन मार्गदर्शकाचे नाव व हुद्दा :		डॉ. के.ह. पुजारी. प्राध्यापक व सहयोगी अधिष्ठाता काढणीपश्चातव्यवस्थापन पदव्युत्तरसंस्था, किल्ला–रोहा जि. रायगड.

प्रबंध गोषवारा

डालिंबावरील फळधारणा व काढणीपश्चात गुणवत्ता यावर सी.पी.पी.यू. (फोरक्लोरोफेन्युरॉन) आणि जिब्रेलिक □□□□(जिए$_3$) यांच्या परिणामाचा अभ्यास संशोधन प्रकल्प साकुर, ता- संगमनेर, जि- अहमदनगर येथे डाळिंबाच्या बागेत २०१५-१६ या वर्षी करण्यात आला.

या संशोधनामध्ये□□□□□□□□□□□□ब्लॉक डिझाईन (आर. बी. डी.) चा वापर करून फळधारणा, फळगळती, रासायनिक आणि भौतिक गुणधर्मांचा अभ्यास करण्यात आला.

या संशोधनाअंती असा निष्कर्ष निघाला की, फळधारणा, फळगळती, आणि फळांच्या रासायनिक गुणधर्मावरती सी.पी.पी.यु. आणि जि.ए$_3$ च्या विविध प्रमाणाच्या □□□□□□□□ विविध परिणाम आढळले. डाळिंबाच्या भगवा प्रजातीवर सी.पी.पी.यु. आणि जि.ए$_3$□□□□□□□□□□ झाडांमध्ये नियंत्रित झाडांपेक्षा फळधारणा, उत्पादनात, एकूण विद्राव्य घटकात लक्षणीय वाढ झाल्याचे आढळून आले, तसेच स्वाद मूल्यमापन चाचणीमध्येसर्वाधिक गुण मिळाले. तथापि सी.पी.पी.यु. सह जि.ए$_3$ ची फवारणी केलेली झाडे व नियंत्रित झाडे यांच्या फळांमधील आम्लता, शर्करा आणि सापेक्ष शर्करा □□□□□□□लक्षणीय असा कोणताही बदल आढळून आला नाही.

फलधारणा, फळगळती, फळाचे वजन, एकूण विद्राव्य घटक आणि प्रति क्विंटल किंमत यांसाठी टी$_3$ (१० पीपीएम सी.पी.पी.यु फुलधारणेच्या वेळी) + (३० सी.पी.पी.यु आणि १० पीपीएम जीए$_3$) ही □□□□□ □□□□□□इतर उपचारांच्या तुलनेत उत्तम दर्जाची □□□□□□□□ □□□□□ □□□.

Chapter-I

Introduction

Pomegranate (*Punica granatum*) is an important fruit crop of arid and semiarid regions of the world. It is a highly remunerative crop for replacing subsistence farming and alleviating poverty food and medicine (Holland *et al.*, 2009). Pomegranate is originated from Iran. This crop is known to have been domesticated in the Middle East about 5000 years ago (Adsule and Patil, 2005).

The total area under pomegranate cultivation in the world is well above 3,00000 ha, of which more than 76% is found in five countries viz.,India, Iran, China, Turkey and the USA. Estimation of world pomegranate production is 3,086 thousand tonnes. However, the countries viz., that fall behind Spain, Egypt and Israel, with a surface between16,000 and 2,400 ha, are the ones that have developed much more in exports, research, market development and new varieties (Melgarejo, 2012).

In India, the area under pomegranate is 1,30,770 hectares with production of 13,45,720 MT. Maharashtra is leading producer of pomegranate with 90000 hectares area and 945000 MT production (Anon., 2015). In Maharashtra, pomegranate is cultivated in the districts of Solapur, Nasik, Ahmednagar, Pune, Sangli, Dhule, Latur, Usmanabad, Jalna, Parbhani, Aurangabad, Beed, and Satara.The varieties that are grown commercially include Bhagwa, Ganesh, G-137 and Mridula.

Pomegranate is one of the first five domesticated edible fruit crops along with fig, date palm, grape and olive. It has been the symbol of health, fertility and rebirth as mentioned in many ancient

cultures. Pomegranate is one of the richest sources of Riboflavin. Rind of the fruit, bark of stem and root of pomegranate contain more than 28 per cent gallotannic acid and dye which is useful in tanning as natural bio-dye. Pomegranates are rich in polyphenols, specifically ellagic acid and punical- gins, which can act as potent antioxidants. Ellagic acid is found in the fleshy testa of the pomegranate besides other red coloured berries. Punicalgins are found only in the outer skin of the pomegranate and are estimated to have twice the antioxidant capability of red wine and green tea (Sevda and Rodrigues, 2011).

Pomegranate is a very promising and emerging crop for its refreshing arils, juice and its chemo-preventive properties having medicinal value. There has been a remarkable increase in the commercial farming of the pomegranates globally due to the potential health benefits of the fruit such as its high antioxidant, anti-mutagenic, anti-hypertension activities and the ability to reduce liver injury. Pomegranate anthocyanins have been demonstrated scavenging activities. The pomegranate polyphenolic compounds are able to elevate the antioxidant capacity of the human body. The juice from the pomegranates is one of the nature's most powerful antioxidants.Nutritional composition of the pomegranate per 100gm is 68 Kcal consumption energy, 0.95gm protein, 0.3gm total lipid, 17.17gm carbohydrate, 0.6gm total dietary fiber, 16.57gm total sugar, 259mg potassium, 8mg phosphorus, 3mg sodium and calcium and 6.1mg ascorbic acid (Dhinesh, 2016).

Bahar treatments like root pruning, root exposure, withholding water, defoliation of plants by hand or by chemical defoliation, etc. are practiced to induce moisture stress, so that plants drop their leaves and the growth is controlled. The main

objective of this treatment is to regulate the crop by forcing to take rest and produce profuse flowering and fruiting during any one of the three bahars which are ambe bahar (January-February), mrig (June-July) and hast bahar (September-October). Due to force full resting and shading leaves of pomegranate trees while managing the bahar, the problems like flower drop and incidence of unopened flower are seen.

Plant growth regulators (PGRs) are organic compounds, other than nutrients, that modify plant physiological processes. PGRs called biostimulants or bioinhibitors, act insideplant cells to stimulate or inhibit specific enzymes or enzyme system and help regulate plant metabolism. They normally are active at very low concentration in plants. The importance of PGRs was first recognized in 1930s. Since then, the natural and synthetic compounds that alter function, shape, and size of crops have been discovered. Today, specific PGRs are used to reduce flower drop, increases fruit setting modify crop growth rate and growth pattern during the various stages of development, from germination through harvest and post-harvest preservation (Harms, 2000).

CPPU i.e Forchlorofenuronis a member of the synthetic cytokinin group with phenyl urea structure, with strong inhibitory effects on cytokinin oxidation (Mok and Mok, 2001). The use of plant growth regulators (PGR) is one way of stimulating cell division or enlargement, both of which promote final fruit size. Forchlorfenuron or N-(2-Chloro-4-pyridyl)-N′-phenylurea) (CPPU) is an effective and well- known PGR for improvement of fruit size through stimulating cell division (Kim, 2006). The physiological actions of CPPU in plants include increasing fruit size and improving plant fruiting performance by postponing the senescence process (Ahmed and Abdel-aal, 2007).The foliar spraying of CPPU (1% SP) when applied

alone or in combination with GA_3(40 % WSG) at the various growth stages and concentration, significantly increased leaf photosynthesis, berry biochemical parameters, quality parameters namely berrylength, berry diameter, bunch weight, T.S.S., acidity and also the yield of Thompson seedless grapes (Khot, 2015).

Gibberellins control the cell elongation and division in plant shoots. They have been shown to stimulate ribonucleic acid and proteins synthesis in plant cells.Gibberellins constitute a group of plant hormones that control developmental processes such as germination, shootelongation, tuber formation, flowering, and fruit set and growth in diverse species. The most widely available plant growth regulator is GA_3 or gibberellic acid, which induces stem and internode elongation, seed germination, enzyme production during germination and fruit setting and growth (Davies, 1995). Gibberellic acid is an important growth regulator that may have many uses to modify the growth, yield and yield contributing characters of plant (Rafeekher et al., 2002).

With this view, the present investigation entitled “Effect of CPPU (Forchlorofenuron) with GA3 (Gibberellic acid) on fruit set and post-harvest quality of pomegranate (*Punica granatum*) Cv. Bhagwa”, was carried out with following objectives.

1. To study the effect of foliar sprays of CPPU with GA_3 on fruit set of pomegranate cv. Bhagwa

2. To study the effect of spraying CPPU with GA_3 on fruit yield and quality of pomegranate cv. Bhagwa

CHAPTER II
RIVIEW OF LITURATURE

The research work entitled “Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post-harvest quality of pomegranate *(Punica granatum)* Cv. Bhagwa” is reviewed in the current chapter under the following headings. The literature in this regard on other important fruit crops is also reviewed under the following headings.

2.1 Effect of foliar sprays of CPPU on fruit set and yield of different fruit crops

2.2 Effect of foliar sprays of CPPU on physical characteristics of different fruit crops

2.2 Effect of foliar sprays of CPPU on chemical composition of different fruit crops

2.1 Effect of foliar sprays of *CPPU* on fruit set, fruit drop and yield of different fruit crops

Curry and Greene (1993) reported that “CPPU influenced fruit quality, fruit Set, return bloom, and preharvest drops in apple. CPPU was applied to ‘Delicious’ apple trees at 0, 6.25, 12.25 and 50 mg/L at full bloom and 2 weeks after full bloom. The flesh firmness of fruit linearly increased with increasing concentration.

Patterson (1993) studied the effects of CPPU (N-(2-chloro-4-pyridyl)-N'-phenylurea) on fruit growth, maturity and storage quality of kiwifruit cv. Hayward. CPPU was applied to fruitlets 21 days after flowering, either as a 5 mg/ lit. dip or as a 5 mg/lit. spray. Dipping increased mean fresh weight of fruit at harvest by 43 per cent and spraying by 33 per cent.

Hayata and Niimi (1995) studied the use of CPPU for promoting fruit set and inducing parthenocarpy in water melon. The results showed that treating pollinated flowers with CPPU increased the fruit set to over 90 per cent. In CPPU treated non pollinated ovaries, fruit set was 65 and 89.5 per cent, respectively with 20 and 200 ppm treatment.

Subhadrabandhu and Iamsub (1996) studied the effect of CPPU (1-(2-chloro-4-pyridyl)-3-phenylurea) on fruit setting of mango (*Mangifera indica* L.) cv. Nam Dok Mai" Mango. The trees were sprayed on to the inflorescences with 0, 20, 40, and 60 ppm of CPPU at ten days after inflorescence emergence and at full bloom. Thus, CPPU had some effects in the early stage of fruit setting in mango and the application at full bloom showed better result than that at ten days after inflorescence emergence.

Han and Lee (2001) investigated the effects of GA_3, CPPU (N-(2-chloro-pyridyl)-N'-phenylurea) and ABA on the fruit quality. The GA_3 treatment increased cluster length, weight, and berry weight. CPPU treatment increased cluster length, diameter, weight and berry weight in yoho (*Vitis vinifera* L. x *V. labrusca* L.) grape. ABA treatment significantly increased the anthocyanin content in grape treated with GA_3 and CPPU.

Stern *et.al.* (2002) studied the effect of CPPU and BA on fruit size in 'Royal Gala' (*Malus domestica*) apple under warm climate. CPPU at a concentration of 10 ppm and synthetic cytokinins BA at a concentration of 50 ppm caused an appreciable (>50%) and significant increase in fruit size when applied two weeks after full bloom. They demonstrate that BA and CPPU have a significant potential to improve fruit size of 'Royal Gala' apple without any negative effects on fruit quality at harvest or in storage of 0°C.

Guirguis *et al.* (2003) while studying the effect of Sitofex (cppu) on fruit set, fruit quality of Le conte pear cultivar reported that percentages of initial fruit set and fruiting of Le Conte pear were significantly increased by all CPPU treatments in the two seasons (2001 and 2002) as compared to the control. The best results with 85 per cent fruit set were obtained by high 40 ppm concentration of CPPU during the first season (2001).

Ahmed and Abdel (2007) studied the effect of Sitofex (CPPU) which was applied at 5, 10 and 15 ppm, one, two, three and four weeks after fruit setting of Le-contre pear. Best results with regard to yield and fruit quality were obtained when CPPU was sprayed at 10 ppm during two weeks after fruit setting.

Notodimedj (1999) studied the effect of plant growth regulators such as NAA, GA_3, and CPPU on to Arumanis mango trees at 14 days after blooming on fruit retention, yield and fruit quality. The result showed that CPPU (1-(2-chloro -4-pyridyl)-3-phenyl urea) @ 10 ppm, gave the best results with increase in the fruit retention, number of fruits per cluster and per plant, weight of fruit, fruit volume and leaf area.

Smith (2008) studied the use of CPPU in wine grapes to increase fruit set. Result showed that the CPPU application increased the berries per cluster and cluster weight.

Sasaki and Utsunomiya (2012) studied the effect of combined application of CPPU and GA_3 on the growth of 'Irwin' mango fruits and reported that the spraying of 10 ppm CPPU plus 100 ppm GA_3 on panicles twice and 4 times from the end of the physiological fruit drop stage promoted the fruit growth. The results indicate that the combined application of 10ppm CPPU plus 100 ppm GA_3 from the

early stage of fruit growth increased the fruit set as well as fruit quality.

