# EFFECT OF SOIL APPLIED PACLOBUTRAZOL TREATMENTS AT DIFFERENT TIME ON GROWTH, FLOWERING, FRUITING, YIELD AND QUALITY OF MANGO (*Mangifera indica* L.) CV. KESAR

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**M. Sc. (Horti.)**



**DEPARTMENT OF HORTICULTURE**

**COLLEGE OF AGRICULTURE**

**JUNAGADH AGRICULTURAL UNIVERSITY**

**JUNAGADH- 362 001**


**OCTOBER – 2021**

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**A THESIS SUBMITTED TO**
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**FOR THE AWARD OF THE DEGREE OF**

## DOCTOR OF PHILOSOPHY

**(Horticulture)**

**IN**

**FRUIT SCIENCE**

**BY**


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**OCTOBER - 2021**

*DEDICATED TO……*

# *MY LOVING*

# *FAMILY, FRIENDS*

# *And*

# *RESPECTED GUIDE*

*Bhavin..*

**DEPARTMENT OF HORTICULTURE**
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Name of the student: **Mr. Gohel Bhavin C.**

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## ABSTRACT

***Key words:*** *Paclobutrazol, Mango, Kesar.*

The present experiment entitled "Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruiting, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" was carried out at Fruit Research Station, Sakkarbaug, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Ta. & Dist. – Junagadh (Gujarat) during 2019-20 and 2020-21. The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) consisting two factors with three replications. The treatment comprised with three time of paclobutrazol application *viz*., 15$^{th}$ July, 1$^{st}$ August and 15$^{th}$ August and four dose of paclobutrazol application *i.e*. 5 g *a. i.*, 8.5 g *a. i.*, 11.5 g *a. i.* and 14.5 g *a. i.*

The results of the study indicated that application of different time of paclobutrazol application had produced non significant effect on growth parameters *viz*., number of shoots per terminal and length of new shoot and quality parameters *viz*., TSS, titrable acidity, reducing sugar, non reducing sugar, total sugar, pulp-skin ratio and shelf life.

The flowering, fruiting, yield and quality parameters were significantly influenced by various time of paclobutrazol application. Among the different time of

paclobutrazol application, time of soil application of paclobutrazol was found significant and minimum days to flower bud initiation (48.68), days to 50% flowering (62.99) and days to full bloom (74.23), maximum number of fruit set per shoot at pea stage (10.28), number of fruit set per shoot at marble stage (3.89), fruit retention per shoot (41.19 %) with minimum fruit drop per shoot (58.81 %) and days to fruit maturity (195.08), maximum number of fruit per tree (105.16), fruit yield (23.57 kg/tree), fruit yield (6.55 t/ha) were recorded on application at on 15$^{th}$ July. However, yield attributing parameters *viz.*, fruit weight, fruit length and fruit breadth were found non significant on time of paclobutrazol application.

In case of dose, the variation was also found non significant on quality parameters *viz*., titrable acidity and non reducing sugar.

Similarly, the variation was also found significant due to different dose of paclobutrazol application. The minimum numbers of new shoots per terminal (1.32), length of new shoot (10.58 cm), days taken to flower bud initiation (46.04), days to 50% flowering (61.82), days to full bloom (70.26), maximum number of fruit set per shoot at pea stage (10.44), number of fruit set per shoot at marble stage (3.97), fruit retention per shoot (44.65 %) with minimum fruit drop per shoot (55.35) and days to fruit maturity (193.55) and maximum number of fruit per tree (106.48) were observed with application of paclobutrazol dose @ 14.5 g *a. i.* However, maximum fruit yield (25.19 kg/tree), fruit yield (7.00 t/ha), fruit weight (261.65 g), fruit length (10.36 cm), fruit breadth (7.08 cm), TSS (18.95 $^{O}$Brix), reducing sugar (5.38 %), total sugar (15.74 %), pulp skin ratio (4.41) and shelf life (14.37 days) were recorded with application of paclobutrazol dose @ 8.5 g *a. i.*

The interaction effect of time and dose of paclobutrazol application were produce non significant effect on growth, flowering, fruiting, yield and yield attributing parameters and quality parameters, respectively.

As far as the economics point of view the maximum net realization (₹2,10,697 ha$^{-1}$) along with benefit cost ratio (1.86) were obtained in treatment combination of paclobutrazol application on 15$^{th}$ July with dose 8.5 g *a. i.*

On the basis of the results obtained from the two year experiment, it seems quite logical to conclude that, the paclobutrazol application on 15$^{th}$ July can be reduced growth, earliness in flowering and fruiting, increase in yield and quality and dose of paclobutrazol @ 8.5 g *a.i.* improved yield and quality of mango cv. Kesar.

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## CERTIFICATE-II

**Date: 18/10/2021**

This is to certify that the thesis entitled **"EFFECT OF SOIL APPLIED PACLOBUTRAZOL TREATMENTS AT DIFFERENT TIME ON GROWTH, FLOWERING, FRUITING, YIELD AND QUALITY OF MANGO (*Mangifera indica* L.) CV. KESAR"** submitted by **Mr. GOHEL BHAVIN CHANDRAKANT (Reg. No. 1020618001)** to Junagadh Agricultural University, Junagadh in partial fulfilment of the requirements for award of the degree of **DOCTOR OF PHILOSOPHY (HORTICULTURE)** in the subject of **FRUIT SCIENCE** after recommendation by the external examiners were defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination was satisfactory. We, therefore, forward with recommendation.

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**Place : Junagadh**

**Date : 29th July, 2021** **(B. C. Gohel)**

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# LIST OF ABBREVIATIONS AND SYMBOLS

| Abbreviations | | Meaning |
|---|---|---|
| **%** | : | Per cent |
| **₹** | : | Rupees |
| **@** | : | At the rate of |
| **$^0$B** | : | Degree Brix |
| **$^0$C** | : | Degree Celsius |
| **$^0$E** | : | Degree East |
| **$^0$N** | : | Degree North |
| **A.A.U** | : | Anand Agricultural University |
| **Anon.** | : | Anonymous |
| **C.D.** | : | Critical difference |
| **C.V.** | : | Co-efficient of variance |
| **BCR** | : | Benefit Cost Ratio |
| **cm** | : | Centimeter |
| **cv.** | : | Cultivar |
| ***et al.*** | : | Et allii, and others |
| **etc.** | : | Etcetera and rest, So on |
| **Fig.** | : | Figure |
| **FRBD** | : | Factorial randomized block design |
| **FYM** | : | Farm yard manure |
| **g** | : | Gram |
| **GA** | : | Gibberellic Acid |
| **ha** | : | Hectare |
| **hrs** | : | Hours |
| ***i.e.*** | : | That is |
| **J.A.U.** | : | Junagadh Agricultural University |
| **kg** | : | Kilogram |
| **Kg ha$^{-1}$** | : | Kilogram per hectare |
| **m** | : | Meter |

| | | |
|---|---|---|
| **max.** | : | Maximum |
| **min.** | : | Minimum |
| **Mg** | : | Milligram |
| **mm** | : | Millimeter |
| **No.** | : | Number |
| **NS** | : | Non significant |
| **RDF** | : | Recommended dose of fertilizers |
| **S. Em.** | : | Standard error of mean |
| **Sr.** | : | Serial |
| **Std. Week** | : | Standard week |
| **T** | : | Tonne |
| **Temp.** | : | Temperature |
| **TSS** | : | Total soluble solids |
| **Var.** | : | Variety |
| ***viz.*****,** | : | Videlicet (Namely) |

# CHAPTER-I

## INTRODUCTION

The mango (*Mangifera indica* L.) (2n=2x=40) belongs to the family Anacardiaceae and originated in Indo-Burma region. It is the national fruit of India. It is one of the choicest fruit of tropical and sub-tropical region of the world, especially in Asia. Its population and importance can easily be realized by the fact that it is often referred as "King of Fruits in the Tropical World" (Singh, 1960). Mango is popular due to its excellent flavour, delicious taste, delicate fragrance, attractive colour and nutritive value which make at rank among the best fruits of world.

The center of diversity of the genus *mengifera* appears to be the island of Borneo (Mukherjee, 1985) whereas the species *indica* appears to have two centers of diversity Indo- Burma and South East Asia. The natural spread of this genus is limited to the Indo- Malaysian region stretching from India to Philippines and New Guinea in the East.

Records suggest that mango has been in cultivation in the Indian continent for well over 4000 years and it was favorable of the kings and commoners alike because of its luscious taste and captivating flavor. However, the greatest tribute to this esteemed plant was paid by Emperor Akbar (1556-1605 A.D.) who established the *Lakh Bagh* (a mango orchard having 100,000 plants) in Dharbanga (Bihar) when large orchards of fruit trees were unknown. In Ain-I-Akbari, a masterpiece of Persian literature, written by the great chronicler Abul Fazl (1590 A.D.) during the reign of Emperor Akbar, the cultivars, cultivation and quality of mangoes have been discussed in details.

Mango is the world's most popular fruit and is referred to as the King of Fruits. Mangoes are excellent source of vitamins A, C and Fiber. Vitamin A promotes healthy vision and bone growth whereas vitamin C promotes healthy immune system. Mangoes are rich in potassium which can help reduce the risk of high blood pressure.

On the broad description of mango tree; the height of tree varies substantially amongst various species and can range from 8-33 m. The bark of the tree is fairly rough, often scored by vertical fissures. Leaves are simple and usually arranged in spiral phyllotaxy. New emerging leaves are bronze in colour which later on turn into different shades of green and generally have leathery texture. Inflorescence known as panicle having pyramidal shape consisting of large number of flowers containing male and hermaphrodite flowers and the ratio of both the kinds of flowers vary with variety and may change in different agro-climatic situation. After fruit set, it matures between 100 to 150 days depending on variety. Since mango is a climacteric fruit, it ripens after harvest. Unripe and ripe fruits differ greatly in terms of size, shape, colour and taste. Different delightful shades of skin colour ranging from light green, yellow with red blush or vermilion flush per blush. Fruit size differs and grouped as small, medium and large, while, fruit shape seems to be round, oblong, elliptical, etc. Development of ventral as well as dorsal shoulder, sinus and beak may appear prominent or absent or intermediate. They are somewhat full and oval shaped tapering to a beak at one end. The orange yellow flesh is sweet and succulent with a wonderfully fragrant and exotic aroma which also gives typical flavour to that variety/ cultivar and each contains one single elongated fibrous seed stone which lings to the flesh. Unripe mangoes contain a highly irritating sap, which cause extreme discomfort to those with allergies or hyper sensitivity (Das, 1999).

Total number of mango species was recorded to be 41 (Mukherjee, 1985). Later on, after the worldwide collection of mango germplasm and critical taxonomical evaluation, Kostermans and Bompard (1993) had described 69 different mango species distributed throughout south East Asia including India to Malaysia, Srilanka, Philippines and New Guinea. Though 69 species of cultivated, semi-wild and wild types exist in the tropics and sub-tropics, almost all the cultivated cultivars of mango belong to single species *Mangifera indica* L. (Singh, 1960; Nair, 1996; Kostermans and Bompard, 1993 and Bose *et al.*, 2002).

Out of 69 species, five species namely *M. indica, M. sylvatica, M. comptosperma, M. andamanica, M. khasiana* have found domesticated in Indian subcontinent.

As mango is grown in India for over 4000 years, more than 1,000 varieties exists today. It is grown in almost all the states of India. India shares about 56 % of total mango production in the world. Its production has been increasing since independence, contributing 39.5% of the total fruit production of India (Radha & Mathew, 2007). India produced around 207.98 lakh tonnes of mango from 22.93 lakh ha area with 9.0 t/ha productivity (Anon., 2019b). Andhra Pradesh tops in total production, whereas Uttar Pradesh tops area-wise. Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Maharashtra, West Bengal and Gujarat together contribute for about 82 % of the total production in India. The most popular commercial cultivars of different regions in India are Alphonso, Banganapalli, Chausa, Dashehari, Kesar, Kishenbhog, Langra, Mallika, Mankurad, Mulgoa, Neelum, Pairi, Samar Behisht, Suvarnarekha, Totapuri, Vanraj, Zardalu, Amrapali, Bangalora, Gulabkhas etc ( Radha & Mathew, 2007).