Kumar *et al.* (2013), while studying the effect of different concentrations of CPPU and fruit thinning on yield and quality of kiwi fruit, recorded maximum fruit yield when kiwi fruit vines were sprayed with 10 ppm CPPU, whereas fruit yield in treatments with 12.5 ppm CPPU and 15 ppm CPPU were at par with each other.

Susila *et al. (*2013) studied the effect of exogenous application of CPPU and GA3 on yield, fruit quality characters and seedlessness in watermelon. The result showed that the application of CPPU at 200ppm and GA at 100ppm to watermelon flowers at anthesis resulted in maximum fruit set than other treatment.

Asaad (2014), while studying the influence of spraying sitofex, iron, manganese and zinc on "Anna" apple trees planted on new reclaimed calcareous land, recorded maximum values when trees sprayed with 15 ppm CPPU + 10gm Fe + 7gm Mn + 10.5gm Zn/20L water (21.92 and 24.21%), followed by spraying with 10 ppm CPPU + 10gm Fe + 7gm Mn + 10.5gm Zn/20L water. The minimum values were obtained from control in the both seasons of study (12.48 and 12.52%).

Mousawinejad *et al.* (2014) studied the effects of CPPU on fruit size and quality of tomato (*Solanum lycopersicum* L.) fruits. Effects of different doses of CPPU (0, 10, and 20 mg.L-1) at two different developmental stages were evaluated on the final fruit size and quality of tomato under field conditions. Statistical analyses showed that the effects of CPPU on fruit mass, volume, density, length and width were statistically significant in which the most significant effect was observed at 20 mg.L-^{1} CPPU concentration.

Paranjape (2014), while studying the effect of CPPU (Forchlorofenuron) on fruit set and post harvest quality of Mango Cv. Alphonso, reported that the maximum (321.5 kg) yield was noticed in the treatment 30 ppm CPPU.

Retamales *et al.* (2014) observed that the repeated applications of CPPU on highbush blueberry cv. Duke increased the yield and enhanced fruit quality at harvest and during postharvest. CPPU was applied at 5 and 10 ml/L at 3, 10, and/or 17 d after full bloom (DAFB) plus a non-sprayed control. Overall, 10 mL L-1 CPPU applied at 3+17 DAFB was the best treatment for year one, since it increased fruit yield and diameter, while soluble solids and postharvest weight loss were similar to control.

Khot *et al.* (2015) conducted the investigation to study the effect of foliar application of Gibberellic acid (40% WSG) and CPPU (1% SP) with regards to the concentration, stage and time of application on yield of grapes reported that the maximum yield was obtained from (40 ppm GA3 (Progibb 40% WSG) + 2 ppm CPPU (Cap-Plus 1% SP) i.e. 8.70 kg as compared to 4.60 kg in control.

2.2 Effect of foliar sprays of CPPU on physical characteristics of different fruit crops

2.2.1 Effect of foliar sprays of CPPU on weight of fruit

It is an important factor in judging its compactness, maturity, juice content, level of carbohydrate and other chemical constituents. The weight of a fruit also determines its acceptance to consumers and thereby, the market price of it.

Zilkah *et al.* (1995), while increasing 'hass' avocado fruit size by CPPU and GA_3 application when fruit size was plotted as function of fruit number per tree, reported that the CPPU treated fruits were

larger than the control fruits for various yield levels on tree. The significant effect of CPPU on the average fruit weight was noticed.

Zabadal (2006), while studying the effect of CPPU on fruit development of selected seedless and seeded grape cultivars, reported that the berry size on cluster treated with 15 ppm CPPU was significantly greater than berries from cluster treated with 5 and 10 ppm at all measurement date.

Ahmed *et al.* (2007), while studying effect of concentrations and date of spraying Sitofex (CPUU) on yield and quality of Le-Conte pear fruits, observed that the maximum values (240 and 230 g in both seasons) were attained in the trees received one spray of 10 ppm Sitofex (CPPU) two weeks after fruit setting.

Abdel-Fattah *et al.* (2010) studied the effect of berry thinning, CPPU spraying and pinching on cluster and berry quality of two grapevine cultivars. CPPU spraying at full bloom characterized by giving the highest berries number compared to pinching ones. The increment percentage of berries number per cluster was (28.05, 26.82, 23.79, 18.07 and 19.29% average of the two seasons) due to CPPU spraying at 2.5 ppm or 5.0 ppm.

Fathi *et al.* (2011) reported that the Costata persimmon fruit size could be attributed directly to the CPPU effects. Exogenous application of CPPU acts early on cell division in the fruitlet and also on subsequent growth, while studying the effect of Sitofex (CPPU) and GA_3 Spray on fruit set, fruit quality, yield and monetary value of " Costata" Persimmon.

Bhat *et al.* (2012), while studying impact of new generation growth regulators (Brassinosteriods and CPPU) on quality parameters of grape Cv. Tas-A-ganesh, observed that the effect of growth regulator treatments, their time of application as well their

interaction was significant on bunch weight. Maximum bunch weight (371.1 g) was recorded when growth regulators were applied twice i.e. on the 7th and15th DAFS compared to one dipping (7th or 15th DAFS). Among various treatments, T7 (CPPU 3 ppm+ BR 0.2 ppm + BA 20 ppm) produced the maximum bunch weight (371.1g) and lowest bunch weight was observed in control (268.6g).

Kumar *et al.* (2013) reported that the fruit weight, fruit length and fruit breadth were gradually increased by increasing the concentration of CPPU. The highest values of fruit weight (88.6 and 93.5 g), between thinning and CPPU concentrations, were significant. The heaviest and largest fruits were obtained by the application of CPPU @ 10 ppm.

Mousawinejad *et al.* (2014) studied effects of CPPU on size and quality of tomato fruits and they reported that the highest mass was observed in the treatment CPPU @ 20 ppm than other treatments i.e. CPPU as 10 ppm and control.

Paranjape (2014), while studying effect of CPPU (Forchlorofenuron) on fruit set and post harvest quality of Mango Cv. Alphonso, reported that the maximum (245.53 gm) fruit weight was recorded in 10 ppm CPPU treatment.

Patterson *et al.* (1993) reported that the CPPU on kiwifruit significantly increased the fruit growth by mid-January (52 days after fruit set). The control, dipped, and sprayed fruit had mean weights of 47, 63, and 62 gm, respectively. At harvest in mid-May (178 days after fruit set), the mean fruit weights were 110,158, and 146 gm, respectively.

Khot *et al.* (2015) studied the effect of foliar application of Gibberellic acid (40% WSG) and CPPU (1% SP) with regards to the concentration, stage and time of application on yield, quality, leaf

photosynthesis and biochemical changes in berries of grapes. The various GA_3 and CPPU concentrations alone or in combination had significant effects on bunch and berry characteristics. Data revealed that the spraying of GA3 concentration alone and in combination with CPPU increased the bunch weight. Maximum bunch weight (234.20 gm) was recorded with treatment 40 ppm GA3 (40 % WSG) + 2 ppm CPPU (1% SP) whereas for control, it was recorded as 111.70 gm.

2.2.2 Effect of foliar sprays of CPPU on volume of fruit

Al-saif (2011) studied the effect of plant growth regulators on fruit growth and quality development of *Syzygium samarangense* (water apple/wax apple) and observed higher fruit volume i.e. 64.4 ml/fruit in 15 ppm CPPU treatment than other treatments.

Kassem *et al.* (2011) studied productivity, fruit quality and profitability of jujube trees by pre harvest application of agro-chemicals. They observed maximum value for volume i.e. 14 cm^3 with for putrescine (PUT) @ in control 50 ppm, followed by 13.50 cm^3 volume with CPPU treatment and 8.80 cm^3 in control.

Kassem *et al.* (2011), while improving yield, quality and profitability of flame seedless grapevine grown under arid environmental by growth regulators preharvest applications, observed that the weight and volume of 100 berries increased by spraying of all treatments compared to control. The GA_3 and CPPU had similar and significantly higher weight and volume of 100 berries than other treatments.

Bhat *et al.* (2012), while studying impact of new generation growth regulators (Brassinosteriods and CPPU) on quality parameters of grape Cv. Tas-A-ganesh, reported that the maximum

volume was measured (4.22) in the CPPU 3ppm + BR 0.2ppm + BA 20ppm and CPPU 3ppm + BR 0.4ppm + BA 20ppm treatments over control.

Mohamed *et al.* (2013) observed the effect of spraying of sitofex (CPPU) on fruit quality of table grapes and recorded that the post flowering treatments of CPPU improved the bunch development. Indeed bunch weight was markedly increased by 24, 31 and 20% as compared to control.

2.3 Effect of foliar sprays of CPPU on chemical composition of different fruit crops

2.3.1 Effect of foliar sprays of CPPU on total soluble solids (TSS)

Guirguis *et al.* (2003), while studying the effect of sitofex (cppu) on fruit set, fruit quality of Le conte pear cultivar, observed that 20 ppm CPPU treatment exhibited more TSS values (16.5^0B) than the control (14^0B) either applied at full bloom or 14 days after full bloom stage.

Kumar *et al.* (2013), while studying Effect of different concentration of CPPU and fruit thinning on yield and quality of Kiwifruit, reported that the different CPPU concentrations considerably increased the TSS. The highest total soluble solids were achieved when fruit vines were sprayed with 10 ppm CPPU during the two seasons.

Mohamed *et al.* (2013) studied the effect of spraying of sitofex (CPPU) on fruit quality of table grapes and they observed the decrease in soluble solid content in all treatments, expect the control.

Khot *et al.* (2015) studied the effect of foliar application of Gibberellic acid (40% WSG) and CPPU (1% SP) on grapes. The TSS was maximum (23.9^{o} B) when 20 ppm GA3 (40% WSG) was applied which was higher than the control (20.10^{o} B)

2.3.2 Effect of foliar sprays of CPPU on Titratable acidity (%)

Guirguis *et al.* (2003), while studying the effect of sitofex (cppu) on fruit set, fruit quality of le conte pear cultivar, reported an increase in the TSS content with 20 ppm CPPU treatment (16.5^{0}B) and lowest (13.75^{0}B) in the control.

Al-saif (2011) studied the effect of plant growth regulators on fruit growth and quality development of *Syzygium samarangense* (water apple/wax apple) and observed the highest increment in TSS content (8.3^{0}B) in 15 ppm CPPU treated fruit, followed by the other treatments i.e. 10 and 20 ppm CPPU and control.

Fathi *et al.* (2011) reported sitofex (CPPU) application with 5 or 10 ppm at full bloom or at fruit set, significantly reduced the fruit juice acidity with increased total tannins content compared to control, especially with 5 ppm CPPU at fruit set.

Kassem *et al.* (2011), while studying productivity, fruit quality and profitability of jujube trees by preharvest application of agro-chemicals, observed the fruit acidity in treatment CPPU @ 10 ppm was higher (0.50 %) than the control (0.44 %).

Bhat *et al.* (2012) studied the impact of new generation growth regulators (Brassinosteriods and CPPU) on quality parameters of grape cv. Tas-A-ganesh. They reported maximum TSS value (19.5^{o}B) was observed with T5 (CPPU 2ppm + BR 0.4ppm + BA 20ppm) over control and other treatments.

Kumar *et al.* (2013), while studying the effect of different concentrations of CPPU and fruit thinning on yield and quality of Kiwifruit, reported that the titrarable acidity decreased significantly with increasing CPPU concentration. The lowest acidity (1%) was achieved when fruit vines were sprayed with 10 ppm CPPU during the two seasons.

Khot *et al.* (2015) studied the effect of foliar application of Gibberellic acid (40% WSG) and CPPU (1% SP) with regards to the concentration, stage and time of application on yield, quality, leaf photosynthesis and biochemical changes in berries of grapes. They reported that the treatment CPPU @ 2 ppm + GA_3 @ 20 ppm showed higher acidity than other treatments and control.

2.3.3 Effect of foliar sprays of CPPU on sugars (reducing and total sugars)

Kassem *et al.* (2011), while studying productivity, fruit quality and profitability of jujube trees by preharvest application of agro-chemicals, observed that the fruit reducing and non-reducing sugar content was increased by all different sprayed substances as compared to the control. No significant difference was obtained between salicylic acid and GA, putrescine, NAA and CPPU or between $CaNO_3$, control, CPPU and NAA on non-reducing sugars in fruit.

Kassem *et al.* (2011), while improving yield, quality and profitability of flame seedless grapevine grown under aried environmental, conditions by preharvest applications, of a growth regulators. They reported that total sugars content of the berry was increased by spraying SA, Eth, GA, CaCl, PUT and CPPU in both seasons.

Bhat *et al.* (2012) studied the impact of new generation growth regulators (Brassinosteriods and CPPU) on quality parameters of grape Cv. Tas-A-ganesh. They observed that the reducing sugars were maximum with CPPU 3ppm+ BR 0.4ppm+ BA 20ppm treatment (14.3%) and lowest percentage of reducing sugars was observed with CPPU @ 3ppm (11.6%) and CPPU @ 2ppm (11.7%).

Kumar *et al.* (2013), while studying the effect of different concentrations of CPPU and fruit thinning on yield and quality of Kiwifruit, showed that the different CPPU concentrations significantly increased the reducing and total sugar content of Kiwifruit cv. Allison and Hayward as compared to control.

Susila *et al.* (2013) studied the effect of exogenous application of CPPU and GA3 on yield, fruit quality character and seedlessness in watermelon. They observed that the total sugars were significantly highest in application of CPPU 200 ppm + GA 100 ppm (11.87%) and GA 100 ppm (11.39%).

Asaad (2014) reported the influence of spraying sitofex, iron, manganese and zinc on "Anna" apple trees planted on new reclaimed calcareous land. The maximum values were obtained from trees sprayed with 15 ppm CPPU + 10gm Fe + 7gm Mn + 10.5gm Zn/20L, water (42.28 and 42.52%) followed in a descending order by spraying with 10 ppm CPPU + 10gm Fe + 7gm Mn + 10.5gm Zn/20L water. The minimum values were obtained from control (36.33 and 36.33%) in both seasons under study.

Khot *et al.* (2015) studied the effect of foliar application of Gibberellic acid (40% WSG) and CPPU (1% SP) with regards to the concentration, stage and time of application on yield, quality, leaf photosynthesis and biochemical changes in the berries of grapes. They reported that the reducing sugars (215.6 mg/g) were found

higher with application of 40 ppm GA3 (40% WSG) as compared to other CPPU treatments and control (170mg/g).

Pramanick *et al.* (2015), while studying effect of bioregulator and nutrient spray on fruit grade and quality of kiwi fruit, reported that the treatments significantly increased the total sugars as compared to control. The maximum total sugars (10.01%) was recorded in T-7 treatment and the minimum (8.5%) in untreated fruit.

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled "Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and postharvest quality of pomegranate *(Punica granatum)* Cv. Bhagwa" was undertaken in the pomegranate orchard at-Post-Sakur, Tal- Sangamner, Dist- Ahmednagar (M.S.) during the year 2015-2016. During the investigation the fruit set and postharvest quality of pomegranate was studied. The experimental details pertaining to the material used and the techniques adopted are presented in this chapter.

3.1 Experimental material

The experiment was conducted in the pomegranate orchard At-Post-Sakur, Tal- Sangamner, Dist- Ahmednagar. The topography of experimental orchard was fairly uniform with a gentle gradient towards the eastern side. The orchard soil was light, fairly homogenous with good drainage.

Sakur is situated on the western Maharashtra region at an altitude of 601 meters above from mean sea level. It is located in tropical region at 19^0 20' 54" North latitude and $74^0$17'56" East latitude. The climate of Sakur was hot and dry with average annual rainfall of578 mm, which normally distributed from June to September. The average relative humidity was about 20 per cent while average minimum and maximum temperatures are 22.4^0C and 38.9^0C, respectively. The topography of the experiment orchard was uniform.

The main objectives of the study were as given below

1. To study the effect of foliar sprays of CPPU with GA_3 on fruit set of pomegranate cv. Bhagwa

2. To study the effect of post-harvest quality of pomegranate cv. Bhagwa after spraying of CPPU with GA_3

For conducting the experiment, the pomegranate Cv. Bhagwa trees having4 years old of age were used. The plant having uniform growth and vigour were selected randomly for the study. The CPPU (Forchlorofenuron) solution of 0.01 per cent concentration at different levels as described in the treatment details were used.

3.2 Experimental method

The experimental details are given as under

Experimental Design : Randomized Block Design (RBD)

No. of Replications : 08

No. of treatments : 06

No. of fruits/treatment/replication:25

Cultivar :Bhagwa

Treatment details

T1:At flowering 10ppm CPPU and

21, 42 and 63 DAF 10ppm CPPU

T2:At flowering 10ppm CPPU and

21, 42 and 63 DAF 20ppm CPPU +10 ppm GA3

T3:At flowering 10ppm CPPU and

21, 42 and 63 DAF 30ppm CPPU + 10 ppm GA3

T4:At flowering 10ppm CPPU and

21, 42 and 63 DAF40ppm CPPU + 10 ppm GA3

T5:At flowering 10ppm CPPU and

21, 42 and 63 DAF10 ppm GA3

T6: Control

(DAF: Days after flowering)

The uniform, 4 years old, pomegranate plants Cv. Bhagwa and 25 fruits were selected and tagged at flowering stage.

The first sprayingwas given at the time of flowering (10ppm CPPU) and subsequent 3 sprayings of CPPU were taken at 21 days interval with different concentrations as per the treatments. The tagged flowers and fruits were observed for different parameters like number of fruits set and percent fruit retention. After harvest, tagged fruits were brought to laboratory in plastic crates and wereanalysed for physico-chemical parameters of pomegranate fruit.

The fruits were sorted according to the treatments and kept in plastic crates to analyse thequality parameters like TSS (°B), acidity (%), and total sugar (%)under ambient storage condition.

3.3 Observations recorded

3.3.1 Fruit set (%)

Fruit set was estimated as number of fruit set per tag per plant.

3.3.2 Fruit drop (%)

Fruit drop was estimated as number of fruit dropped per tag per plant.

3.3.3 Yield (kg)

Yield was estimated at harvest by counting the number of fruits present on each tree.

3.3.3 Physical characteristics of pomegranate fruits

For this study, five fruits were randomly selected per treatment per replication per plant and observations were recorded on following physical parameters.

3.3.3.1Fruit weight (g)

Individual fruit was weighted on electronic balance (Model- Contech, India) and average weight of these fruits were recorded in grams.

3.3.3.2 Fruit volume (ml)

Individual fruit was completely dipped in a measuring cylinder filled with water up to brim. The volume of displaced water was noted and it was recorded in ml.

3.3.3.3 Specific gravity

Specific gravity of pomegranate fruit was determined by dividing the value of fresh weight of pomegranate fruit by the volume of the fruit.

3.3.4 Chemical parameters pomegranate of fruit

The randomly selected eight fruits from each treatment were used for estimating the following chemical constituents of the fruit after harvesting.

3.3.4.1 Total soluble solids (^{0}B)

Total soluble solids were determined with the help of hand refractometer (Atago, India) and were expressed in ^{0}Brix.

3.3.4.2 Titratable acidity (%)

A known quantity of sample was titrated against 0.1 N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (A.O.A.C., 1975). A known quantity of sample was blended in pestle and mortar with 20-25 ml distilled water. It was then transferred to 100ml volumetric flask and filtered. A

known volume of aliquot was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator. The results were expressed as per cent anhydrous citric acid (Ranganna, 1986).

$$\text{Titratable acidity (\%)} = \frac{\text{Titre of alkali} \times \text{Normality made up} \times \text{Volume wt. of acid} \times \text{Equivalent}}{\text{Volume of sample taken for estimation} \times \text{Wt. of sample taken} \times 1000} \times 100$$

3.3.4.3 Reducing sugars

Reducing sugar content was determined by method of Lane and Eynon (1923) as reported by Ranganna (1986) as follows.

A known quantity of sample was taken in 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1 N sodium hydroxide. Then, 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Exact quantity of potassium oxalate was added to it to precipitate the excess of lead. The volume was then made to 250 ml with distilled water and solution was filtered through filter paper. This filtrate was used for determination of reducing sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' (5 ml each) using methylene blue as indicator. The results were expressed on per cent basis.

Formula

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight of sample taken}} \times 100$$

3.3.4.4 Total sugars

Total sugar content was determined by method of Lane and Eynon (1923) as reported by Ranganna (1986) as follows.

The total sugars were estimated by the same procedure of reducing sugar after acid hydrolysis of an aliquot of de-leaded sample with 35 per cent hydrochloric acid, followed by neutralization with sodium hydroxide (40%). This filtrate was used for titration against standard Fehling's mixture (Fehling's A and B) using methylene blue as an indicator to brick red end point.

Formula

$$\text{Total sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Wt. of sample taken}} \times 100$$

3.3.5 Sensory-evaluation

The fruits were evaluated for their sensory qualities after harvesting for accessing the colour, flavour and texture. It was carried out by panel of 5 judges with 9 point Hedonic scale score (Amerine *et al.*, 1965) as given below.

Sensory Score	Rating
9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly

3	Dislike moderately
2	Dislike very much
1	Dislike extremely

(Source: Amerine *et al.*, 1965)

The overall rating was obtained by averaging score of evaluation. The fruits with score of 5.5 and above were rated as acceptable.

3.3.6 Statistical analysis

The data obtained was analysed statistically as per the method suggested by Panse and Sukhatme (1985). The standard error of mean (S.Em.) was worked out and the critical difference (C.D.) at 5 per cent was calculated whenever the results were found significant. The important results have been supported through graphs and plates.

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation entitled "Effect of CPPU (Forchlorofenuron) with GA_3(Gibberellic acid)on fruit set and post harvest quality of pomegranate Cv. Bhagwa" was undertaken in the pomegranate orchard at Sakur, Tal-Sangamner, Dist-Ahmednagar (M.S.) during the year 2015-2016. The results obtained are presented and discussed as under.

4.1 Effect of foliar sprays of CPPUon fruit set, fruit drop and yield of pomegranate Cv. Bhagwa

4.1.1 Fruit set (%)

The data on effect of foliar sprays of different concentrations of CPPU with GA_3 in fruit set in pomegranate Cv. Bhagwa are presented in Table 01 and illustrated with Fig 01. From the data it was revealed that the fruit set was varied due to various concentrations of CPPU with GA_3.

There was significant effect of different concentrations of CPPU withGA_3sprays on fruit set21 days after flowering. The maximum fruit set was recorded in T_3 (87.50%) which was significantly superior over all other treatments, followed by T_2 (81.50%). However, the treatmentT_2 (81.50%) was superior to the treatmentsT_1 (75.50%), T_4 (74.00%), T_5 (70.00%),T_6 (66.50%). The minimum fruit set was noticed in T_6 (66.50%) which was at par with T_5(70.00%)

Similar trend was also observed on 42 days after flowering. The maximum fruit set was observed in the treatment T_3 (81.00%) which was followed by T_2 (74.00%), T_1 (66.50%), T_4 (63.00%), T_5 (58.00%). The minimum fruit set was noticed in T_6 (51.00%).

Significant effect was also observed 63 days after flowering when different concentrations of CPPU with GA_3 sprays were given. The maximum fruit set was observed in the treatment T_3 (78.50%) which was at par with T_2 (71.50%) which is followed by T_1 (64.50%), T_4 (56.50%), T_5 (51.00%). The minimum fruit set was noticed in T_6 (41.50%). The CPPU has a promoting effect on fruit set and reducing ABA content, due to the physiological basis of CPPU action in promoting fruit setting and fruit enlargement (Fathi et. al., 2011).

The observations similar to this findings were also reported by Guirguis*et al.* (2013) in Le Conte Pear and Paranjape (2014) in mango.

4.1.2 Fruit Drop (%)

The data on effect of foliar sprays of different concentrations of CPPU with GA_3 in fruit drop in pomegranate Cv. Bhagwa are presented in Table 02 and illustrated with Fig 02. From the data, it was revealed that the fruit drop was significantly varied due to foliar sprays of different concentrations of CPPU with GA_3.

There was significant effect ofdifferent concentrations of CPPU with GA_3sprays on fruit drop 21 days after flowering. The maximum fruit drop was recorded in T_6 (33.50%) which was at par with T_5 (30.00%), followed by T_4 (26.00%), T_1 (24.50%), T_2 (18.50%). The minimum fruit drop was noticed in T_3 (12.50%).

Similar trend of fruit drop was also observed on 42 days after flowering. The maximum fruit drop was observed in the treatment T_6(49.00%) followed by the treatment T_5 (42.00%), T_4 (37.00%), T_1 (33.50%) and T_2(26.00%). The minimum fruit drop was noticed in T_3 (19.00%).

Significant effect was also observed on 63 days after flowering when different concentrations of CPPU with GA_3 sprays were given. The maximum fruit drop was observed in the treatment T_6 (58.50%) which was significantly superior over all other treatments, followed by T_5 (49.00%), T_4 (43.50%), T_1 (35.50%) and T_2 (28.50%). But treatment T_5 (49.00%)was at par with T_4 (43.50%) and significantly superior over T_1 (28.5%) and T_2 (28.50%). The minimum fruit drop was noticed in T_3 (21.50%). which was at par with T_1 (28.5%).

In general, it was observed that all CPPU and GA_3 treatment exhibited significant effect on reducing the fruit drop over control.Similar findings were observed by Ahmed *et al.* (2007) in Le-Conte pear; Curry *et al.* (1993) in apple and Guirguis*et al.* (2003) in Le-Conte pear.

4.1.3 Fruit yield (kg)

The data on effect of foliar sprays of CPPU with GA_3on yield of pomegranate Cv. Bhagwa are presented in Table 03and illustrated with Fig 03.

The pattern of variation in fruit yield on pomegranate Cv. Bhagwa was affected by foliar sprays of different concentrations CPPU with GA_3. The data presented in the Table 03 showed that the fruit yield was significantly increased in terms of Kg fruits/plant. The maximum yield was noticed in T_3(25.49 Kg) which was at par with T_2 (23.69 Kg) and was followed by T_4 (18.93 Kg), T_5 (17.09 Kg), T_1 (16.71 Kg) and minimum yield was reported in T_6 (16.07 Kg) which was at par with T_1 (16.71 Kg), T_5 (17.09 Kg), and T_4 (18.93 Kg).

The observations regarding the effect of CPPU on different fruit crops were also reported by several workers viz., Ahmed *et al.* (2007)

in pear fruits; Kumar *et al.* (2013) in kiwi fruits; Fathi *et al.* (2011) in persimmon; Susila *et al.* 2013 in watermelon; Pramanick *et al.* (2015) in kiwi; Paranjape (2014) in mango.