Although, essentially a tropical fruit, the mango can grow from sea level to an altitude of about 1400 m, but there should no high humidity, rain or frost during the flowering period. It does well within a temperature ranging from 24-30°C, although it can successfully endure even temperature as high as 48°C during the period of fruit development and maturity. Cold temperature limits crop production. Low temperature promotes floral induction of mango. Higher temperatures during fruit developing hasten maturity and improve fruit size and quality. Water stress imposed on plants during cool autumn months did not increase the proportion of apical bud forming inflorescence. The amount of rainfall in a given locality is not so important as its intensity and distribution. It can do well in areas having average rainfall as low as 25 cm to as high as 250 cm. However, mango does not do well where there is a frequent rain or high humidity (80 %) during flowering period.

It is also known that, available plant nutrients and soil types affect yield and fruit quality. Mango can grow well in all types of soil from alluvial to lateritic, except black cotton soils which are considered to be poor. The only pre-requisite is a deep (2 to 2.5 m) and well drained soil. However, it grows successfully in soft rocky areas of west coast. Saline and alkaline conditions are not conducive to profitable mango cultivation (Singh, 1960).

Gujarat is one of the major mango growing states which mainly focus on export purpose. A larger area is being brought under mango cultivation, which needs technological backup for making Gujarat a strong mango growing state, for better income generation, employment opportunities and nutritional security. In Gujarat; Valsad, Navsari, Junagadh, Surat, Kutch, Amreli and Bhavnagar districts are the main mango growing belts. Gujarat, itself produces 12.22 lakh tonnes of mango from 1.66 lakh ha area with 7.3 t/ha productivity, which contributes around 7 % of the total production of mango in India. Specially, in Junagadh district, total of 58,123 tonnes mango produces from 8,675 ha area (Anon., 2019a).

Saurashtra contributes about 0.49 lakh ha area, production of 3.56 lakh MT annually. Productivity of mango in Saurashtra region is about 7.2 MT/ha (Anon., 2019a).

Kesar is the most popular and important commercial cultivar and also leading variety for export. It is also preferred variety for mango pulp processors. The area under Kesar variety is increasing not only in Gujarat but also in nearby states like Maharashtra, Madhya Pradesh and Andhra Pradesh due to its higher productivity, regularity in bearing, excellent fruit quality, pleasant flavour and overall high commercial value. It is known for its vigorous growth, having good consumer's acceptance, attractive shape and size, colour of fruit pulp and good keeping quality. It has excellent sugar: acid blend with good processing quality.

Kesar cultivation in Gir started about a century ago. In the past 100 years, the region has emerged as the hub of this fruit. Alike Darjeeling tea or Solapur chaddar, Kesar mango of Gir (Talala) has its own identity. The luscious fruit has got registration with Geographical Indication Registry (GIR) of India, which conveys assurance of quality and distinctiveness-essentially attributed to the place of its origin in a defined geographical locality. The variety has got registered Geographical Indication under GI number-185 as Gir Kesar Mango Class-31 under on June 14, 2011 (Geographical Indications Journal-2011). Kesar mango is the first agricultural produce from Gujarat which has got this registration.

The severe case of alternate bearing, erratic flowering, low yield, poor fruit quality and short availability in most Indian cultivar of mango has led to growing woe among mango growers. In this regard there was formidable research carried out

for crop improvement, but due to hindrance of incorporation of gene for regularity and poor acceptance of new breed varieties among growers and mostly among consumer. This lead to look for other ways, let to introduction of effective chemical retardants. The first report about the use of paclobutrazol (PBZ) on mango in India was given by Kulkarni (1988) tested concentration of 1.25 to 10 g *a.i.*/tree on the cultivars Dashehari and Banganapalli. The induction of flowering in mango through chemical substances such as paclobutrazol, block the biosynthesis of gibberellins and reduced the growth of plants there by leading to blossoming (Rademacher, 1991).

Mango flowering is an important physiological event that sets the start of fruit production. Mango trees flower in response to the age of the last vegetative flush in tropical conditions. It is andromonoecious plant bearing male and hermaphrodite flowers separately on terminal panicles. There are two different types of flowers in succession on the same tree but usually on different panicles or branches, hermaphrodite with abortive ovary (functional male), hermaphrodite female with non-dehiscent anthers (functional female) and male (Mustard and Lynch, 1946).

Flowering in mango is preceded by the differentiation of the flower bud in the shoots. The period of differentiation is reported to be October –December, depending upon the local climatic conditions. It takes about a fortnight for the tiny bud to develop and open into a flower. A part from the inherent character of the variety, the time of flowering in different regions is mainly governed by the local climatic conditions. Under Saurashtra climatic conditions, mango may start flowering from December itself, where under extreme climatic conditions of the flowering is comparatively more precise and late.

Paclobutrazol has been extensively used in the horticulture industry to regulate the growth and production of fruit trees. This is anti- gibberellin compound which is very active low rates, taken up into the xylem through the leave, stems or root and translocate to growing sub apical meristems. Movement of paclobutrazol within plant is acropetal (base to apex), absorbed by roots and translocate in the xylem only. It results in retardation of vegetative growth and diversion of assimilates to reproductive organs there by enhance the bud break and improve the fruit set and yield.

Application of paclobutrazol in mango plants in the month of July-August promote the inflorescence emergence during October to November and fruits mature in the month of middle of march to April. Taking the crop during March – May by means of paclobutrazol application is highly remunerative to the farmer due to more market demand which fetch high price to produce. Soil application of paclobutrazol increase the yield by checking the vegetative growth and increase the flowering, fruit set, fruit weight, fruit size and also quality enhanced (Burondkar and Gunjate, 1993).

**Practical utility of research work**

Mango is an important fruit crop of tropical and subtropical region. For successful production of mango, flowering is an important factor. Now a day's farmers facing a problem of flowering.

Flowering in mango, the most important thing is the trees should be able to produce new vegetative growth in the 'on' year which should also be mature to be ready to enter in to reproduction phase and give flowering in following season. Early flowering results in advanced fruit maturity and provided opportunities to have the commercial advantages of early marketing in season.

The endogenous hormonal level of tree especially in vegetative growth is probably the most favor for this problem. So, exogenous application of chemicals play a major role in the enhancing flowering, reducing fruit drop and increasing fruit yield and quality of mango fruit. With this background, the present study "Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruiting, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" was undertaken with the following objectives:

1. To study the effect of time of paclobutrazol application on growth, flowering, fruiting, yield and quality of mango cv. Kesar.
2. To study the effect of different doses of paclobutrazol application on growth, flowering, fruiting, yield and quality of mango cv. Kesar.

**3.** To study the interaction effect between different time and dose of paclobutrazol application on growth, flowering, fruiting, yield and quality of mango cv. Kesar.

# CHAPTER: II

## REVIEW OF LITERETURE

Problem of alternate bearing in fruit trees has been investigated and reviewed on many occasions in the past. The fact that different types of fruit trees show alternate bearing not withstanding wide differences in dormancy, time of flower formation, flowering habit, set abscission relationships, length of fruit development stage as compared with vegetative activities and many other aspects indicated that alternation is some how inherent to the nature of the polycarpic plant and calls for a unified theory at least a logical set of alternative hypothesis explaining the alternating behaviours in a unified way.

The present investigation entitled "Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruiting, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" was carried out during the years 2019-20 and 2020-21 was carried out and the related literature pertaining to the present study has been reviewed in this chapter under following heads.

### 2.1 EFFECT OF TIME OF APPLICATION OF PECLOBUTRAZOL

### 2.2 EFFECT OF DOSES OF APPLICATION OF PACLOBUTRAZOL

### 2.3 INTERACTION EEFECT OF TIME AND DOSE OF PACLOBUTRAZOL

### 2.1 EFFECT OF TIME OF APPLICATION OF PACLOBUTRAZOL

#### 2.1.1 MANGO

Kulkarni (1989) tried paclobutrazol in mango at various places and reported a reduction in vegetative growth and an induction of early flowering as well as an optimum crop production in different mango cultivars viz.. Banganpalli, Dashehari and Peddarasam at Sangareddy.

Ram and Tripathi, (1993) obsereved that treatment of paclobutrazol in Dashehari mango induced flowering and fruiting in the newly produced shoots of July in response to pruning without any loss in fruit quality. September to November treatment was highly effective in increasing flowering and fruiting besides reducing vegetative growth by 30-35 per cent. The treatment resulted in better flowering, more panicles without affecting length of panicle and production of hermaphrodite flowers and improved fruit set than untreated trees.

Desai (1994) studied the effect of soil application of paclobutrazol at different doses in Alphanso mango at Department of Horticulture, Gujarat Agricultural University, Navsari. They applied three different dose of paclobutrazol @ 4, 8 and 12 g *a.i.* per plant in the month of middle August to middle September. Among different treatments, paclobutrazol @ 8 g *a.i.* per plant significantly increased the flowering, number of fruits per plant and yield kg per plant.

Joshi *et al.* (1998) reported that the best treatment to promote early and regular flowering was noted with paclobutrazol at 7.5 g/tree applied on 31$^{st}$ August to mango cv. Ratna.

Singh and Ram (1998) reported that application of paclobutrazol @ 2.3 g *a.i.* per meter tree canopy diameter on 15$^{th}$ September and 15$^{th}$ October increased pulp: stone ratio and decreased skin weight.

Padhiar (1999) applied cultar between 15$^{th}$ August to 15$^{th}$ September in mango in South Gujarat cvs . Alphonso. Kesar. Rajapuri, Dasehari and Totapuri and observed that cultar (40 ml/tree) over all suppressed vegetative growth in October and November, induced flowering and increased yield . He also observed reduce fruit size and weight at higher rate of paclobutrazol but neither improved nor impaired fruit quality.

Hoda *et al.* (2001) observed that effect of cultar on flowering, fruiting and fruit quality of mango cv. Langra at Department of horticulture, BAC, Sabour during 1997 and 1998. There were seven treatments $T_1$: cultar 500 ppm spray, $T_2$: cultar 1000 ppm spray, $T_3$: cultar 2000 ppm spray, $T_4$: 5 g *a.i* per tree by trunk soil line pour method, $T_5$: 10 g *a.i.* per tree by trunk soil line pour method, $T_6$: Control (water spray) and $T_7$: control (water trunk soil line pour method). They revealed that the soil

application of cultar @ 5 g *a.i.* per tree in the month of September recorded the highest flowering shoots and significantly increased fruit yield in mango cv. Langra.

Murti *et al.* (2001) studied the effects of three annual soil drenching treatments of paclobutrazol (5 and 10 *a.i.* g per tree) given to the mango cv. Alphanso during months of Aug-Sept. and reported that reduction in tree height, mean shoot length and number of dormant shoots, and enhancement in flowering.

Yeshitela *et al.* (2004) treated uniform trees of Tomey Atkins mango at different time and found application of paclobutrazol on 15$^{th}$ October gave the significant result in growth, early flowering, fruiting and yield.

Reddy and Kurian (2008) noted that cumulative and residual effect of paclobutrazol on growth, yield and fruit quality of "Alphanso" mango at Indian Institute of Horticultural Research, Bangalore. They revealed that application of paclobutrazol as a soil drench @ 5 g *a.i.* per plant in seventeen years old Alphanso mango during September significantly increased the flowering, increased the number of fruits per tree and fruit yield (kg per tree).

Rathod (2007) reported that the soil application of paclobutrazol on application of paclobutrazol (20ml cultar per tree) in mid of July controlled the vegetative growth, induced early flowering and early maturity and also increased the number of fruits and yield per tree in all cultivar under study viz., Alphonso, Kesar and Rajapuri.