4.2 Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruits of pomegranate Cv. Bhagwa

The data on physical parameters of fruits viz., weight, volume and specific gravity are recorded after harvest are presented in Tables 05 to 07.

4.2.1. Fruit Weight (g)

The data on effect of foliar sprays of different concentrations of CPPU with GA_3on weight of the fruit in pomegranate Cv. Bhagwa are presented in Table 04 and illustrated with Fig 04. From the data it was revealed that the fruit weight was varied due to foliar sprays of different concentrations of CPPU with GA_3.

At harvest, there wasa significant effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit weight of pomegranate. The maximum fruit weight recorded in T_3 (301.1 g),which was at par with T_4 (299.67 g), T_5 (285.89 g) and T_2 (285.5 g). The minimum fruit weight was noticed in T_6 (270.37 g)which was at par with T_1 (277.55 g), T_5 (285.89 g) and T_2 (285.5 g).The different concentrationsof CPPU with GA_3 had significant effect on increasing the fruit weight of pomegranate. The increase in fruit weight may be due to application of CPPU which might be described to its positive action on enhancing both cell division and cell elongation as well great role in activating the biosynthesis of proteins, RNA and DNA (Nickell, 1985)

The observations similar to this findings were also reported byKhot *et al.* (2015) in grapes; Paranjape (2014) in mango; Susila

*et.al (*2013) in watermelon; Ahmed *et al.* pear; Cruz-Castillo *et al.* (2014) in kiwi; Fathi *et al.* (2011) in perssimon; Guirguis *et al.* (2003) in Le-Conte pear and Kumar *et al.* (2013) in kiwi.

4.2.2. Fruit Volume(ml)

The data on effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit volume in pomegranate Cv. Bhagwa are presented in Table 05 and illustrated with Fig. 05.

From the data, it was revealed that the fruit volume was varied due to foliar sprays of different concentrations of CPPU with GA_3.

At harvest, there was significant effect of different concentrations of CPPU with GA_3 on fruit volume of pomegranate. The maximum fruit volume recorded in T_4 (270.74 ml), which was at par with T_3 (265.65 ml) and T_2 (254.79 ml). The minimum fruit volume was noticed in T_6 (233.13 ml)which was at par with T_5 (242.41 ml), T_1 (245.46 ml) and T_2 (254.79 ml).

Exogenous application of CPPU acts early on cell division in the fruit let and also on subsequent growth. Thus, the fruit becomes bigger in size due to the efficient cells, the building blocks of fruit mass and also because the cells have been able to attract so much water, minerals and carbohydrates that enable the fruit to expand to large size (Kano, 2003).

The observations similar to this findings were also reported by Mousawinjad *et al.* (2014) in tomato and Paranjape (2014) in mango.

4.2.3. Specific gravity

The data on effect of foliar sprays of different concentrations of CPPU with GA_3on specific gravity of the fruit in pomegranate Cv. Bhagwa are presented in Table 06 and illustrated with Fig.06.

At harvest, there was non-significant effect of different concentrations of CPPU with GA_3 on specific gravity of pomegranate. The maximum specific gravity numerically was recorded in T_4 (1.156), followed by treatments T_5 (1.151), T_6(1.133), T_3 (1.132) and T_2 (1.127). The minimum specific gravity was noticed in T_6 (1.113).

The observations similar to this finding were also reported by Paranjape (2014) in mango.

4.2.4 Colour value (L*, a* and b* value)

4.2.4.1. L* value for colour

The data onthe effect of foliar sprays ofdifferent concentrations of CPPU with GA_3on L* value for colour of pomegranate juice after harvest are presented in Table 07 and depicted at Fig.07. The L* value represents lightness of the peel.

It was observed from the data that there was a significant effect of foliar sprays of different concentrations of CPPU and GA_3on L* value for colour. Highest L* value for colour was observed in the treatment T_1 (51.67) which was significantly superior to all other treatments and it was followed by T_4 (50.89), T_6 (50.83) T_5 (49.65)and T_2 (45.04). The lowest L* value for colourwas recorded in T_3 (44.49).

4.2.4.2 a* value for colour

The data onthe effect of foliar sprays ofdifferent concentrations of CPPU with GA_3on a* value for colour of pomegranate juice after

harvest are presented in Table 07 and depicted at Fig.07. It was observed from the data that there was a significant effect on a* value for colour. Highest a* value was observed in thetreatment T_5 (43.89) which was significantly superior to all other treatments, followed by T_3 (41.57), T_1 (39.99) T_6 (39.72) and T_2 (39.18). The lowest value was recorded for T_4 (38.83).The a* value for colour denotes red colour and the application of different concentrations of CPPU with GA_3 had significant effect on red colour development. CPPU seemed to increase red pigmentation in the commercial field trial (Curry and Greene, 1993).

4.2.4.3 b* value for colour

Thedata on the effect of foliar sprays ofdifferent concentrations of CPPU with GA_3onb* value for colour of pomegranate juice after harvest are presented in Table 07 and depicted at Fig.07. It was observed from the data that there was a significant effect on b* value of colour. Highest b* value was observed in the treatment T_3 (16.88), followed by the treatment T_5 (15.59), T_1 (14.42), T_6 (13.12) and T_2 (13.09). But treatment T_6 (13.12) and T_2 (13.09) were at par with each other. The lowest value was recorded for T_4 (12.28).

4.3 Effect of foliar sprays of different concentrationsCPPUwith GA_3 on chemical composition of fruit

4.3.1. TSS (°B)

The data regarding the effect foliar sprays of different concentrations CPPU with GA_3 on TSS (°B) in pomegranate Cv. Bhagwafruits are presented in Table 08 and illustrated with Fig 08.

After harvest, there was significant effect of different concentrations CPPU with GA_3on TSS. The maximum TSS was recorded in the treatment T_3 (16.05° B), which was at par with T_2(15.86 °B), T_1 (15.56 °B) and T_4 (15.55°B).The minimum TSS was recorded in T_6 (14.36 °B)which was at par withT_5 (14.81^{0}B). This increase in TSS and sugar content with CPPU application may be attributed to early ripening induced by CPPU due to more ethylene evolution (Costa et al., 1997).

The observations similar to this findings were also reported by Bhat *et al.* (2012); Curry *et al.* (1993) in apple; Fathi *et al.* (2011) in Persimmon; Guirguis *et al.* (2003) in Le-Conte pear; Hassan *et al.* (2009) in banana; Kumar *et al.* (2013) in kiwi; Pramanick *et al.* (2015) in kiwi and Susila *et al.* (2013) in watermelon.

4.3.2 Titratable Acidity (%)

While the observation of effect of foliar sprays of different concentrations of CPPU and GA_3on acidity (%) of pomegranate Cv. Bhagwafruits are presented in Table 09 and illustrated with Fig. 09.

After harvest, there was non-significant effect CPPU on acidity. Numerically the maximum acidity was assessed in T_6 (0.256 %), which was followed by the T_5(0.252 %), T_2 (0.251%), T_4 (0.250 %), T_1 (0.248%) and the minimum acidity was found in T_3 (0.246 %).

The observations similar to this findings were also reported by Ahmed *et al.* (2007); Curry *et al.* (1993) in apple; Hassan *et al.* (2009) in banana; Kumar *et al.* (2013) in kiwiand Paranjape (2014) in mango.

4.3.3 Reducing sugars (%)

The data on the effect of foliar sprays of different concentrations of CPPU and GA_3 on reducing sugars (%) of pomegranate Cv. Bhagwa fruits are presented in Table 10 and illustrated with Fig. 10.

After harvest, there was non-significant effect of CPPU on reducing sugar content on the fruit.It was maximum numerically in the treatment T_5 (11.04 %), which was followed by the T_1 (11.02 %), T_2 (10.37 %), T_3 (10.11 %), T3 (10.01%) and the minimum in T_4(9.99 %).

The observations similar to this findings were also reported by Ahmed *et al.* (2007); Kumar *et al.* (2013) in kiwi and Paranjape (2014) in mango.

4.3.4 Total sugars (%)

The data on the effect foliar sprays of different concentrations of CPPU and GA_3 on total sugars (%) in fruits of pomegranate Cv. Bhagwa are presented in Table 11 and illustrated with Fig. 11.

After harvest, there was non-significant effect of CPPU on total sugar. It was maximum numerically in T_5 (12.03%) which was followed by T_1 (11.80%), T_2 (11.49%), T_3(11.41%) and T_6 (11.23%) and where it was minimum in T_4 (11.03%).

The observations similar to this findings were also reported by Kumar *et al.* (2013) in kiwiand Paranjape (2014) in mango.

4.4 Sensory evaluation of pomegranate Cv. Bhagwa fruits

The data regarding effect of foliar sprays of different concentrationsof CPPU and GA_3 on sensory evaluation of

pomegranate Cv. Bhagwafruits at mature stage are presented in Table 12 and illustrated with Fig. 12.

The variation recorded for score of fruit colour was significant after harvesting. The average sensory colour score of fruits after harvesting was 7.85. It was observed maximum in treatment T_4(8.22), which was at par with T_3 (8.17) and T_5 (7.97) followed by T_1 (7.63) and T_6 (7.58). The minimum colour score was observed in the treatment T_2(7.55)which was at par with T_6 (7.58) and T_1 (7.63); T_1 (7.63).

Among the different treatments, the variation was recorded for flavour score of fruits was non-significant different after harvesting. The average flavour score after harvesting was 7.88. It was numerically maximum in the treatment T_3(8.17) followed by T_5 (8.0), T_4 (7.97), T_2(7.92), T_1 (7.75). The minimum score for flavour of fruits was recorded in treatment T_6(7.5).

Also the variation was recorded for sensory score for texture of fruits after harvesting was 7.81. The variation recorded for texture score of fruit was non-significant. It was numerically maximum in the treatment T_3 (8.13) which was followed by treatments T_4 (7.92), T5 and T_2 (7.83), T1 (7.67). The minimum score of texture in fruits was recorded in the treatment T_6 (7.5).

The average score for fruits after harvesting was 7.85. However,the significant variation was recorded for average score of fruit. It was maximum in the treatment T_3 (8.15) which was followed by treatments T_4 (8.06), T_5 (7.93) and T_2 (7.76). The minimum average score of fruits was recorded in the treatment T_6 (7.53) i.e. control.

4.5Cost of cultivation of pomegranate Cv. Bhagwa

The economics for cost of cultivationof pomegranate is presented in Table 13. It could be observed from the data that the net cost for produce was highest (Rs. 299518.60) in T_4 and lowest (Rs. 272401.85) in the treatment T_6.

Higher produce output was of (Rs. 1176410) found in treatment T_3 and lowest produce output was of (Rs. 741638.58)found in treatment T_6.

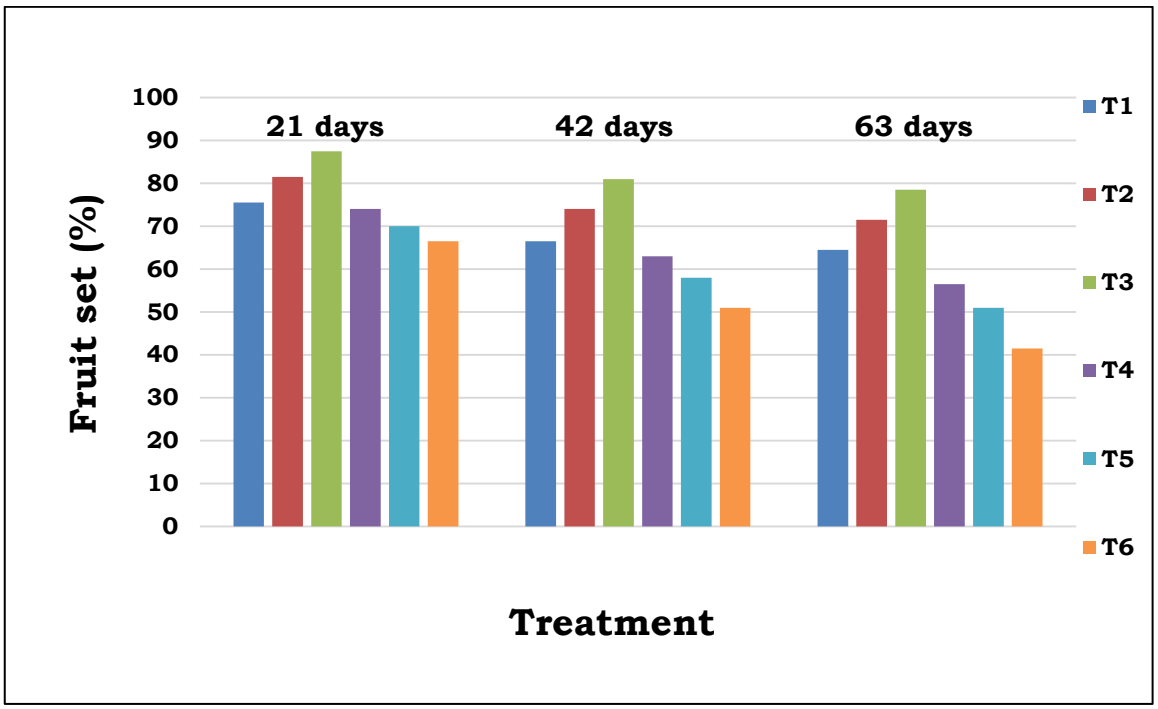
The data for cost of cultivation revealed that the lowest cost per quintal was observed in treatment T_3(Rs. 1343.30) and highest cost per quintal was observed in treatment T_6(Rs.1978.08).

The highest production (218.44 quintals), produce outcome Rs.1176410 and lowest (Rs. 1343.30) cost per quintal was observed in treatment T_3 which is also superior in overall acceptability over all other treatments.

Table 01: Effect of foliar sprays of different concentrations of CPPU with GA_3on fruit set(%)inpomegranate Cv. Bhagwa

Treatment	Fruit set (%)		
	Days after Flowering		
	21 days	42 days	63 days
T_1:(10 ppm CPPU)	75.50	66.50	64.50
T_2: T_1 +(20 ppmCPPU + 10 ppm GA_3)	81.50	74.00	71.50
T_3: T_1 + (30 ppm CPPU+ 10 ppm GA_3)	87.50	81.00	78.50
T_4: T_1 + (40 ppmCPPU + 10 ppm GA_3)	74.00	63.00	56.50
T_5: T_1+ (10 ppm GA_3)	70.00	58.00	51.00
T_6:(Control)	66.50	51.00	41.50
Mean	75.83	65.58	60.58
S. Em ±	1.95	2.43	2.85
C.D at 5%	4.86	6.05	7.09

Fig. 01: Effect of foliar sprays of different concentrations of CPPU and GA_3 on fruit set (%) in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

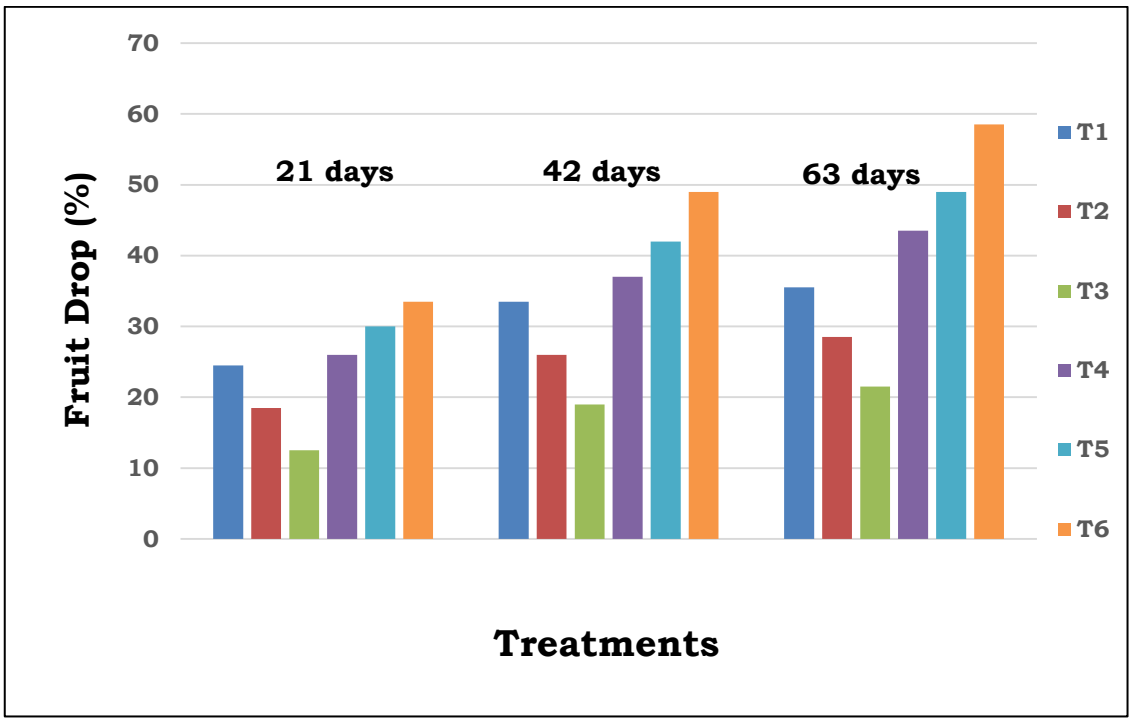
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 02: Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit drop (%) in pomegranate Cv. Bhagwa

Treatment	Fruit drop (%)		
	Days after Flowering		
	21 days	42 days	63 days
T_1: (10 ppm CPPU)	24.50	33.50	35.50
T_2: T_1+ (20 ppm CPPU + 10 ppm GA_3)	18.50	26.00	28.50
T_3: T_1 + (30 ppm CPPU + 10 ppm GA_3)	12.50	19.00	21.50
T_4: T_1 + (40 ppm CPPU + 10 ppm GA_3)	26.00	37.00	43.50
T_5: T_1 + (10 ppm GA_3)	30.00	42.00	49.00
T_6:(Control)	33.50	49.00	58.50
Mean	24.16	34.41	39.41
S. Em ±	1.95	2.43	2.85
C.D at 5%	4.86	6.05	7.09

Fig.02: Effect of foliar sprays of different concentrations of CPPU with GA_3on fruit drop (%) in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

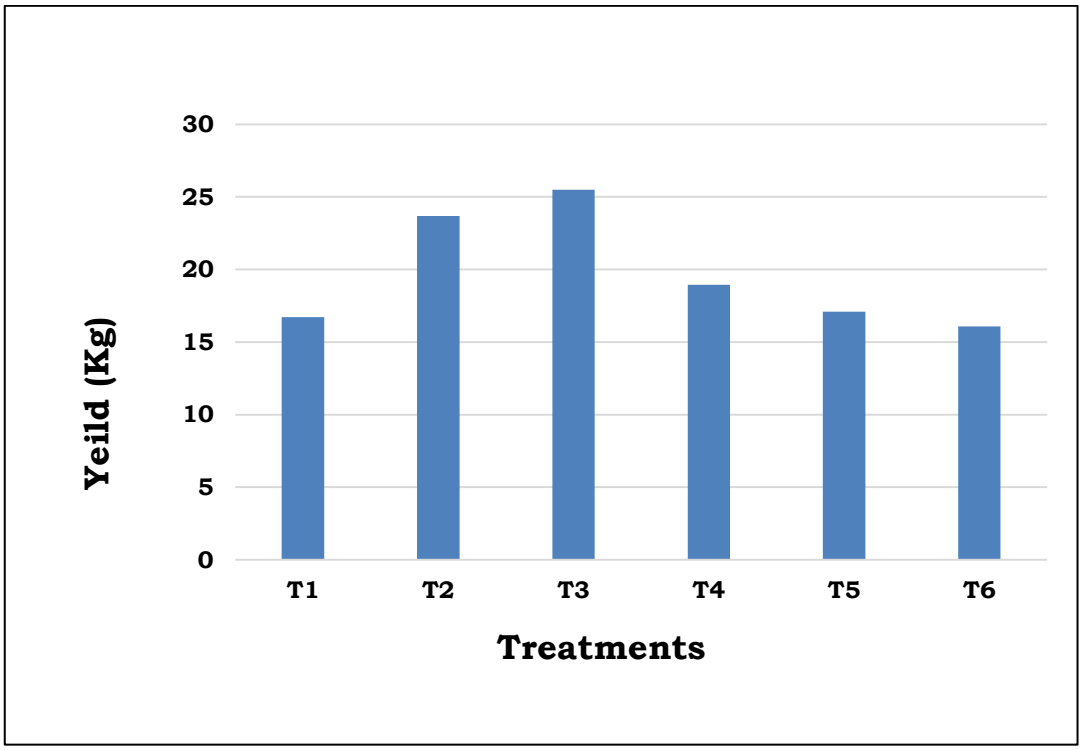
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 03: Effect of foliar sprays of different concentrations of CPPU with GA_3 on yield in pomegranate Cv. Bhagwa

Treatments	Fruit yield at harvest (kg)	
	Kg/ plant	Kg/ha
T_1: (10 ppm CPPU)	16.71	14320
T_2: T_1 +(20 ppm CPPU + 10 ppm GA_3)	23.69	20302
T_3: T_1 + (30 ppm CPPU + 10 ppm GA_3)	25.49	21844
T_4: T_1 + (40 ppm CPPU + 10 ppm GA_3)	18.93	16223
T_5: T_1 + (10 ppm GA_3)	17.09	14646
T_6: (Control)	16.07	13771
Mean	19.66	16851
S. Em ±	2.07	
C. D. at 5%	5.16	

Fig. 03:Effect of foliar sprays of different concentrations of CPPU with GA_3 on yield in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

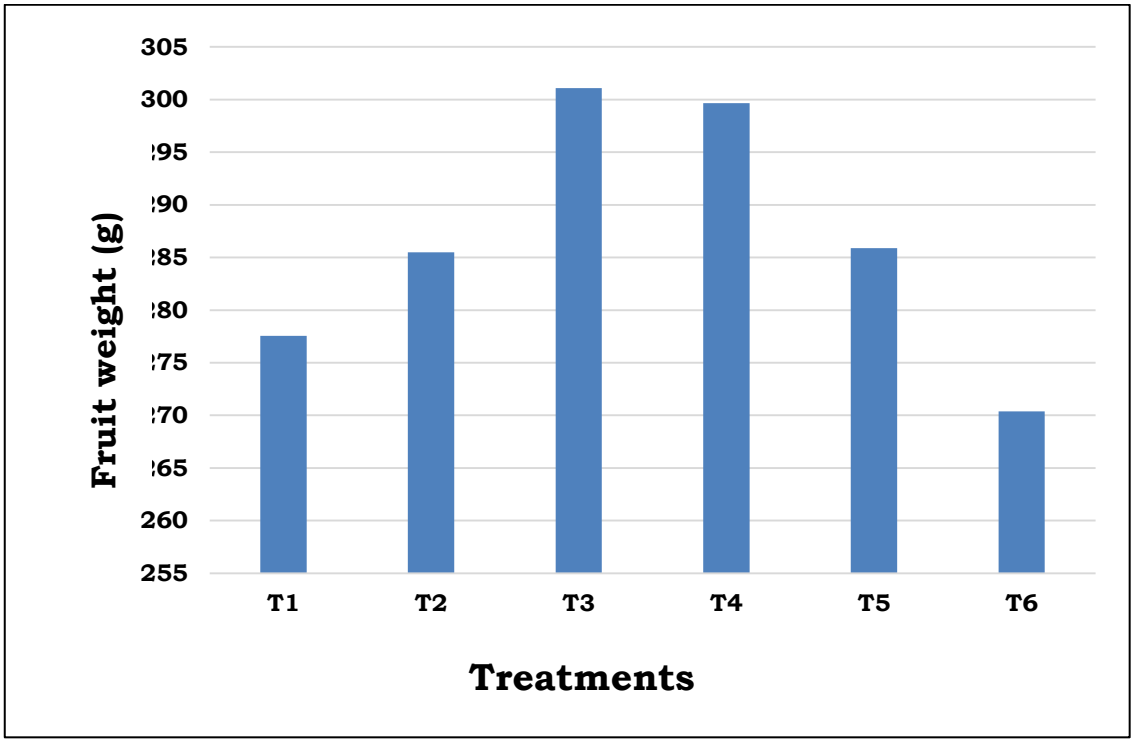
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 04: Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit weight in pomegranate Cv. Bhagwa

Treatments	Fruit weight (g)
	At harvest
T_1:(10 ppm CPPU)	277.55
T_2: T1 + (20 ppm CPPU + 10 ppm GA_3)	285.50
T_3: T1 + (30 ppm CPPU + 10 ppm GA_3)	301.10
T_4: T1 + (40 ppm CPPU + 10 ppm GA_3)	299.67
T_5: T1 + (10 ppm GA_3)	285.89
T_6:(Control)	270.37
Mean	286.68
S. Em ±	8.72
C. D. at 5%	21.69

Fig. 04: Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit weight in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

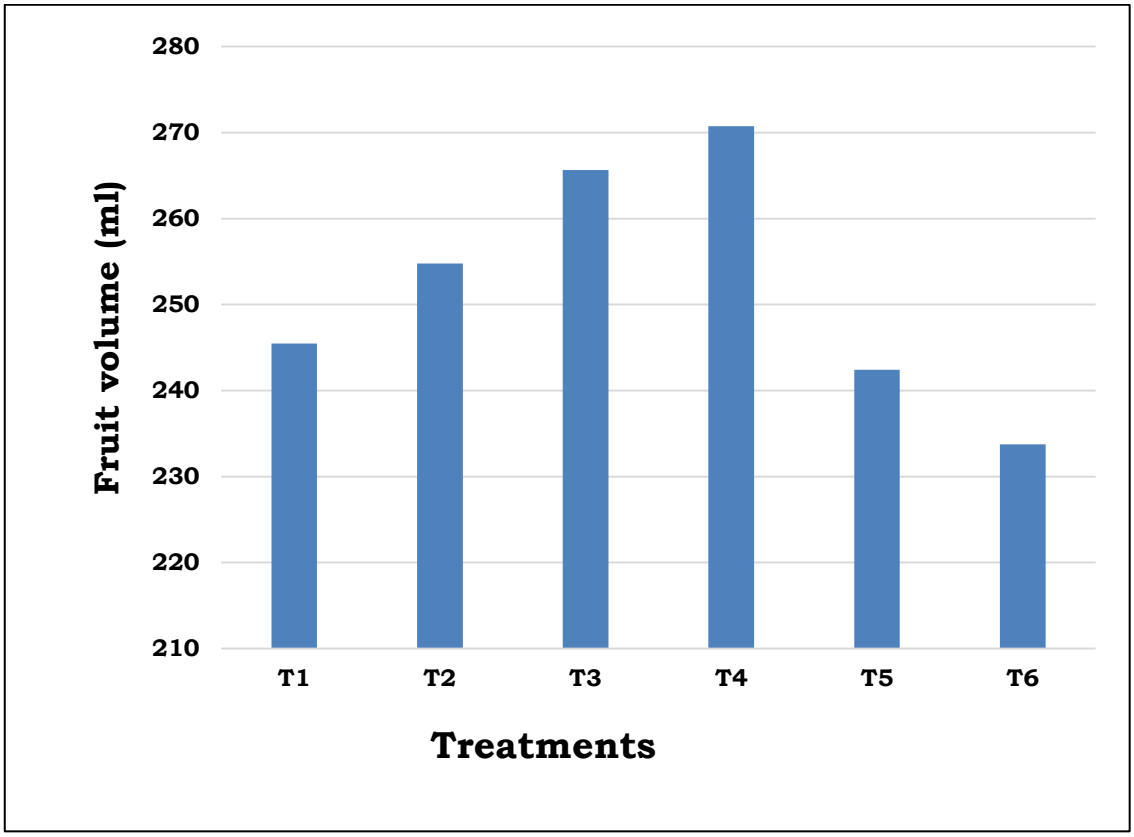
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 05: Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit volume in pomegranate Cv. Bhagwa