Tandel and Patel (2011) studied the effect of chemical on growth, yield and economic of mango at Regional Horticultural Research Station, ACHF, NAU, Navsari. They revealed that the number of fruits per tree, fruit yield per tree and per hectare were recorded maximum in all mango varieties drenched with paclobutrazol @ 5 g *a.i.* /tree (cultar 20 ml per tree) in mid-July . On the basis of calculated economics of all three varieties *viz.*, Alphonso, Kesar and Rajapuri the maximum net realization and cost benefit ratio were obtained in paclobutrazol @ 5 g *a.i.* per tree (cultar 20 ml per tree) in mid of July.

Shinde (2015) revealed the effect of paclobutrazol application time on flowering, fruiting and yield of mango (*Mangifera indica* L.) cv. Alphanso. at

Department of Horticulture, College of Agriculture, Dr. B. S. K. K. V, Dapoli and he revealed that soil drenching application of paclobutrazol at second fort night of July caused earlier panicle emergence and highest yield as compared with control.

Pal *et al.* (2017) conducted an experiment where the application of paclobutrazol significantly decreases shoot length than the control plants, clearly indicating the inhibitory effect of cultar on the shoot elongation in mango cv. Himsagar. Among the treated plants, the minimum shoot length was noted in September, and soil applied paclobutrazol was most effective in reducing the shoot elongation at the time of panicle initiation.

**2.1.2 CITRUS**

Smeirat and Qrunfleh (1989) treated sixteen year old "Lisbon" lemon trees with various concentrations of paclobutrazol twice in the season at 500, 1000 and 2000 ppm. Results indicated the significant reduction in shoot length in the spring and the summer. In the spring, paclobutrazol residues from the 1000 and 2000 ppm treatments reduced shoot length.

Medina-Urrutia and Buenrostro-Nava (1995) conducted the investigation on effect of paclobutrazol on vegetative growth, flowering, fruit size, and yield of Mexican lime. All paclobutrazol treatments (soil drench 6o ml per tree cultar during May or June and foliar spray of cultar 30 ml per tree or 1000 ppm in August) increased flowering during the summer fall months. They also found that June soil drenches produced the greatest flowering responses and yield increments as well as reduction in shoot length, shoot girth, vegetative and number of floral shoots.

**2.1.3 PINEAPPLE**

Parssana *et. al.* (2018) concluded that application of paclobutrazol concentration 100 ppm at $8^{th}$ and $9^{th}$ month after planting gave maximum fruit weight with crown (1043.32 g), fruit weight without crown (865.49 g), number of eyes (115.64), fruit yield with crown (51.51 t/ha) and fruit yield without crown (42.73 t/ha), pulp weight (586.43 g), peel weight (197.77 g), TSS (16.74ºBrix), ascorbic acid content (35.88 mg/ 100 g of fruit pulp), total sugar (12.42 %) and reducing sugar (2.35 %) of Mauritius cv. pineapple.

### 2.1.4 APPLE

Bonomo *et al*. (1989) tested paclobutrazol on Golden Delicious apple trees at different concentrations and dates and concluded that it strongly affect shoot growth especially with spring sprays (May) in the year of treatment. Summer sprays (July) had good results in the following year. The overall rate of 2000 ppm paclobutrazol reduced fruit size.

## 2.2 EFFECT OF DOSES OF PECLOBUTRAZOL

### 2.2.1 MANGO

Khader (1991) studied that paclobutrazol reduced plant height, trunk girth, the number of new shoots, internode length and total plant weight, it increased the percentage of flowering. The best results were generally obtained with the 2000 mg/litre rate which is therefore recommended for control of tree growth and early flowering of mango cv. Dashehari.

Vuillaume (1992) conducted experiment on soil application of cultar and noted suppressed vegetative growth. enhanced flowering by 45 days than normal period of flowering while number and weight of fruits were increased in most of the cultivars out of 16 cultivars of mango were tested.

Burondkar and Gunjate (1993) applied Cultar (Paclobutrazol 25 %) either as foliar spray or as soil drench to mango. However soil drenching was more significant, convenient and cost effective. Based on the recommendations, the favourable response was received from mango growers of Konkan region and applied in Alphonso, Ratna, Kesar, Pairi, Goa Mankur, Amrapali, Doodh Penda varieties of mango of varying age under different locations with spectacular success.

Kurian and Iyer (1993) observed that fruit set and retention were higher on Alphanso mango trees, which were given soil drenching with paclobutrazol at 2.5 g *a.i.* per tree but at 10.0 g *a.i.* per tree, it had detrimental effect on fruit retention, probably because of the reduced leaf area resulting from the treatment of paclobutrazol 7.5 g *a.i.*/tree produced highest number of fruits at marble stage, lowest fruit dropping and produced maximum number of fruits (598/ tree) in mango cv. Alphanso.

In the gujarat, the studies conducted at Paria, maximum floweiring and least fruit droppingon tree treated with 30 ml cultar in 5 liters of water as soil drench, however it did not differ significantly from trees applied with cultar 16 ml/ 5 liters of water in Alphanso mango (Anno., 1994).

Bhatt and Kumar (1997) reported that paclobutrazol at 4 g *a.i.*/tree in 5 liters of water, applied as soil drench to 25-year-old mango trees during the rainy season (end of August), recorded the highest flowering (85.82%), fruit set (322.66 fruit/tree) and yield (80.88 kg/tree) values, and lowest fruit drop (17.08 %). Cultar application tended to reduce vegetative growth and advanced flowering by 8 to 9 days compared with the control.

Oosthuyse and Jacobs (1997) reported that the 10 ml of Cultar made up to 100 ml with water (0.25 g a.i. or 2.50 g a.i.) was applied to the soil by making a 60 cm-diameter ring around the trunk of two-year-old Sensation and Tommy Atkins mango trees just prior to the initiation of postharvest flushing. In Sensation, average fruit weight (final fruit size) and tree revenue were increased in direct relation to the rate ofpaclobutrazol (PBZ) applied. Number of fruit retained and tree yield were not affected. In Tommy Atkins, number of fruit retained, average fruit weight, tree yield, and tree revenue were reduced in direct relation to the rate of PBZ applied. The contrasting results between the cultivars appeared to relate to a difference in responsiveness to paclobutrazoI. The retarding effect of paclobutrazol on extension or expansion growth was generally limited in Sensation, but was pronounced in Tommy Atkins.

Salazar-Garcia and Vazquez-Valdivia (1997) reported that the application of higher rate of paclobutrazol increased the earliness of flowering and yield but reduced fruit size and weight.

Tongumpai *et al*. (1997) treated 3 year old mango trees of Nam Dok Mai in Thailand for inducing off season flowering by single and multiple foliar application of paclobutrazol at 1000 ppm and at 2000 ppm. Result indicated that flowering was initiated 29- 41 days earlier in the treated trees than the controls. Two applications of either @1000 ppm or @ 2000 ppm paclobutrazol resulted in the largest number of flowering panicles and the most uniform flowering.

Sarkar *et al.* (1998) observed that the application of 6.0 g *a.i.* paclobutrazol was most effective in suppressing the tree growth, showing different growth contributing characters of mango cv. Kesar. Both paclobutrazol and cycocel increased the flowering to varying degree. Drenching with 3.0 g *a.i.* paclobutrazol was most effective in controlling the tree vigour as well as inducing flowering and fruiting in young trees.

Vijayalakshmi and Srinivasan (1998) studied the effect of soil drenching with paclobutrazol (10 ml/tree) on the induction of flowering in off-year mango cv. Alphonso at Coimbatore and observed that treatment improve flowering, fuit yield and quality charecters in the soil drenching of paclobutrazol having the greatest effect.

Padhiar (1999) applied cultar (40 ml/tree) in mango cvs. Alphanso, Kesar, Rajapuri, Dashehari and Totapuri and observed that cultar over all suppressed vegetative growth in October and November, induced early flowering and fruit yield.

Burondkar *et al.* (2000) conducted an experiment on rejuvenation of old overcrowded Alphanso Mango orchard with pruning and use of Paclobutrazol at Konkan Krishi Vidyapeeth, Dapoli. The results regarding the percentage of flowering, indicated that application of 10 g *a.i.* of PBZ numerically recorded the maximum flowering (85.71%) as compared to control plants (8.59 %). It was also observed that more fruit set per panicle for two years pooled in paclobutrazol applied trees (10.52 to 12.38) over the control (8.17). All the pruned trees with application PBZ showed higher yields (300 to 429 fruits; 69.2 to 96.6 kg per trees) over the untreated control (34 fruits; 8.1 kg per trees). During the third year, when PBZ was not applied, effect of only two higher doses 10.0 g (278 fruits ; 64.5 kg) followed by 7.5 g (191 fruits ; 450 kg) recorded significantly higher yield over control, rest treatment were at par with control.

Kurian *et al.* (2001) found that the soil drenched with paclobutrazol at 0.0, 2.5, or 7.5 g a.i. per tree. In each paclobutrazol-treated tree, photosynthate and metabolite translocation to 30 leaves with a single fruit was inhibited by girdling the branch (1 cm wide ring of bark) at a uniform distance from the fruit. Girdling was conducted when Dashehari fruits were 4.9+or-0.7 cm long and weighed 27.9+or-8.5 g, and when Alphonso fruits were 4.0+or-1.0 cm long and weighed 32.9+or-7.5 g. Twenty-eight

fruits on ungirdled shoots of trees not treated with paclobutrazol served as the control. However, the weight of fruits of girdled trees treated with 2.5 and 7.5 g *a.i.* paclobutrazol was on a par with that of the control. Paclobutrazol appeared to favourably alter the source-sink relationship of mango to support fruit growth with lower leaf number and area.

Earliness in flower initiation was noted with the treatment of paclobutrazol 8 ml/tree in mango cv. Alphonso (Patel *et al.*, 2000).

Nartvaranant *et al.* (2000) reported that the soil drenching with paclobutrazol was more effective for the induction of flowering than foliar application. The rate of paclobutrazol application depends on the size of tree canopy as well as on cultivar. For most cultivars, the rate of paclobutrazol applied is generally determined by multiplying the diameter of tree canopy (expressed in meters) with 1-1.5 g *a.i.* of paclobutrazol. At 120 days after the application of paclobutrazol, 0.5 % thiourea was sprayed to the tree to induce bud break. The earliness in flower initiation was noted with the treatment of paclobutrazol 8 g *a.i.* per tree in mango cv. Alphanso.

Singh (2000) reported that soil application of cultar promoted flowering, along with cauliflory and axillary flowering in Kent mango, recording a height of (5.1cm), followed by Haden (11.0cm) and Vandyke (15.0cm).

Anbu *et al.* (2001) reported that the soil drenching of 5 ml paclobutrazol 90 days before bud break recorded the maximum number of fruit and fruits yield/tree.

Mendonca *et al.* (2001) reported that the greatest flowering (81.75%) and number of fruits (86) were observed with application of 2 % calcium nitrate + 1500 mg PBZ/litre and 3 % calcium nitrate + 1500 mg PBZ/litre, respectively. No significant differences were observed among the chemicals in terms of production in mango cv. Tommy Atkins.

Tahir *et al.* (2002) noted that vegetative growth was reduced by paclobutrazol and thus intensity of flushing was minimized on treated plants after application. Paclobutrazol was found more effective in which least number of growth flushes was observed. As a result of decreased number of flushes, the production of vegetative

flush was also minimized. The paclobutrazol showed the effect on growth and flowering in Alphanso, Dashehari and Rajapuri mango tree.

Cardenas and Rojas (2003) observed that paclobutrazol inhibited vegetative growth and stimulated flower development in Tommy Atkins mango. Flowering was initiated six weeks earlier than under normal conditions.

Mendonca *et al.* (2003) studied the effect of paclobutrazol, potassium nitrate and ethephon on the flower induction in mango. They observed that application of paclobutrazol at 1500 mg/l caused the highest reduction in the growth of the crop, where as potassium nitrate and ethephon had no significant effects on the flower induction parameter.

Sanjay and Jayant (2003) conducted study on the effect of cultar on mango cv . Dashehari and revealed that cultar applied either by spraying (500, 1000 or 2000 ppm) or by soil line pour method (5 or 10 g *a.i.*/ tree) reduced the length of terminal shoots . They also noted the minimum length of terminal shoots in soil application of cultar 5 g *a.i.*/ plant which was closely followed by so il application of cultar 10 g *a.i.*/ plant. Further, they observed that cultar treatment induced profuse flowering and higher production over control.