Treatments	Fruit volume (ml)
	At harvest
T_1:(10 ppm CPPU)	245.46
T_2: T1 + (20 ppm CPPU + 10 ppm GA_3)	254.79
T_3: T1 + (30 ppm CPPU + 10 ppm GA_3)	265.65
T_4: T1 + (40 ppm CPPU + 10 ppm GA_3)	270.74
T_5: T1 + (10 ppm GA_3)	242.41
T_6:(Control)	233.75
Mean	252.13
S. Em ±	9.81
C. D. at 5%	24.39

Fig.05: Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit volume in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

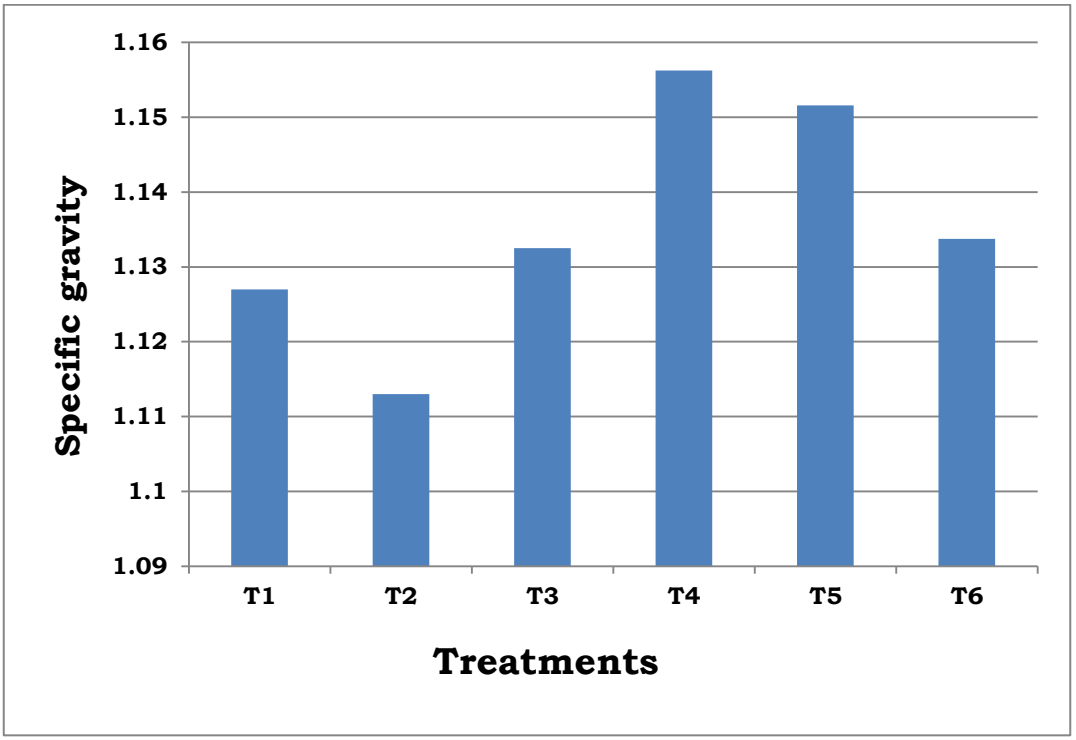
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 06: Effect of foliar sprays of different concentrations of CPPU with GA_3 on specific gravity of fruits in pomegranate Cv. Bhagwa

Treatments	Specific gravity
	At harvest
T_1:(10 ppm CPPU)	1.127
T_2: T_1 +(20 ppm CPPU + 10 ppm GA_3)	1.113
T_3: T_1 +(30 ppm CPPU + 10 ppm GA_3)	1.132
T_4: T_1 +(40 ppm CPPU + 10 ppm GA_3)	1.156
T_5: T_1 +(10 ppm GA_3)	1.151
T_6:(Control)	1.133
Mean	1.135
S. Em ±	0.022
C. D. at 5%	NS

Fig. 06: Effect of foliar sprays of different concentrations of CPPU with GA_3 on specific gravity of fruits in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

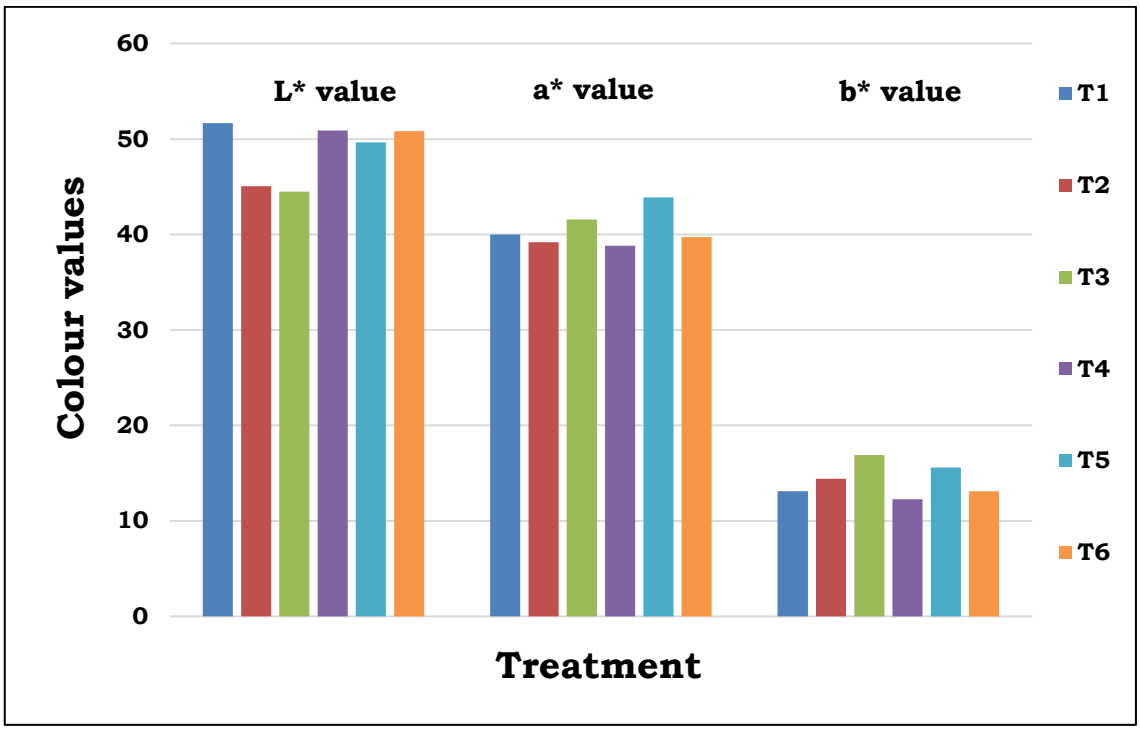
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 07: Effect of foliar sprays of different concentrations CPPU with GA_3 L* value, a* value and b* value for colour of fruits juice ofpomegranate Cv. Bhagwa

Treatment	L* Value	a* Value	b* Value
T_1:(10 ppm CPPU)	51.67	39.99	13.09
T_2: T_1 +(20 ppm CPPU + 10 ppm GA_3)	45.04	39.18	14.42
T_3: T_1 +(30 ppm CPPU + 10 ppm GA_3)	44.49	41.57	16.88
T_4: T_1 +(40 ppm CPPU + 10 ppm GA_3)	50.89	38.83	12.28
T_5: T_1 +(10 ppm GA_3)	49.65	43.89	15.59
T_6:(Control)	50.83	39.72	13.12
MEAN	48.76	40.53	14.23
S Em±	0.20	0.05	0.07
C. D.	0.51	0.13	0.18

Table 07: Effect of foliar sprays of different concentrations CPPU with GA_3 L* value, a* value and b* value for colour of fruits juice of pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

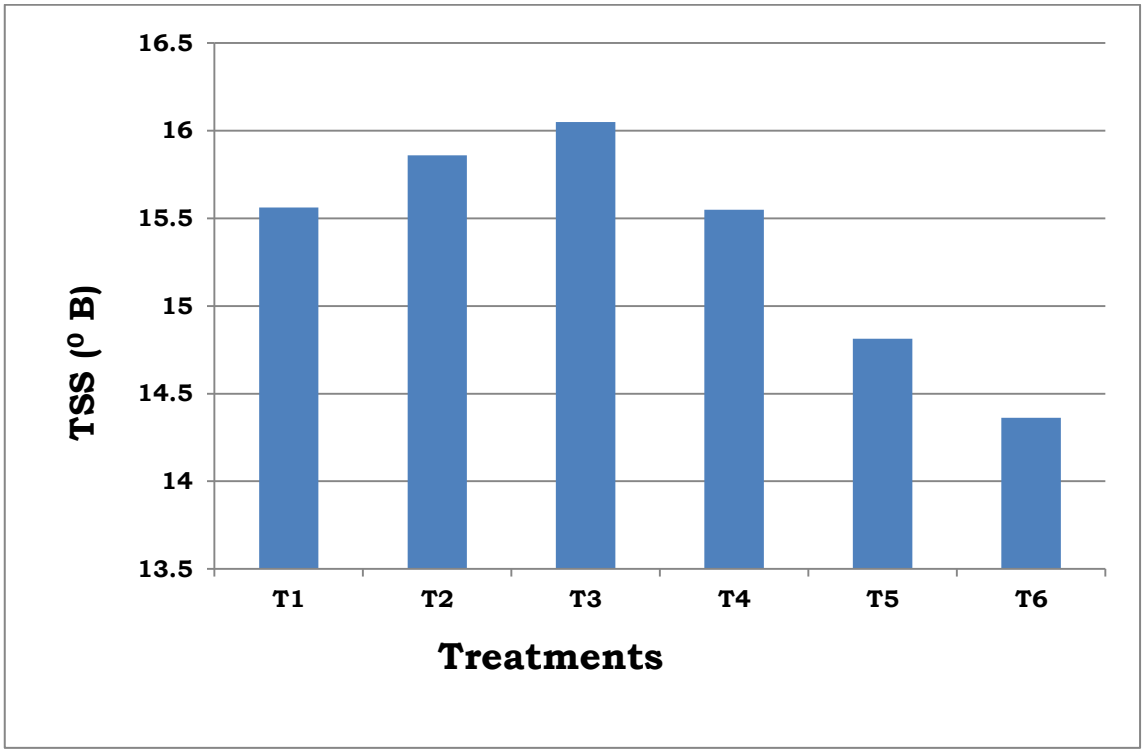
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 08: Effect of foliar sprays of different concentrations of CPPU with GA_3 on TSS °Brix of fruits in pomegranate Cv. Bhagwa

Treatments	TSS (^{0}B)
	At harvest
T_1:(10 ppm CPPU)	15.56
T_2: T1 + (20 ppm CPPU + 10 ppm GA_3)	15.86
T_3: T1 + (30 ppm CPPU + 10 ppm GA_3)	16.05
T_4: T1 + (40 ppm CPPU + 10 ppm GA_3)	15.55
T_5: T1 + (10 ppm GA_3)	14.81
T_6: (Control)	14.36
Mean	15.36
S. Em ±	0.23
C. D. at 5%	0.58

Fig. 8: Effect of foliar sprays of different concentrations of CPPU with GA_3 on TSS °Brix of fruits in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