Winston (2004) concluded that paclobutrazol 8 g *a.i./* tree, applied as a single yearly collar drench, significantly reduced length of vegetative growth in mango. Yield increased was due to fruit numbers rather than size. Rates of paclobutrazol 4 ml *a.i./* tree appeared the best application rate given the prevailing soil type, climatic conditions, and tree size and age. Paclobutrazol was tried not only on aged trees but on the younger plants of 2 to 5 years of age in mango cv. Kensington Pride.

Yeshitela *et al.* (2004) treated uniform trees of Tommy Atkins mango with paclobutrazol (0, 2.75, 5.50, and 8.25 g *a.i.*/ tree). The result showed that application of paclobutrazol at rates of 5.50 and 8.25 g *a.i./* tree both as a soil drench and spray application were effective in suppressing vegetative growth.

An experiment was conducted in Brazil to study the effect of paclobutrazol by Mouca *et al.* (2005) and they observed that soil application of paclobutrazol at the rate of 0.5, 1.0, 1.5, and 2.0 g *a.i./* tree promoted flowering in mango trees in any season

of the year under tropical semi arid conditions while paclobutrazol was inefficient as a growth regulator when applied as foliar spray (500 and 1000 ppm).

Patil and Talathi (2005) noted that application of 5g of paclobutrazol through soil enabled to induce early flowering over control in mango cv. Parbhani Bhushan.

Benjawan *et al.* (2006) studied the effect of paclobutrazol (PBZ) on flower and fruit development, fruit yield and quality of Kaew mango *(Mangifera indicci* L.) at Chaiyaphum Province North-East Thailand. Five rates of paclobutrazol were used, *i.e.,* 0, 1000, 3000, 5000 and 7000 ppm/plant. The experiment consisted of two sets of treatments. *i.e.,* $T_1$ - $T_5$ represent the first set and $T_6$-$T_{10}$ for second set. The results showed that fruit sets were significantly increased with PBZ rates applied. PBZ had a highly significant effect on fruit length but significantly decreased fruit thickness. Fruit yields were significantly increased with PBZ application. The best application rate of PBZ was found with $T_7$ (1000 ppm per plant) gave the highest mango fruit yield of 48,281.25 kg/ ha.

Singh and Ranganath (2006) studied the effectiveness of paclobutrazol for induction of regular and early fruiting and improvement in quality of mango cv. "Banganapalli" grown under tropical and humid climate. Regular, profuse and early bearing were found due to paclobutrazol application. Paclobutrazol 5 ml/litre/tree applied once was found to increase fruiting, fruit set, fruit retention, yield and brought slight improvement in fruit weight and TSS.

Singh and Singh (2006) studied the regulation of shoot growth and flowering in mango cv. Gulabkhas by paclobutrazol at Department of Horticulture, Bihar Agricultural College, Sabour Bhagalpur, Bihar and found that soil application of paclobutrazol @ 5 g *a.i.* per tree was found most effective to induce more number of flowering shoots.

Cardoso *et al.* (2007) studied the effect of different paclobutrazol doses (0.40, 0.80 and 1.20 g *a.i.* per plant) on the flowering of mango cv. Rosa at Universidade Estadual do Sudoeste da Bahia, Estrada do Bem Querer. Among these treatments, soil application of paclobutrazol @ 1.20 g *a.i.* per plant gave the higher percentage of flowering, maximum fruits/ plant with the highest total production as compared to control.

Kumari and Mankar (2008) conducted an experiment to encourage shoot growth and fruiting in Langra mango and they noted that all the applied chemicals Urea 2%, Paclobutrazol (0.5, 7.5, and 10.0 g *a.i.*), NAA (50 and 100 ppm) and ethrel (100 and 200 ppm) inhibited the shoot growth leading to carbohydrate accumulation and improved bearing in mango.

Kumbhar *et al*. (2009) reported that the soil application of paclobutrazol @ 1 and 1.25 g *a.i.*/ tree in the month of July had more effectiveness on induction of flowering and earliness of flowering by 20 to 30 days than the untreated trees and number of fruits/ plant, fruit set and three to four week earlier fruiting in Kesar mango.

Mistry and Patel (2009) studied the impact of heading back + paclobutrazol on rejuvenation of old and overcrowded orchards. The experiment was conducted on 35-40 years old and almost non- bearing trees of cv. Alphanso at AES, Navsari Agricultural University, Paria during eight mango seasons (1994-2002). The treatments were $T_1$: heading back (5-6 m) + PBZ @ 5 g *a.i.* per tree, $T_2$: heading back (5-6 m) + PBZ @ 7.5 g *a.i.* per tree, $T_3$: heading back (5 - 6 m) + PBZ @ 10 g *a.i.* per tree, $T_4$: heading back but no PBZ and $T_5$: no heading back no PBZ applied to collar drenching during second fortnight of August every year. They observed that heading backed old (35-40 years) "Alphanso" mango orchard + application of PBZ @7.5 g *a.i.* per tree was found more beneficial for earliness in flowering and higher fruit yield.

Mouco *et al.* (2010) studied the effect of foliar applied growth regulators prohexadione-Ca, trinexapac-ethyl and chlormequat chloride in mango cultivar Kent as regard to their efficiency for blossom management in order to allow off seasonmango production. They concluded that prohexadione-Ca and chlormequat chloride induced a 15-day early harvest, while paclobutrazol (soil-drench), alone or combined with prohexadione-Ca allow harvesting 25 days in advance when compared to trinexapac-ethyl and control trees.

Nafeez *et al.,* (2010) reported that the soil drenching with paclobutrazol at the rates of 8, 10, and 12 g a.i. suppressed the vegetative growth, canopy volume, and flush length of reproductive shoots, fruit setting, panicle length as compared to control in mango.

Jasmine *et al.* (2011) revealed the influence of paclobutrazol on "off" season flowering of mango and also to standardize the doze, time and application. The results suggested a positive effect of treatment 3 ml/m diameter of tree canopy applied during May which recording highest mean number of inflorescences/ tree (28.83), longer inflorescence (29.38 cm), maximum number of fruits/ tree (33.00), highest yield/ plant (9.92 kg) and an average fruit weight of (275.35g).

Sarker and Rahim (2012) observed that effect of paclobutrazol in manipulating the harvesting time, increasing yield and quality in mango (*Mangifera indica* L.) cv. Bari Aam-3 (Amrapali) plants at the BAU Germplasm Centre, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. Soil drench application of paclobutrazol at 10000 ppm and 7500 ppm were more effective in suppressing vegetative growth *i.e.* terminal shoot length, number of leaves and leaf area and earlier panicle emergence caused by 19 days as well as harvesting by 15 days compared to control. Paclobutrazol at 7500 ppm produced the highest number of fruits as well as yield per plant and also resulted in higher edible portion, lower stone pulp ratio and peel pulp ratio, longer shelf life, higher TSS, increased vitamin C, lower titratable acidity, higher dry matter, reducing, non-reducing and total sugar contents as compared to control plants. The present results suggested that the application of paclobutrazol at 7500 ppm enhances yield and quality in mango.

Reddy *at al.* (2014) reported that soil drenching of paclobutrazol 3 ml/ l increases fruit weight (266.09 g), TSS ($13.51^0$B), total sugars (91.79 mg/ g), reducing sugars (69.07 mg/ g) and non- reducing sugars (22.79 mg/ g) as compaire to control of mango cv. Totapuri.

Narvariya *et al.* (2014) studied the response of cultar on growth, flowering and yield behaviour of mango cv. Dashehari at the Horticultural Research Centre, Patharchatta, G. B. Pant University of Agriculture and Technology, Pantnagar during 2010- 11. They applied seven levels of cultar as soil drench @ 15, 20, 25, 30, 35 and 60 ml/ tree and control (without any treatment) in September, 2010. The maximum reduction in vegetative growth parameters and the minimum duration of flowering period were recorded under cultar 60 ml per tree followed by cultar 35 ml and 30 ml per tree. The maximum flowering with more hermaphrodite flowers, fruit set/

panicle, fruit retention, number of fruits, fruit size and fruit yield/ tree were recorded in 30 ml cultar treated trees.

Srilatha *et al.* (2015) studied the pruning and paclobutrazol induced vigour, flowering and hormonal changes in mango. The different treatment combinations were $T_1$: pruning of current season's growth + PBZ application @ 3 ml/m canopy diameter, $T_2$: pruning of current seasons growth, $T_3$: pruning of previous seasons growth + PBZ application @ 3 ml/m canopy diameter, $T_4$: pruning of previous seasons growth, $T_5$: no pruning and no PBZ application (control). Results reviled that the morphological attributes like plant height, trunk girth and canopy spread were significantly reduced by pruning alone in cv. Raspuri and Dashehari. $T_1$ treatment recorded lesser plant height (62, 52 and 61.5%), lesser trunk girth (50.2, 27.3 and 35.3%) and lesser canopy spread (51.5, 45.8 and 35.3%) in the cvs. Raspuri, Dashehari and Amrapali, respectively followed by $T_5$ treatment when compared with control ($T_6$).

Patel *et al.* (2016) revieled that the On the bases of pooled data, treatment $T_6$- Paclobutrazol 23% W/W SC @ 9.2 g *a.i.*/tree as soil drench (i.e. 40 ml/tree) produced earlier flowers with respect to panicle emergence, full bloom and total days for fruit harvesting from the date of treatments given. Maximum number of fruits at pea stage, marble stage and harvesting stage as well as highest fruit number and yield was noted with treatment $T_6$. Average fruit weight was also higher in $T_6$ but it was at par with $T_1$ – untreated check. On the basis of economics, maximum net realization and BCR, treatment $T_6$- Paclobutrazol 23% W/W @ 9.2 g *a.i.*/tree as soil drench (i.e. 40 ml/tree) was found better than other treatments in mango cv. Alphanso.

Chaudhari (2017) concluded that soil application of paclobutrazol @ 2.50 g *a.i.*/ tree with foliar spray of $KNO_3$ @ 1% was superior in fruit retention at pea stage, marble stage and at harvest per panicle, panicle breath, number of fruits per tree, fruit yield, fruit weight, fruit length, fruit volume, shelf life and improving the quality parameters like maximum TSS, total sugar and non reducing sugar of mango cv. Sonpari.

Golla *et al.* (2017) recorded application of paclobutrazol 3 ml/ m canopy of tree alone increases percent flowering (25% over control) panicle length, highest

fruits per panicle at the time of full bloom stage, and yield (42.17% over control) of mango cv. Banganapalli.

Subbaiah *et al.* (2017) noticed that soil drenching of PBZ 4 ml/$m^2$ of tree canopy required fewer days to full bloom, increase panicle length, hermaphrodite flower and PBZ 4 ml/$m^2$ + NAA 25 ppm increases more number of fruit per tree, yield per tree and fruit weight of mango cv. Banganapalli.

Kumar *et al.* (2019) revealed that paclobutrazol was applied as soil drench around the tree trunk @ 15ml, 20ml, 25ml, 30ml, 35ml, 60ml and 30ml (ES)/ tree along with control. There was significant variations observed in growth, flowering, fruiting, yield and quality attributes due to different doses of paclobutrazol. Treatment $T_4$ (paclobutrazol 30ml/tree) was found superior with respect to yield and quality parameters. It was found to reduce vegetative growth and increase flowering, fruit set, fruit retention, yield attributes, TSS, sugars and ascorbic acid. Therefore, it is finally recommended that paclobutrazol @ 30 ml/ tree should be applied for getting maximum fruit yield without affecting the fruit quality of mango cv. Alphanso.

**2.2.2 GUAVA**

Jain and Dashora (2007) examined a two season study on response of paclobutrazol in guava cv. Sardar. Paclobutrazol showed significant effect on fruit set in both rainy and winter season crops of guava. In the first season (rainy season) it was recorded the highest fruit set (56.89%) with the application of paclobutrazol at the rate 500 ppm in treated plants followed by 51.07% with the same concentration. In the next season (winter season) cultar enhanced fruit set was recorded maximum with the application of paclobutrazol at the rate 500 ppm (71.66%) followed by 70.84% in paclobutrazol applied at the rate 1000 ppm treated plants, while the minimum fruit set (65.96%) was found in control.

Brarr (2010) conducted a study during 2002-03 and 2003-04 on effect of different concentration of Paclobutrazol i.e., 250 and 500 ppm with tnacontanol @ 5 and 10 ppm on 10 year old guava trees cv. Sardar. The application of paclobutrazol reduced the vegetative growth and increased flowering, fruit set and yield of winter season crop of guava. The minimum increment in shoot length (15.95%) was recorded with the application of paclobutrazol @ 500 ppm then the control.

### 2.2.3 JAMUN

Hedge *et al.* (2018) reported that application of PBZ at 3.0 g *a.i.*/ plant gave the less increment in plant height and canopy spread in N-S and E-W direction, 2.5 g a.i/ plant resulted in highest number of panicles per plant, number of flowers per panicle and length of flowering panicle and PBZ at 1.5 g *a.i.*/ plant resulted in highest number of new flushes per plant which ultimately led to highest fruit number and fruit yield per plant of six year old grafted plant of jamun cv. Chintamani.

### 2.2.4 APPLE

Pant and Kumar (2004) found that soil applied paclobutrazol @ 1000 mg/ l increased the number of fruit per spurs, flowering percentage and yield in 'Red Delicious' apple. They also estimated maximum fruit spurs and flower per branch by the application of Paclobutrazol at the rate 1500 mg/ l.

### 2.2.5 CHERRY

Edgerton (1986) concluded that paclobutrazol applications both soil and foliar sprays on sweet cherry reduced shoot growth the first year and increased flowering and fruiting the following year. In sweet cherry, the increased yield on treated trees with the large increase in flowers initiated on the spurs and shoots.

Stan *et al*. (1989) revealed that soil and foliar applications of paclobutrazol to high density plantings of sweet cherry and plum reduced vegetative growth for 2–3 years after treatment, enhanced flower bud formation and fruit set. Fruit yield per unit of canopy volume was increased up to five times in sweet cherry depending on concentration, method and time of application.

### 2.4.6 PEAR

Rai and Bist (1992) observed that the application of 125 and 250 ppm paclobutrazol (PP 333) by trunk soil line pour (TSLP) given once at late dormancy, or by three sequential foliar sprays (FS) given at petal fall and after 3 and 6 weeks, reduced most of the growth characteristics and increased fruit yield in oriental pear cultivar 'Gola' trees growing in the subtropical region of Uttar Pradesh. TSLP was superior to the FS method. Application of 1 I of 250 ppm PP 333 per tree by TSLP

was most effective in reducing tree growth and increasing the number of spurs and yield.

**2.4.7 PECAN**

Casper and Taylor (1989) observed that application of paclobutrazol significantly reduced vegetative growth. Increased flowering and yield without much affecting the fruit size , weight and quality in pecan.

**2.2.8 PLUM**

Webster (1990) compared paclobutrazol in relation to growth and cropping of three plum cultivars (Opal, Cambridge Gage and River's Early Prolific) by soil drench (1.6, 0.8 and 0.4 g a.i. tree) and foliar spray method (1500 and 750 mg/l). They showed that when paclobutrazol applied to the soil beneath to European plum trees prior to bud break in early spring significantly reduced mean extension shoot length. In the season of treatment, growth inhibition was apparent earlier on the soil treated trees.

**2.2.9 PEACH**

Edgerton (1986) concluded that paclobutrazol applications both soil and foliar sprays on peach reduced shoot growth the first year and increased flowering and fruiting the following year. The increased yield with 'Redhaven' peach appears to be a composite of increased flower bud density, improved flower bud survival during the dormant season, and increased fruit size at harvest.

Stan *et al*. (1989) revealed that soil and foliar applications of paclobutrazol to high density plantings of peach reduced vegetative growth for 2–3 years after treatment, enhanced flower bud formation and fruit set. Fruit yield per unit of canopy volume was increased up to twice in peach depending on concentration, method and time of application.

**2.2.10 LITCHI**

Lal *et al.* (2000) stated that soil application of cultar (paclobutrazol) significantly reduced shoot growth as compared to the control which resulted in

profuse flowering, increased fruit set and yield of 'Rose Scented' litchi. They also found the application of paclobutrazol @ 4 g *a.i.*/tree improved flowering shoot as well as duration of flowering by the soil application method.

Bhutia *et al.* (2017) obsereved that the maximum panicle length (34.85 cm), fruit weight (20.20 g), pulp weight (13.13 g) and highest fruit length (3.87 cm) were recorded with the application of paclobutrazol @ 2.5 ml/tree as well as highest yield (4158.49 number/ tree and 7.89 t/ha.) with the application of paclobutrazol @ 12 ml/ tree by the soil application method. Whereas, maximum fruit/ penicle (40.10 and 40.06) was noted under 2.5 ml/ tree as well as 5 ml/ tree as compaired to control (38.60) in litchi.

Pandey *et al.* (2017) recorded that the soil application of paclobutrazol @ 3.0 g tree recorded the maximum number of fruit/ penicle (22.00) followed by 2.0 g/ tree (18.00 fruit/ penicle), while minimum fruit/ penicle (12.00) was noted under control. treatment by the trunk soil line pour method (TSLP) in litchi.

### 2.2.11 CASHEW

Meena *et al.* (2018) the influence of Paclobutrazol (PBZ) on flowering, fruiting and yield of cashew cultivar ullal- 3. The various doses of paclobutrazol *i.e.* 1.0, 2.0 and 3.0 g *a.i.*, per plant was applied as soil drench annually, biennially and once in three years in the month of October before vegetative flushing of plants. The application of paclobutrazol @ 2.0 g *a.i* per plant found effective in improving flowering and fruiting parameters of cashew. The average yield of treated plants ranged from 0.76 kg to 1.13 g/plant while, in untreated plants nut yield of 0.67 to 0.73 kg per plant.

## 2.3 INTERACTION EEFECT OF TIME AND DOSE OF PACLOBUTRAZOL

### 2.3.1 MANGO

Shinde *et al.* (2000) studied the different doses of paclobutrazol $PP_{333}$ (0.75 and 1.25 g *a.i.* per m applied as cultar at 3 and 5 ml/m) which were applied on 25-year-old Alphanso mango trees at Regional Fruit Research Station, Vengurle and they applied soil drenching of $PP_{333}$ 60 days before bud break (15 September), 90 days

before bud break (15 August) and 120 days before bud break (15 July). Results revealed that, both rates of paclobutrazol applied 90 to 120 days before bud break significantly increased flowering (68.48-80.60%) and increased fruit yield (92.82-117.87 kg/tree) as compared to control (30.03 kg /tree).

# CHAPTER: III

## MATERIALS AND METHODS

The details of materials used and techniques adopted during the course of investigation on "Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruitng, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" is described in this chapter.

### 3.1 EXPERIMENTAL SITE

#### 3.1.1 Location of experimental field

The research work was carried out at Fruit Research Station, Sakkarbaug, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh falls under South Saurashtra Agro- climatic Zone during the year 2019-2020 and 2020- 2021.

Junagadh is situated at 21.5°N latitude and 70.5°E longitude with an altitude of 60 meters above MSL on the western side at the foot hill of mountain Girnar sierra (Gujarat).

#### 3.1.2 Site of laboratory work

Physical and Biochemical parameters were measured at laboratory of Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh.

#### 3.1.3 Climate and weather

Climate is typically subtropical, characterized by fairly cool and dry winter, hot and dry summer and warm and moderately humid monsoon. The rainy season commences by third week of June and ends in September. July and August are the months of heavy precipitation. Winter sets in the month of November and continues till the month of February. December and January are the coldest months of winter.

Summer commence in the second fortnight of February and ends in the middle of June. April and May are the hottest months.

The weekly average weather data during the period of experiment recorded at the Agro-Meteorological Observatory, located at Instructional Farm, Junagadh Agricultural University, Junagadh are presented in Appendix-I and II and also graphically depicted in Fig. 3.1 and 3.2, respectively.

## 3.2 EXPERIMENTAL MATERIALS

The experimental material consisted of 12 year old grafted trees of Kesar cultivar of mango. These trees are spaced at 10 × 10 m. almost uniform size and vigour trees were selected for experiment.

All the experimental trees were uniformly fed and maintained in respect of irrigation and plant protection measures during the period of investigation.

## 3.3 TREATMENT MATERIALS

Mango variety Kesar were chosen for present study at Fruit Research Station, Sakkar baug, Junagadh Agricultural University, Junagadh. Fully grown healthy, free from diseases and pests, mature and bearing trees of Kesar mango variety of about 10 years old were selected from the orchard. The trees were erect, medium in size and shoots are medium to thick with spreading nature. Utmost care was taken while selecting the healthy and optimum productive trees. During the course of study, all the trees received uniform cultural management practices. Descriptions of mango cultivar Kesar are as follows.

### 3.3.1 Kesar

It is the most important commercial variety not only for this region, but emerging as one of the leading variety of Gujarat. Kesar is chance selection from "Salebhai ni Amadi", the indigenous variety. Kesar is the only variety which is grown under systematic orchards in Saurashtra region and it also get geographical indication from this region with GI No. 185. It posses pleasant characteristics like medium sized (3 to 4 fruits per kg) fruit, oblong in shape with an attractive light

apricot-yellow colour, saffron coloured pulp, sweet taste & good sugar/acid blend, fibreless pulp, small & flat stone, etc.

## 3.4 EXPERIMENTAL DETAILS

### 3.4.1 Experimental information

| | | | |
|---|---|---|---|
| **3.4.1.1** | **Experimental site / Location** | **:** | Fruit Research Station<br>Sakkar Baugh<br>Department of Horticulture<br>Junagadh Agricultural University<br>Junagadh |
| **3.4.1.2** | **Year of Experiment** | **:** | 2019-20 and 2020-21 |
| **3.4.1.3** | **Crop name & Variety** | **:** | Mango cv. Kesar |
| **3.4.1.4** | **Age of orchard** | **:** | 12 years old |
| **3.4.1.5** | **Spacing** | **:** | 6 X 6 m |
| **3.4.1.6** | **Experimental design** | **:** | Randomized Block Design (RBD) with factorial concept |
| **3.4.1.7** | **Number of factors** | **:** | Factor A - Time of soil application of Paclobutrazol (S)<br>Factor B - Dose of soil application of Paclobutrazol (D) |
| **3.4.1.8** | **Number of treatments** | **:** | 12 (Twelve) |
| **3.4.1.9** | **Number of replications** | **:** | 3 (Three) |
| **3.4.1.10** | **Number of plant per treatment** | **:** | 1 (One) |
| **3.4.1.11** | **Total number of plants** | **:** | 36 |

## 3.5 TREATMENT DETAILS

### 3.5.1 FACTOR A (Time of soil application of Paclobutrazol)

**1.** $S_1$: 15$^{th}$ July

**2.** $S_2$: 1$^{st}$ August

**3.** $S_3$: 15$^{th}$ August

### 3.5.2 FACTOR B (Dose of soil application of Paclobutrazol)

**1.** $D_1$: 5 g *a.i*/ tree

**2.** $D_2$: 8.5 g *a.i*/ tree

**3.** $D_3$: 11.5 g *a.i*/ tree

**4.** $D_4$: 14.5 g *a.i*/ tree

Thus, the experiment was composed of twelve combinations under as given below:

| Treatment code | Particulars of the Treatment |
|---|---|
| $S_1D_1$ | 15$^{th}$ July X 5 g *a.i.*/ tree |
| $S_1D_2$ | 15$^{th}$ July X 8.5 g *a.i.*/ tree |
| $S_1D_3$ | 15$^{th}$ July X 11.5 g *a.i.*/ tree |
| $S_1D_4$ | 15$^{th}$ July X 14.5 g *a.i.*/ tree |
| $S_2D_1$ | 1$^{st}$ August X 5 g *a.i.*/ tree |
| $S_2D_2$ | 1$^{st}$ August X 8.5 g *a.i.*/ tree |
| $S_2D_3$ | 1$^{st}$ August X 11.5 g *a.i.*/ tree |
| $S_2D_4$ | 1$^{st}$ August X 14.5 g *a.i.*/ tree |
| $S_3D_1$ | 15$^{th}$ August X 5 g *a.i.*/ tree |
| $S_3D_2$ | 15$^{th}$ August X 8.5 g *a.i.*/ tree |
| $S_3D_3$ | 15$^{th}$ August X 11.5 g *a.i.*/ tree |
| $S_3D_4$ | 15$^{th}$ August X 14.5 g *a.i.*/ tree |

### 3.5.3 Experimental plot and layout

The site of experimental plot was on medium black soil. Grafted Kesar mango plants are shown by distance 6 × 6 m. The plants were twelve years old. The experimental lay out is mantion in Fig. 3.3

## 3.6 PREPARATION OF SOLUTION AND APPLICATION METHOD

The application of paclobutrazol to soil as a drench around the tree trunk (collar drench) is the most effective method, as it ensures proper uptake by the tree. Paclobutrazol (PBZ) was applied as single soil application. The required quantity of paclobutrazol 23% active ingredient was dissolved in 20 liters of water and solution was poured in the ring 1 m from tree trunk.