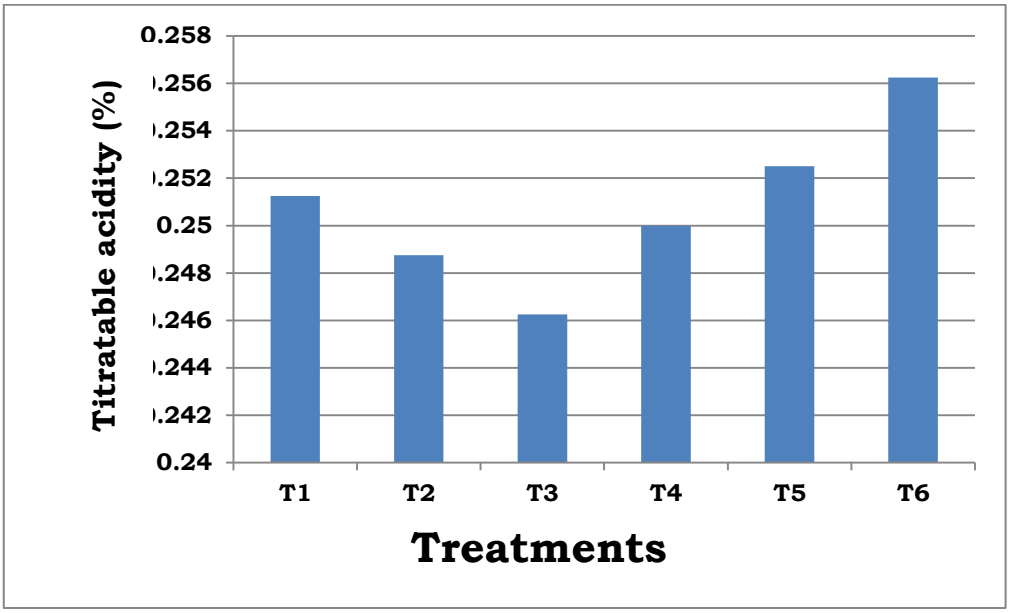
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 09: Effect of foliar sprays of different concentrations of CPPU with GA_3on acidity (%) of fruits in pomegranate Cv. Bhagwa

Treatments	Titratable Acidity (%)
	At harvest
T_1:(10 ppm CPPU)	0.251
T_2: T_1 +(20 ppm CPPU + 10 ppm GA_3)	0.248
T_3: T_1 +(30 ppm CPPU + 10 ppm GA_3)	0.246
T_4: T_1 +(40 ppm CPPU + 10 ppm GA_3)	0.250
T_5: T_1 +(10 ppm GA_3)	0.252
T_6: (Control)	0.256
Mean	0.250
S. Em ±	0.008
C. D. at 5%	NS

Fig. 09: Effect of foliar sprays of different concentrations of CPPU with GA_3on acidity (%) of fruits in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

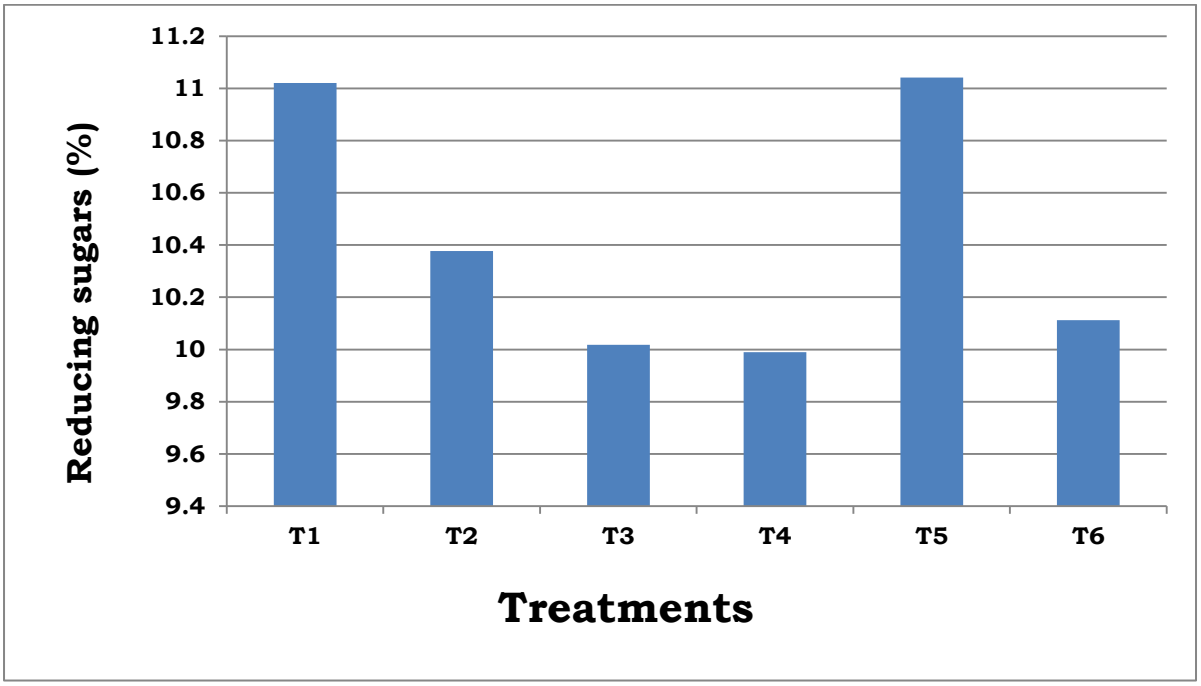
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 10: Effect of foliar sprays of different concentrations of CPPUwith GA_3on reducing sugars of fruits in pomegranate Cv. Bhagwa

Treatments	Reducing sugar (%)
	At harvest
T_1: (10 ppm CPPU)	11.02
T_2: T_1 + (20 ppm CPPU + 10 ppm GA_3)	10.37
T_3: T_1 + (30 ppm CPPU + 10 ppm GA_3)	10.01
T_4: T_1 + (40 ppm CPPU + 10 ppm GA_3)	9.99
T_5: T_1 + (10 ppm GA_3)	11.04
T_6: (Control)	10.11
Mean	10.42
S. Em ±	0.57
C. D. at 5%	NS

Fig. 10: Effect of foliar sprays of different concentrations of CPPUwith GA_3on reducing sugar (%) of fruits in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

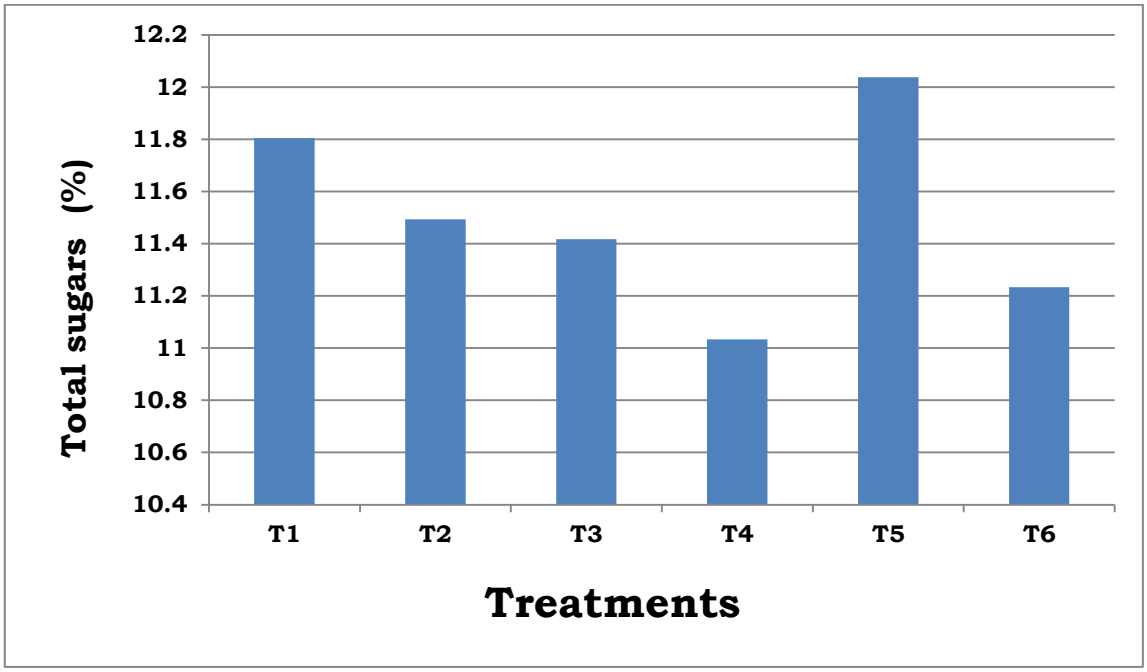
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 11: Effect of foliar sprays of different concentrations of CPPU with GA_3 on total sugars in fruits of pomegranate Cv. Bhagwa

Treatments	Total sugar (%)
	At harvest
T_1:(10 ppm CPPU)	11.80
T_2: T_1 + (20 ppm CPPU + 10 ppm GA_3)	11.49
T_3: T_1 + (30 ppm CPPU + 10 ppm GA_3)	11.41
T_4: T_1 + (40 ppm CPPU + 10 ppm GA_3)	11.03
T_5: T_1 + (10 ppm GA_3)	12.03
T_6:(Control)	11.23
Mean	11.50
S. Em ±	0.35
C. D. at 5%	NS

Fig. 11: Effect of foliar sprays of different concentrations of CPPU with GA_3 on total sugars in fruits of pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

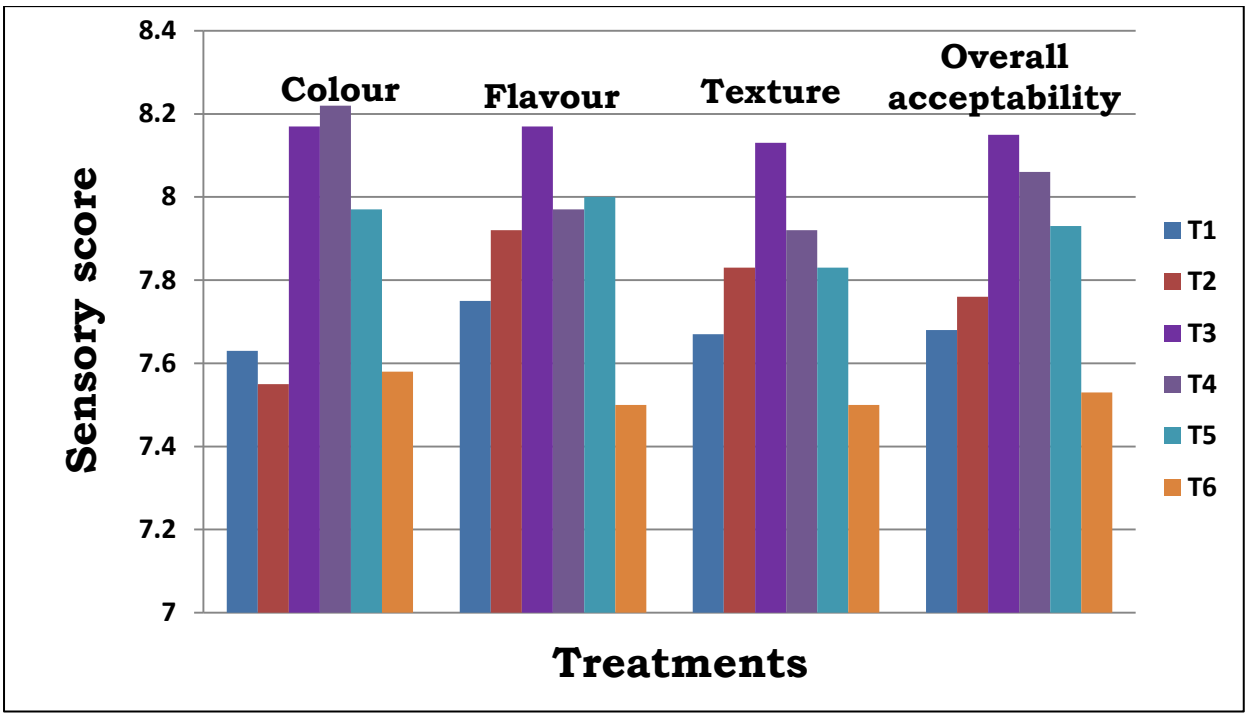
T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

Table 12: Effect of foliar sprays of different concentrations of CPPU with GA_3 on sensory evaluation of ripe fruits in pomegranate Cv. Bhagwa

Treatments	Sensory score for			
	Colour	**Flavour**	**Texture**	**Overall acceptability**
T_1:(10 ppm CPPU)	7.63	7.75	7.67	7.68
T_2: T_1 +(20 ppm CPPU + 10 ppm GA_3)	7.55	7.92	7.83	7.76
T_3: T_1 +(30 ppm CPPU + 10 ppm GA_3)	8.17	8.17	8.13	8.15
T_4: T_1 +(40 ppm CPPU + 10 ppm GA_3)	8.22	7.97	7.92	8.06
T_5: T_1 +(10 ppm GA_3)	7.97	8	7.83	7.93
T_6: (Control)	7.58	7.5	7.5	7.53
Mean	7.85	7.88	7.81	7.85
S. Em ±	0.16	0.16	0.2	0.14
C. D. at 5%	0.45	NS	NS	0.4

Fig. 12: Effect of foliar sprays of different concentrations of CPPU with GA_3 on sensory evaluation of ripe fruits in pomegranate Cv. Bhagwa



T_1: (10 ppm CPPU)

T_2 : T1 + (20 ppm CPPU + 10 ppm GA_3)

T_3 : T1 + (30 ppm CPPU + 10 ppm GA_3)

T_4 : T1 + (40 ppm CPPU + 10 ppm GA_3)

T_5 : T1 + (10 ppm GA_3)

T_6 : (Control)

PLATE I: Effect of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set at mature stage of pomegranate Cv.Bhagwa

Treatment 1

Treatment 2

Treatment 3

Treatment 4

Treatment 5

Treatment 6

PLA[illegible]f different concentration[illegible]hlorofenuron) with GA_3 (Gibberellic acid) on post-harvest quality of pomegranate Cv. Bhagwa