## 3.7 CULTURAL OPERATION

### 3.7.1 Weeding

Hand weeding was done as and when required in the orchard.

### 3.7.2 Interculturing

Interculturing was done by power tiller as well as with the help of "Kudali" and then basin was prepared.

### 3.7.3 Manures and Fertilizers

Well rotten Farm Yard Manure was applied @ 100 kg/tree. Chemical fertilizers were applied to the tune of 700: 200: 500 N-P-K grams per tree. The manures and fertilizer were applied by preparing ring 45 to 90 cm away from the main trunk up to periphery of the tree and incorporated. Nitrogen was applied in the form of ammonium sulphate, phosphorus in the form of single super phosphate and potash in the form of muriate of potash. Half dose of nitrogen, full dose of phosphorus and potash were applied at the time of onset of monsoon by preparing a ring of one meter diameter as basal dose during July. Remaining dose of nitrogen was applied when fruits attain mustard size (February).

### 3.7.4 Irrigation

First irrigation was applied to the mango plants when fruits attained mustard size. Before the first irrigation withholding of irrigation water was done since withdrawal of monsoon. After the first irrigation, trees were irrigated as and when required at 8-10 days interval.

### 3.7.5 Harvesting

The mango fruits were harvested when the skin of fruit shows powdery shining with small white dots on it. Another maturity indices taken in to considerations was when 2- 3 fruits fallen down on ground naturally (known as sankh padvi in vernacular language and 'Tapka' in Hindi) or fruit show fullness of shoulder. The fruits don't mature and ripe at the same time. So, it requires frequent hand pickings. The final yield per tree in kilogram was obtained by sum up the yield of all the pickings.

## 3.8 OBSERVATIONS RECORDED

Two inflorescences were selected and tagged on each direction (North- South- East- West) which was arisen from the earlier tagged twigs. The tagging was done on each tree. So, total twenty inflorescences were selected per tree and tagged. All the further observations of flowering and fruiting parameters were recorded from the tagged inflorescences.

### 3.8.1 Growth and flowering parameters

#### 3.8.1.1 Number of shoots per terminal

Twenty terminals, five from each direction were tagged per tree for recording observations on emergence of new shoots per terminal and counting was done in month of October- November before flowering and average value was worked out.

#### 3.8.1.2 Length of new shoot (cm)

The length of new shoots emerged from the twenty tagged terminal was measured in centimeter with the help of scale in November before flowering from the point of emergence to the apex of the shoots and average value was worked out.

#### 3.8.1.3 Days to flower bud initiation

During the period of flowering the experimental trees were regularly visited and when two or three newly emerging flowering bud appeared on trees, was considered as date of Initiation of flowering bud. For the calculation of days taken to f lowering bud initiation, it was counted from cutoff date 1$^{st}$ October to date of

appearance of two or three newly emerging flowering bud and average value was worked out.

**3.8.1.4 Days to 50% flowering**

Date of 50% flowering was recorded when 50 % of the panicle emerged had fully expanded. For the calculation of days taken to 50% flowering from flower bud initiation, it was counted from cutoff date 1st October to date of appearance of 50% flowering and average value was worked out.

**3.8.1.5 Days to full bloom**

Date of full bloom was recorded when most of the panicles emerged had fully expanded. For the calculation of days taken to full bloom stage from flower bud initiation, it was counted from cutoff date 1st October to date of appearance of full bloom stage and average value was worked out.

**3.8.2 Yield and yield attributing parameters**

**3.8.2.1 Number of fruit per shoot at pea stage**

Five panicles per each direction of a tree were randomly tagged for counting the fruit set at pea size per panicles at the time of full bloom. When the fruit set and attained pea size, they were counted and average values were worked out for recording fruit set per panicle.

**3.8.2.2 Number of fruit per shoot at marble stage**

The panicles which were tagged for recording the fruit at pea size, those fruits were subsequently counted at marble stage and their average values were worked out.

**3.8.2.3 Fruit retention (%) per shoot**

Fruit retention at harvest stage (%) of mango was calculated as follows,

$$\text{Fruit retention (\%)} = \frac{\text{No. of fruit at marble stage} - \text{No. of fruit dropped at harvest stage}}{\text{No. of fruit at marble stage}} \times 100$$

**3.8.2.4 Fruit drop (%) per shoot**

At the marble stage, the numbers of fruits on each labelled panicle were counted. The numbers of fruit retention on these labelled panicles were once again recorded at harvesting. Fruit drop per panicle was calculated by subtracting the number of fruits at harvest from the number of fruits at marble stage.

$$\text{Fruit drop (\%)} = \frac{\text{No. of fruit at marble stage} - \text{No. of fruit at harvest stage}}{\text{No. of fruit at marble stage}} \text{ X } 100$$

**3.8.2.5 Days to fruit maturity from**

Date was noted when the fruits were harvested at full maturity but not ripen. For the calculation of days taken to fruit maturity from cutoff date 1st November, it was counted from cutoff date 1st October to date of fruit mature and average value was worked out.

**3.8.2.6 Number of fruits per tree**

The numbers of fruits were counted treatment wise at harvest. The result was expressed as number of fruits per tree.

**3.8.2.7 fruit yield (kg/ tree)**

For recording yield, total produce per tree was weighted and recorded in kilogram.

**3.8.2.8 Fruit yield (t/ha)**

The yield of fruits in tons per hectare was calculated by multiplying the yield of fruit per plant with the number of plants per hectare and divided by 1000.

$$\text{Yield in t/ha} = \frac{\text{Yield (kg/plant)} \times \text{Number of plants/ha.}}{10000}$$

### 3.8.3 Quality parameters

Harvesting of mango was done on the basis of development of fruit size in three picking and random sample of fruit were taken from first picking and utilized for treatment wise qualitative estimations. Fruit were allowed to ripen at room temperature.

#### 3.8.3.1 Total soluble solids (TSS) ($^{O}$Brix)

Total soluble solids were measured by using Erma hand refractrometer (range 0-32$^{0}$Brix). A drop of homogenized pulp was used to measure the TSS and values were expressed as °Brix.

#### 3.8.3.2 Titrable Acidity (%)

The method described by Rangana (1986) was adopted. For the estimation of acidity 10g of homogenized pulp was transferred to 100 ml volumetric flask and the volume was made up to 100 ml with distilled water. The suspension was filtered through Watman No.1 filter paper and the filtrate was used for titration. Five ml of the aliquot was taken from the filtrate and titrated against standard 0.1N NaOH using phenolphthalein indicator. The titrable acidity was expressed as percentage citric acid equivalent adopting the following formula.

$$\text{Acidity \%} = \frac{\text{Titrate} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Equivalent weight of citric acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{Weight of the sample} \times 1000}$$

#### 3.8.3.3 Reducing sugar (%)

The titrimetric method of Lane and Eynon described by Ranganna (1986) was adopted for estimation of reducing sugars. The method is based on the principle that invert sugars or reducing sugars reduces copper in the Fehling's solution to red insoluble cuprous oxide. Sugars in a sample were estimated by determining the volume of unknown sugar solution required to completely reduce a measured volume of Fehling's solution. Before using, the mixture (1:1) of Fehling's solution A and B (5ml of each) was standardized against standard glucose for obtaining glucose equivalent and to arrive at a conversion factor.

**Procedure**

25g of the pulp was taken in a volumetric flask and two milliliters of 45% basic lead acetate solution was added for clarification. After 10 minutes, the solution was deleaded by adding potassium oxalate crystals in excess and the volume was made upto 250ml with distilled water and filtered through Whatman No. 1 filter paper. The filtrate was taken in a burette and titrated against boiling Fehling's mixture (5ml of Fehling's solution A + 5ml of Fehling's solution B) till the blue colour faded. Then few drops of methylene blue indicator (1%) were added and the titration was continued till the contents attained a brick red colour and titrate value was noted. The percentage of reducing sugars was calculated according to the following formula:

$$\text{Reducing sugar (\%)} = \frac{\text{Glucose Eq (0.05)} \times \text{Total volume made up} \times 100}{\text{Titre value} \times \text{Weight of the pulp}}$$

**3.8.3.4 Non- Reducing sugars (%)**

The value of non-reducing sugars was recorded by subtracting the value of reducing sugars from total sugars.

**3.8.3.5 Total sugar (%)**

For estimation of total sugars, the filtrate obtained in the above estimation was used. An aliquot from the filtrate was taken and the one fifth of its volume of hydrochloric acid (1:1) was added and the inversion was carried out at room temperature for 24 hours. Subsequently, the contents were cooled and neutralized with 40 per cent sodium hydroxide using phenolphthalein as an indicator and the final volume was made up to 100ml. The solution was filtered and titration was carried out using filtrate as described for reducing sugars. The total sugars content was expressed as percentage in terms of invert sugars according to the following formula.

$$\text{Total sugars (\%)} = \frac{\text{Glucose Eq of Fehling's Solution (0.05)} \times \text{Total volume made up} \times \text{Volume made up after inversion} \times 100}{\text{Titre value} \times \text{Weight of the pulp} \times \text{Aliquot taken for inversion}}$$

### 3.8.3.5 Pulp skin ratio

From the recorded weight of pulp and skin, the pulp to skin ratio of ripe fruit was calculated according to treatments.

### 3.8.3.6 Shelf life

The shelf life of fruits was noted by keeping the fruits at room temperature and noted the days taken from harvesting up to the appearance of any spoilage symptoms or discoloration.

## 3.9 ECONOMICS

### 3.9.1 Cost of Cultivation (₹ $ha^{-1}$)

In order to evaluate the effectiveness of different treatments and ascertain the most remunerative treatment, the expenses incurred for all the cultivation operations from preparatory tillage to final harvesting including cost of inputs *viz*., paclobutrazol, irrigation, weeding and labour cost etc. applied to each treatment were calculated on the basis of prevailing local charges.

### 3.9.2 Gross Returns (₹ $ha^{-1}$)

The gross realization in terms of rupees per hectare was worked out taking into consideration of fruit yields from each treatment and local market prices.

### 3.9.3 Net Returns (₹ $ha^{-1}$)

A net return of each treatment was calculated by deducting the total cost of cultivation from the gross returns.

The benefit cost ratio (BCR) was calculated on the bases of following formula.

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Total cost of cultivation (₹ ha}^{-1}\text{)}}$$

## 3.10 STATISTICAL ANALYSIS

Statistical analysis of the individual data of various characters studied in the experiment carried out as per Factorial Randomized Block Design (FRBD) through

computer. Analysis of variance worked out by using standard statistical procedures as described by Panse and Sukhatme (1985). Standard error of mean (S.E.m ±), critical difference (C.D.) at 5 per cent probability and coefficient of variance (C.V. %) were also worked out for the interpretation of the results.

# CHAPTER: IV

## EXPERIMENTAL RESULTS

Results of the present experiment entitled "Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruiting, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" is presented in this chapter. The data pertaining to the growth, flowering, fruiting, yield and yield attributes and quality parameters were subjected to statistical analysis for the test of significance of the results. The results are described as here under in the succeeding paragraphs and have been presented tabular form and also graphically wherever felt necessary. The results are discussed as per the following heads.

4.1 Effect on growth parameters

4.2 Effect on flowering parameters

4.3 Effect on fruiting parameters

4.4 Effect on yield and yield attribute parameters

4.5 Effect on quality parameters

4.6 Effect on economics

### 4.1 EFFECT ON GROWTH PARAMETERS

#### 4.1.1 Number of shoots per terminal

##### 4.1.1.1 Effect of time

The data revealed that the variation in number of shoots per terminal was observed non significant of different time of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. However, minimum number of shoots per terminal (1.46, 1.35 and 1.41) was recorded at application of paclobutrazol on 15$^{th}$ July ($S_1$). Whereas, the maximum number of new shoots per terminal (1.57, 1.42 and 1.50) was

noted at application of paclobutrazol on 15th August ($S_3$) during both the year and pooled. The data are presented in Table 4.1

**4.1.1.2 Effect of dose**

The experimental finding shows that different treatment of paclobutrazol dose exerted significant effect on number of new shoots per terminal of mango during the year 2019-20, 2020-21 and in pooled. The minimum number of new shoots per terminal (1.41, 1.27 and 1.34) was observed with a dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$) which was at par with the dose of paclobutrazol @ 11.5 g *a.i.* ($D_3$) during the year 2019- 20, 2020-21 and pooled. The gradual reduction in number of vegetative shoots per terminal was observed against the increase in concentration rate of paclobutrazol. Significantly, the maximum number of new shoots per terminal (1.62, 1.48 and 1.55) was recorded in dose of paclobutrazol @ 5.0 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and in pooled, respectively. The data are presented in Table 4.1

**4.1.1.3 Interaction Effect**

The interaction effect of different application time and dose of paclobutrazol on number of new shoots per terminal were found non significant during the year 2019-20, 2020-21 and pooled.

**4.1.2 Length of new shoot**

**4.1.2.1 Effect of time**

Similarly, the result pertaining to variation in length of new shoot was also found non significant as influenced by different time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. While, minimum length of new shoot (12.75, 12.32 and 12.54 cm) was noted at application of paclobutrazol on 15th July ($S_1$). However, maximum length of new shoot (13.66, 13.16 and 13.41 cm) was recorded at application of paclobutrazol on 15th August ($S_3$) during both the year and pooled. The data are presented in Table 4.2

**Table 4.1: Effect of time and dose of paclobutrazol application on number of new shoots per terminal of mango cv. Kesar**

| Treatments | Number of new shoots per terminal | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 1.46 | 1.35 | 1.41 |
| $S_2$- 1$^{st}$ August | 1.51 | 1.38 | 1.44 |
| $S_3$- 15$^{th}$ August | 1.57 | 1.42 | 1.50 |
| **S.Em.±** | 0.040 | 0.032 | 0.026 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 1.62 | 1.48 | 1.55 |
| $D_2$- 8.5 g *a.i.* | 1.54 | 1.42 | 1.48 |
| $D_3$- 11.5 g *a.i.* | 1.48 | 1.35 | 1.42 |
| $D_4$- 14.5 g *a.i.* | 1.41 | 1.27 | 1.34 |
| **S.Em.±** | 0.046 | 0.037 | 0.030 |
| **C.D. at 5%** | 0.14 | 0.11 | 0.08 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.080 | 0.064 | 0.051 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.021 |
| **C.D. at 5%** | | | 0.06 |
| **Y× S** | | | |
| **S.Em.±** | | | 0.036 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.042 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.073 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 9.21 | 8.01 | 8.69 |

**Table 4.2: Effect of time and dose of paclobutrazol application on length of new shoot of mango cv. Kesar**

| Treatments | Length of new shoot (cm) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 12.75 | 12.32 | 12.54 |
| $S_2$- 1st August | 13.00 | 12.66 | 12.83 |
| $S_3$- 15th August | 13.66 | 13.16 | 13.41 |
| **S.Em.±** | 0.349 | 0.373 | 0.256 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 15.22 | 14.95 | 15.09 |
| $D_2$- 8.5 g *a.i.* | 14.40 | 13.88 | 14.14 |
| $D_3$- 11.5 g *a.i.* | 12.07 | 11.74 | 11.91 |
| $D_4$- 14.5 g *a.i.* | 10.86 | 10.29 | 10.58 |
| **S.Em.±** | 0.403 | 0.431 | 0.295 |
| **C.D. at 5%** | 1.18 | 1.26 | 0.84 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.699 | 0.746 | 0.511 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.209 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.361 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.417 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.723 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 9.21 | 10.17 | 9.69 |

**4.1.2.2 Effect of dose**

The effect of different dose of paclobutrazol on length of new shoot during the year 2019-20, 2020-21 and pooled was differed significantly. The length of new shoot

of mango was significantly reduced by paclobutrazol application, however, the effect was more pronounced in the higher concentrations than the lower concentration. The length of new shoot (10.86, 10.29 and 10.58 cm) was recorded minimum with the dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$). While, maximum length of new shoot (15.22, 14.95 and 15.09 cm) was obtained with the dose of paclobutrazol @ 5 g *a.i.* ($D_1$) during both the years and pooled, respectively. The data are presented in Table 4.2

#### 4.1.2.3 Interaction Effect

Similarly, the interaction effect of time and dose of paclobutrazol application on length of new shoot were also found non significant during the year 2019-20, 2020-21 and pooled.

## 4.2 EFFECT ON FLOWERING PARAMETERS

### 4.2.1 Days to flower bud initiation

The result revealed that days to flower bud initiation was significantly influenced by different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. The data on days to flower bud initiation are presented in Table 4.3 and graphically depicted in Fig 4.1

#### 4.2.1.1 Effect of time

Significantly, minimum days to flower bud initiation (48.00, 49.37 and 48.68) were recorded at application of paclobutrazol on 15$^{th}$ July ($S_1$) during both the year as well as pooled and which was at par with application of paclobutrazol on 1$^{st}$ August ($S_2$) during the year 2020-21. While, maximum days to flower bud initiation (54.75, 56.34 and 55.56) were found at application of paclobutrazol on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled, respectively.

#### 4.2.1.2 Effect of dose

The experimental finding revealed that different dose of paclobutrazol produced significant effect on days to flower bud initiation of mango during the year 2019-20, 2020-21 and in pooled. The minimum days to flower bud initiation (45.17,

46.90 and 46.04) was observed with a dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and in pooled, respectively. While, the maximum days to flower bud initiation (58.04, 58.95 and 58.50) was recorded with dose of paclobutrazol @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.2.1.3 Interaction Effect

Meanwhile, the interaction between time and dose of paclobutrazol application on days to flower bud initiation was failed to give significant effect during both the years and as well as in pooled.

### 4.2.2 Days to 50% flowering

The result found that days to 50% flowering was significantly influenced by different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. The data on days to 50% flowering are presented in Table 4.4 and graphically depicted in Fig 4.2

#### 4.2.2.1 Effect of time

Similarly, effect of time of paclobutrazol application on days to 50% flowering was also found significant during the year 2019-20, 2020-21 and pooled. Minimum days to 50% flowering (62.40, 63.58 and 62.99) were noted at application of paclobutrazol on 15$^{th}$ July ($S_1$) which was at par with paclobutrazol application on 1$^{st}$ August ($S_2$) during both the year and pooled. While, maximum days to 50% flowering (73.73, 74.11 and 73.92) was recorded at application of paclobutrazol on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled.

#### 4.2.2.2 Effect of dose

In case of dose of paclobutrazol, application of different treatment of paclobutrazol dose reported significant effect on days to 50% flowering during the year 2019-20, 2020-21 and in pooled. However, minimum days taken to 50% flowering (61.44, 62.20 and 61.82) were noted in dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$) which was at par with dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) during the year 2019-20. Whereas, maximum days taken to 50% flowering (72.62, 73.25 and

72.93) was recorded in dose of paclobutrazol @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and pooled.

**Table 4.3: Effect of time and dose of paclobutrazol application on days to flower bud initiation of mango cv. Kesar**

| Treatments | Days to flower bud initiation | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 48.00 | 49.37 | 48.68 |
| $S_2$- 1$^{st}$ August | 51.27 | 52.14 | 51.70 |
| $S_3$- 15$^{th}$ August | 54.75 | 56.34 | 55.56 |
| **S.Em.±** | 0.933 | 1.095 | 0.719 |
| **C.D. at 5%** | 2.74 | 3.21 | 2.05 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 58.04 | 58.95 | 58.50 |
| $D_2$- 8.5 g *a.i.* | 53.03 | 53.98 | 53.50 |
| $D_3$- 11.5 g *a.i.* | 49.11 | 50.68 | 48.89 |
| $D_4$- 14.5 g *a.i.* | 45.17 | 46.90 | 46.04 |
| **S.Em.±** | 1.077 | 1.265 | 0.831 |
| **C.D. at 5%** | 3.16 | 3.71 | 2.37 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 1.865 | 2.191 | 1.439 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.587 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 1.017 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 1.175 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 2.035 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 6.29 | 7.21 | 6.78 |

**Table 4.4: Effect of time and dose of paclobutrazol application on days to 50% flowering of mango cv. Kesar**

| Treatments | Days to 50% flowering | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 62.40 | 63.58 | 62.99 |
| $S_2$- 1$^{st}$ August | 66.42 | 67.79 | 67.11 |
| $S_3$- 15$^{th}$ August | 73.73 | 74.11 | 73.92 |
| **S.Em.±** | 1.616 | 1.443 | 1.083 |
| **C.D. at 5%** | 4.74 | 4.23 | 3.09 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 72.62 | 73.25 | 72.93 |
| $D_2$- 8.5 g *a.i.* | 69.92 | 71.05 | 70.48 |
| $D_3$- 11.5 g *a.i.* | 66.10 | 67.49 | 66.79 |
| $D_4$- 14.5 g *a.i.* | 61.44 | 62.20 | 61.82 |
| **S.Em.±** | 1.866 | 1.667 | 1.251 |
| **C.D. at 5%** | 5.47 | 4.89 | 3.57 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 3.232 | 2.887 | 2.167 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.885 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 1.532 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 1.769 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 3.064 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 8.29 | 7.30 | 7.80 |

#### 4.2.2.3 Interaction Effect

Furthermore, the interaction effect of time and dose of paclobutrazol application were found non significant on days to 50% flowering during the year 2019-20, 2020-21 and in pooled.

### 4.2.3 Days to full bloom

The result found that days to full bloom was significantly influenced by different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. The data on days to full bloom are presented in Table 4.5 and graphically depicted in Fig 4.3

#### 4.2.3.1 Effect of time

The result pertaining to variation in days to full bloom was also found significant as influenced by time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. However, minimum days taken to full bloom (73.64, 74.83 and 74.23) were noted at application of paclobutrazol on 15$^{th}$ July ($S_1$) which was at par with application of paclobutrazol on 1$^{st}$ August ($S_2$) during both the year and pooled. Whereas, maximum days to full bloom (81.01, 82.27 and 81.64) were recorded at application of paclobutrazol on 15$^{th}$ August ($S_3$) during both the year and pooled.

#### 4.2.3.2 Effect of dose

Similarly, the experimental finding observed that different dose of paclobutrazol application noted significant effect on days to full bloom during the year 2019-20, 2020-21 and in pooled. Furthermore, a minimum day to full bloom (69.61, 70.90 and 70.26) was noted in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) which was at par with application of paclobutrazol @ 11.5 g *a.i.* ($D_3$) during the year 2019-20 and 2020-21. Whereas, maximum days taken to full bloom from flower bud initiation (84.27, 85.19 and 84.73) was recorded in dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during both the year and pooled.