Treatment 1

Treatment 2

Treatment 3

Treatment 4

Treatment 5

Treatment 6

TABLE 13: Cost of production of pomegranate

Sr. no.	Cost item	Quantity	Rate	T_1	T_2	T_3	T_4	T_5	T_6
1	Hired human labours (day)								
	i. Male	67.46	295.23	19916.54	19916.54	19916.54	19916.54	19916.54	19916.54
	ii. Female	46.59	144.66	6739.70	6739.70	6739.70	6739.70	6739.70	6739.70
2	Bullock power (Pair days)	0.20	137.62	227.4	227.4	227.4	227.4	227.4	227.4
3	Machine powers (Hrs)	111.08	39.84	4425.42	4425.42	4425.42	4425.42	4425.42	4425.42
4	Manures(QHS)	182.13	235.83	42952.71	42952.71	42952.71	42952.71	42952.71	42952.71
5	Fertilizers(Kgs)								
	I. Nitrogen	45.52	66.71	3036.63	3036.63	3036.63	3036.63	3036.63	3036.63
	II. Phosphorus	125.24	64.13	8031.64	8031.64	8031.64	8031.64	8031.64	8031.64
	II. Potash	116.40	44.60	5191.44	5191.44	5191.44	5191.44	5191.44	5191.44
6	Irrigation charges			13282.41	13282.41	13282.41	13282.41	13282.41	13282.41
7	Bio – fertilizer/micro nutrient			13244.80	13244.80	13244.80	13244.80	13244.80	13244.80
8	Plant protection charge			22893.14	22893.14	22893.14	22893.14	22893.14	22893.14
9	Incidental charge			3242.74	3242.74	3242.74	3242.74	3242.74	3242.74
10	Repair on farm implement			282.24	282.24	282.24	282.24	282.24	282.24
11	Growth regulator			7638.4	14139.6	19859.6	25606	2690.8	0.00

12	Working capital (1 to 11)			151105.21	157606.41	163326.41	169072.81	14615.61	143466.81
13	Interest on working capital			8915.20	9298.77	9636.25	9975.29	8623.29	8464.54
14	Depreciation on farm implement			4042.23	4042.23	4042.23	4042.23	4042.23	4042.23
15	Land revenue and other taxes			108.05	108.05	108.05	108.05	108.05	108.05
16	Cost A (12 to 15)			164170.69	171055.46	177112.94	183198.38	158931.18	156081.63
17	Rental value of land			72008.58	72008.58	72008.58	72008.58	72008.58	72008.58
18	Interest on fixed capital			9824.64	9824.64	9824.64	9824.64	9824.64	9824.64
19	Amortization cost			729286	7292.86	7292.86	7292.86	7292.86	7292.86
20	Cost B (16 to 19)			253296.77	260181.54	266239.02	272324.46	248057.26	245207.71
21	Family labour (days)								
	I. Male	80.24	248.22	19917.17	19917.17	19917.17	19917.17	19917.17	19917.17
	II. Female	52.39	138.90	7276.97	7276.97	7276.97	7276.97	7276.97	7276.97
22	Cost C (20+21)			280490.91	287375.68	293433.14	299518.6	275251.4	272401.85
23	Produce output (Quintals)	T_1-143.20 T_2 -203.02 T_3-218.44 T_4-162.23 T_5-146.46 T_6-137.71	5385.51	771205.03	1093336.62	1176410	873691.28	788761.79	741638.58
24	Cost (Net produce)			280490.91	287375.68	293433.14	299518.6	275251.4	272401.85

25	Per quintal cost			1958.73	1415.50	1343.3	1846.25	1877.56	1978.08

CHAPTER V

SUMMARY AND CONCLUSION

The present investigation entitled "Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and postharvest quality of pomegranate *(Punica granatum)* Cv. Bhagwa " was undertaken in the pomegranate orchard at-Post- Sakur, Tal- Sangamner, Dist- Ahmednagar (M.S.) during the year 2015-2016. During the investigation, the fruit set and postharvest quality of pomegranate were studied. The results obtained are presented and discussed as under.

5.1 Effect of foliar sprays of different concentrations of CPPU with GA_3 on fruit set, fruit drop and yield of pomegranate Cv. Bhagwa

5.1.1 Fruit set (%)

Investigation on the effect of sprays of different concentrations CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of Pomegranate Cv. Bhagwa indicated that the difference for fruit set and retention significantly increased per tree. The maximum fruit set recorded in T_3 (87.50%) 21 days after flowering, while minimum fruit set was noticed in T_6 (66.50%). After 42 days of flowering, the maximum fruit set was recorded in T_3 (81.00%) while minimum fruit set was noticed in T_6 (51.00%). The maximum fruit set was recorded 63 days after flowering in T_3 (78.50%), while minimum fruit set was noticed in T_4 (41.50%).

5.1.2 Fruit drop (%)

The effect of sprays of different concentrations CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of Pomegranate Cv. Bhagwa indicated that the difference for fruit drop significantly increased per tree. After 21 days of flowering, the maximum fruit set was recorded in T_6 (33.50%) while the minimum fruit drop was noticed in T_3 (12.50%). The maximum fruit drop recorded 42 days after flowering in T_6 (49.00%) while minimum fruit drop was noticed in T_3 (19.00%). The maximum fruit drop recorded in T_6 (58.50%) while minimum fruit drop was noticed in T_3 (21.50%) 63 days after flowering.

5.1.3 Fruit yield (kg)

Results on the effect of sprays of different concentrations CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa indicated that the difference for fruit yield was significantly increased per tree. However, the maximum yield Kg/tree was noticed in T_3 (25.49 Kg) while minimum fruit yield in Kg/tree was found in T_5 (16.07 Kg).

5.2 Effect of foliar sprays of different concentrations of CPPU with GA_3 on physical parameters in fruits of pomegranate Cv. Bhagwa

5.2.1. Fruit Weight (g)

The studies on the effect of sprays of different concentrations CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa

revealed that there was significant effect of CPPU sprays on fruit weight. At harvest, the maximum fruit weight was recorded in T_3 (301.1 g) however, minimum fruit weight was noticed in T_6 (270.37 g).

5.2.2. Fruit Volume (ml)

Investigation on the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was significant effect of CPPU sprays on fruit volume. At harvest, the maximum fruit volume was recorded in T_4 (270.74 ml). While minimum fruit volume was noticed in T_6 (233.13 ml).

5.2.3. Specific gravity

While the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was no significant effect of CPPU sprays on specific gravity.

At harvest, the maximum specific gravity was recorded in T_4 (1.156) while minimum specific gravity was noticed in T_6 (1.113).

5.2.4 Colour value (L*, a* and b* values)

5.2.4.1. L* value for colour

Observation for the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic

acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was a significant effect on L* value for colour. Highest L* value for colour was observed in T_1 (51.67) while it was lowest in T_3 (44.49).

5.2.4.2 a* value for colour

While the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was a significant effect on a* value for colour. Highest a* value for colour was observed in T_5 (43.89), and the lowest value for T_4 (38.83).

5.2.4.3 b* value for colour

Investigation on the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was a significant effect on b* value for colour. Highest b* value for colour was observed in in T_3 (16.88) and lowest value for T_4 (12.28).

5.3 Effect of foliar sprays of different concentrations of CPPU with GA_3 on chemical composition of fruit

5.3.1. TSS (°B)

Observation for the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic

acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was a significant effect of foliar sprays of CPPU on TSS (°B) in pomegranate Cv. Bhagwa fruits. The maximum TSS was recorded in the treatment T_3 (16.05°B) while minimum TSS was recorded in T_6 (14.36°B).

5.3.2 Titratable Acidity (%)

Result on the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was no significant effect foliar sprays of CPPU on the acidity of fruits. The maximum acidity was assessed in T_6 (0.256%) while minimum acidity was in T_3 (0.246 %).

5.3.3 Reducing sugars (%)

The effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was no significant effect foliar sprays of CPPU on reducing sugar content of fruits. It was maximum in T_1 (11.04 %) while minimum in T_5 (9.99 %).

5.3.4 Total sugars (%)

Also the effect of sprays of different concentrations of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate Cv. Bhagwa revealed that there was no significant effect of foliar sprays of CPPU on total sugar

content of fruits. Highest total sugar was noted in T_5 (12.03%) while lowest in T_4 (11.03%).

5.4 Sensory evaluation

The highest sensory score for colour (8.22) was noticed in T_4 and the lowest (7.55) was recorded in T_5. The highest sensory score for flavour (8.17) was noticed in T_3 and lowest (7.5) was observed in T_6. The highest sensory score for texture (8.13) was recorded in T_3 and the lowest (7.5) was recorded in T_6. The maximum (8.15) average sensory score for colour, flavour and texture was observed in T_3 and was minimum (7.53) in T_6.

5.5 Cost of cultivation

As far as the cost of cultivation is concerned, the lowest (Rs. 1343.30) cost per quintal was observed in treatment T_3 and highest (Rs.1978.08) cost per quintal was observed in the treatment T_6.

The highest yield (218.44 quintals), produce outcome (Rs.1176410) and (Rs. 1343.3) lowest cost per quintal was observed in treatment T_3 which is also superior in overall acceptability over all other treatments.

CONCLUSION

The experiment entitled "Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and postharvest quality of pomegranate *(Punica granatum)* Cv. Bhagwa" results indicated that the fruit set, fruit drop and physico-chemical

properties of pomegranate Cv. Bhagwa were influenced by different concentrations of CPPU sprays. Significantly higher fruit set, yield, weight, volume, colour, TSS as well as organoleptic quality of pomegranate Cv. Bhagwa was observed in CPPU sprayed trees over control trees. However, there was no significant difference in terms of specific gravity, acidity, reducing sugar and total sugars of fruits in CPPU treated trees over control trees.

The treatment T_3 i.e. T_1 (10ppm CPPU at flowering) + (30ppm CPPU with 10ppm GA_3) was significantly superior to all other treatment in terms of fruit set, fruit drop, yield, fruit weight, TSS and cost per quintal.

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*Orignal not seen

APPENDIX I

Weekly Weather Data Sangamner,

From September 2015 to March 2016

Period	Temperature (°C)		Relative Humidity (%)	
	Max.	Min.	Max.	Min.
03.09 – 9.09	33.3	23.1	81	55
10.09 – 16.09	32.3	21.8	79	58
17.09 – 23.09	30.2	22.6	79	59
24.09 – 30.09	33.5	19.8	68	41
01.10 – 07.10	32.8	21.0	76	50
08.10 – 14.10	34.2	20.9	72	39
15.10 – 21.10	35.0	19.1	57	30
22.10 – 28.10	34.7	20.8	59	36
29.10 – 04.11	32.1	17.7	57	37
05.11 – 11.11	32.9	17.3	58	38
12.11 – 18.11	32.4	14.6	50	30
19.11 – 25.11	30.1	17.9	71	59
26.11 – 02.12	31.7	17.8	70	44
03.12 – 09.12	31.6	13.9	57	33
10.12 – 16.12	32.3	15.9	49	33
17.12 – 23.12	31.1	13.7	64	36
24.12 – 31.12	32.9	9.4	45	25
01.01 – 07.01	31.4	11.6	47.3	26.4
08.01 – 14.01	30.3	11.8	47.3	27
15.01 – 21.01	28.7	11.8	59.4	30.4
22.01 – 28.01	29.4	9.3	46.6	22.4
29.01 – 04.02	33.5	12.0	47	25

05.02 – 11.02	32.4	13.04	53.6	24.3
12.02 – 18.02	32.8	14.9	64.1	27.1
19.02 – 25.02	35.0	17.5	52.6	23.6
26.02 – 04.03	35.1	18.7	57.4	30.9
05.03 – 11.03	34.5	17.1	51.4	21.9
12.03 – 18.03	35.9	17.3	40.9	19.9
19.03 – 25.03	37.01	18.8	34.9	17.3
26.03 – 31.03	38.9	19.5	34.5	19.2

APPENDIX II

Abbreviations used

SR.NO.	ABBREVIATIONS	MEANING
1	%	Per cent
2	@	At the rate of
3	/	Per
4	A.O.A.C	Association of Official Analytical Chemist
5	Anon.	Anonymous
6	^{0}Brix	Degree Brix
7	^{0}C	Degree centigrade
8	C.D.	Critical difference
9	Cv.	Cultivar
10	Cm	Centimeter
11	*et al.*	And others
12	*etc.*	et cetera (and so on)
13	RBD	Randomized block Design
14	Fig.	Figure
15	g	Gram
16	Hrs	Hours
17	ha.	Hectare
18	*i.e.*	id est. (That is)
19	Kg	Kilogram
20	Ltd.	Limited
21	Mm	Millimeter
23	M. S.	Maharashtra State
24	µg/l00g	Micro gram per 100 grams
25	Ml	Milliliter
26	NS	Non-significant
27	Ppm	Part per million

28	Pvt.	Private
29	RH	Relative humidity
30	S.Em.	Standard error of mean
31	Std.	Standard
32	TSS	Total soluble solids
33	T	Treatment
34	*viz.,*	Videlicet (Namely)
35	Wt.	Weight
36	Ppm	Part per million

VITAE

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A candidate for the degree of

M.Sc. (Post Harvest Management)

Title of thesis

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Effect of CPPU (Forchlorofenuron) with GA_3 (Gibberellic acid) on fruit set and post harvest quality of pomegranate (*Punica granatum*) Cv. Bhagwa

Major Field Post Harvest Management of Fruit Vegetable and Flower Crops

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