**Table 4.5: Effect of time and dose of paclobutrazol application on days to full bloom of mango cv. Kesar**

| Treatments | Days to full bloom | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 73.64 | 74.83 | 74.23 |
| $S_2$- 1st August | 75.54 | 76.73 | 76.14 |
| $S_3$- 15th August | 81.01 | 82.27 | 81.64 |
| **S.Em.±** | 1.816 | 1.663 | 1.231 |
| **C.D. at 5%** | 5.33 | 4.88 | 3.51 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 84.27 | 85.19 | 84.73 |
| $D_2$- 8.5 g *a.i.* | 78.91 | 80.06 | 79.49 |
| $D_3$- 11.5 g *a.i.* | 74.14 | 75.61 | 74.88 |
| $D_4$- 14.5 g *a.i.* | 69.61 | 70.90 | 70.26 |
| **S.Em.±** | 2.097 | 1.920 | 1.422 |
| **C.D. at 5%** | 6.15 | 5.63 | 4.05 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 3.633 | 3.326 | 2.463 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 1.005 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 1.741 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 2.011 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 3.483 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 8.20 | 7.39 | 7.80 |

**4.2.3.3 Interaction Effect**

Similarly, the interaction effect of different application time and dose of

paclobutrazol were found non significant on days to full boom during the year 2019-20, 2020-21 and in pooled.

## 4.3 EFFECT ON FRUITING PARAMETERS

### 4.3.1 Number of fruit per shoot at pea stage

The result revealed that number of fruit per shoot at pea stage was significantly influenced by different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. The data on number of fruit set at pea stage are presented in Table 4.6 and graphically depicted in Fig 4.4

#### 4.3.1.1 Effect of time

Significantly, a maximum number of fruit at pea stage (10.16, 10.41 and 10.28) was recorded at application of paclobutrazol on 15$^{th}$ July ($S_1$) and which was at par with application of paclobutrazol on 1$^{st}$ August ($S_2$). While, a minimum number of fruit per shoot at pea stage (9.43, 9.68 and 9.56) was found at application of paclobutrazol on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled, respectively.

#### 4.3.1.2 Effect of dose

The experimental finding shows that different dose of paclobutrazol reported significant effect on number of fruit per shoot at pea stage of mango during the year 2019-20, 2020-21 and in pooled. The maximum number of fruit per shoot at pea stage (10.27, 10.61 and 10.44) was observed with an application of paclobutrazol @ 14.5 g *a.i.* ($D_4$) and which was at par with application of paclobutrazol @ 11.5 g *a.i.* ($D_3$) during the year 2019-20, 2020-21 and in pooled and application of paclobutrazol @ 8.5 g *a.i.* ($D_2$) during the year 2019-20, 2020-21. Significantly, the minimum number of fruit per shoot at pea stage (9.12, 9.61 and 9.37) was recorded in treatment with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.3.1.3 Interaction Effect

Meanwhile, the interaction between different time and dose of paclobutrazol

application on number of fruit per shoot at pea stage was found non significant during both the years and as well as in pooled.

**Table 4.6: Effect of time and dose of paclobutrazol application on number of fruit per shoot at pea stage of mango cv. Kesar**

| Treatments | Number of fruit per shoot at pea stage | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 10.16 | 10.41 | 10.28 |
| $S_2$- 1st August | 9.84 | 10.34 | 10.09 |
| $S_3$- 15th August | 9.43 | 9.68 | 9.56 |
| **S.Em.±** | 0.170 | 0.207 | 0.134 |
| **C.D. at 5%** | 0.50 | 0.61 | 0.38 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 9.12 | 9.61 | 9.37 |
| $D_2$- 8.5 g *a.i.* | 9.77 | 10.05 | 9.91 |
| $D_3$- 11.5 g *a.i.* | 10.09 | 10.31 | 10.20 |
| $D_4$- 14.5 g *a.i.* | 10.27 | 10.61 | 10.44 |
| **S.Em.±** | 0.196 | 0.239 | 0.154 |
| **C.D. at 5%** | 0.58 | 0.70 | 0.44 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.340 | 0.413 | 0.267 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.109 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.189 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.218 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.378 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 6.00 | 7.06 | 6.57 |

### 4.3.2 Number of fruit per shoot at marble stage

The result found that number of fruit per shoot at marble stage was significantly influenced by different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and in pooled. The data on number of fruit set per shoot at marble stage are presented in Table 4.7 and graphically depicted in Fig 4.5

#### 4.3.2.1 Effect of time

Meanwhile, the highest number of fruit per shoot at marble stage (3.81, 3.96 and 3.89) was obtained when the trees were treated on paclobutrazol application on 15$^{th}$ July ($S_1$) which was at par with paclobutrazol application on 1$^{st}$ August ($S_2$) in 2019-20 and 2020-21. While, applied paclobutrazol on 15$^{th}$ August ($S_3$) was recorded lowest number of fruit per shoot at marble stage (3.21, 3.39 and 3.30) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.3.2.2 Effect of dose

Similarly, in case of dose of application of paclobutrazol noted non significant effect on number of fruit per shoot at marble stage during the year 2019-20, 2020-21 and in pooled. However, maximum number of fruit per shoot at marble stage (3.90, 4.03 and 3.97) was noted in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$). Whereas, a minimum number of fruit per shoot at marble stage (4.07, 4.15 and 4.11) was recorded in dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and pooled.

#### 4.3.2.3 Interaction Effect

The interaction effect of all treatments like time and dose of paclobutrazol application combinations on number of fruit per shoot at marble stage were found non significant during the year 2019-20, 2020-21 and pooled.

**Table 4.7: Effect of time and dose of paclobutrazol application on number of fruit per shoot at marble stage of mango cv. Kesar**

| Treatments | Number of fruit per shoot at marble stage | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 3.81 | 3.96 | 3.89 |
| $S_2$- 1$^{st}$ August | 3.59 | 3.71 | 3.65 |
| $S_3$- 15$^{th}$ August | 3.21 | 3.39 | 3.30 |
| **S.Em.±** | 0.076 | 0.086 | 0.058 |
| **C.D. at 5%** | 0.22 | 0.25 | 0.16 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 3.26 | 3.38 | 3.32 |
| $D_2$- 8.5 g *a.i.* | 3.42 | 3.62 | 3.52 |
| $D_3$- 11.5 g *a.i.* | 3.56 | 3.72 | 3.64 |
| $D_4$- 14.5 g *a.i.* | 3.90 | 4.03 | 3.97 |
| **S.Em.±** | 0.088 | 0.100 | 0.067 |
| **C.D. at 5%** | 0.26 | 0.29 | 0.19 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.153 | 0.173 | 0.115 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.047 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.082 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.094 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.163 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 7.49 | 8.12 | 7.83 |

### 4.3.3 Fruit retention percentage per shoot

The variation in fruit retention percentage per shoot was observed significant

due to different treatments like time and dose of paclobutrazol application during the year 2019-20, 2020-21 and pooled which are presented in Table 4.8 and graphically depicted in Fig. 4.6

#### 4.3.3.1 Effect of time

Effect of time of paclobutrazol application on fruit retention percentage per shoot was also found significant as influenced by time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. Similarly, maximum fruit retention percentage per shoot (40.56, 41.83 and 41.19) was noted at application of paclobutrazol on 15$^{th}$ July ($S_1$) which was at par with application of paclobutrazol on 1$^{st}$ August ($S_2$) during the year 2019-20. On the other hand, minimum fruit retention percentage per shoot (37.84, 38.08 and 37.96) was recorded at application of paclobutrazol on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled.

#### 4.3.3.2 Effect of dose

The variation due to different dose of paclobutrazol application was exerted significant effect on fruit retention percentage per shoot during the year 2019-20, 2020-21 and pooled (Table 4.8). The maximum fruit retention percentage per shoot (44.27, 45.02 and 44.65) was observed in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$). Significantly, the minimum fruit retention percentage per shoot (34.29, 34.92 and 34.61) was noted in dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.3.3.3 Interaction Effect

Furthermore, the interaction effect between time and dose of paclobutrazol application was non significant on fruit retention percentage per shoot during the year 2019-20, 2020-21 and pooled.

### 4.3.4 Fruit drop percentage per shoot

Similarly, the variation in fruit drop percentage per shoot was observed significant due to different treatments like time and dose of paclobutrazol application during the year 2019-20, 2020-21 and pooled which are presented in Table 4.9 and graphically depicted in Fig. 4.7

**Table 4.8: Effect of time and dose of paclobutrazol application on fruit retention per cent per shoot of mango cv. Kesar**

| Treatments | Fruit retention (%) per shoot | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 40.56 | 41.83 | 41.19 |
| $S_2$- 1$^{st}$ August | 38.69 | 38.85 | 38.77 |
| $S_3$- 15$^{th}$ August | 37.84 | 38.08 | 37.96 |
| **S.Em.±** | 0.733 | 0.848 | 0.560 |
| **C.D. at 5%** | 2.15 | 2.49 | 1.60 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 34.29 | 34.92 | 34.61 |
| $D_2$- 8.5 g *a.i.* | 36.77 | 37.05 | 36.91 |
| $D_3$- 11.5 g *a.i.* | 40.78 | 41.34 | 41.06 |
| $D_4$- 14.5 g *a.i.* | 44.27 | 45.02 | 44.65 |
| **S.Em.±** | 0.846 | 0.980 | 0.647 |
| **C.D. at 5%** | 2.48 | 2.87 | 1.84 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 1.465 | 1.697 | 1.121 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.458 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.793 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.915 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 1.585 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 6.50 | 7.42 | 6.99 |

**4.3.4.1 Effect of time**

Similarly, the result pertaining to variation in fruit drop percentage per shoot was found significant as influenced by different application time during the year

2019-20, 2020-21 and pooled. However, minimum fruit drop percentage per shoot (59.44, 58.17 and 58.81) was noted at application of paclobutrazol on 15$^{th}$ July ($S_1$) which was at par with application of paclobutrazol on 1$^{st}$ August ($S_2$) during the year 2019-20. Whereas, maximum fruit drop percentage per shoot (62.16, 61.92 and 62.04) was recorded at application of paclobutrazol on 15$^{th}$ August ($S_3$) during both the year and pooled.

**4.3.4.2 Effect of dose**

An appraisal of data (Table 4.9) indicated that treatments exerted their significant consequence on fruit drop percentage per shoot. Significantly, lower fruit drop percentage per shoot (55.73, 54.98 and 55.35) was registered under the dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$). While, dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) was found significantly highest with respect to fruit drop percentage per shoot of mango (65.71, 65.08 and 65.39) during both the years and pooled, respectively.

**4.3.4.3 Interaction Effect**

Meanwhile, the interaction between different application time and dose of paclobutrazol on fruit drop percentage per shoot was also found non significant during both the years and as well as in pooled.

**4.3.5 Days taken to fruit maturity**

The treatments effect of time and dose of paclobutrazol application was also significantly influenced for days taken to fruit maturity of mango during the year 2019-20, 2020-21 and pooled. The days taken to fruit maturity are conferred in Table 4.10 and also designed in Fig.4.8

**4.3.5.1 Effect of time**

Significantly minimum days taken to fruit maturity (194.70, 195.46 and 195.08) was obtained at the paclobutrazol application on 15$^{th}$ July ($S_1$) and it was at par with paclobutrazol application on 1$^{st}$ August ($S_2$) during the year 2019-20, 2020-21 and pooled, respectively. Significantly, maximum days taken to fruit maturity (205.38, 206.10 and 205.74) was noted during paclobutrazol application on 15$^{th}$

August ($S_3$) during the year 2019-20, 2020-21 and pooled, respectively.

**Table 4.9: Effect of time and dose of paclobutrazol application on fruit drop per cent per shoot of mango cv. Kesar**

| Treatments | fruit drop (%) per shoot | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 59.44 | 58.17 | 58.81 |
| $S_2$- 1$^{st}$ August | 61.31 | 61.15 | 61.23 |
| $S_3$- 15$^{th}$ August | 62.16 | 61.92 | 62.04 |
| **S.Em.±** | 0.733 | 0.848 | 0.560 |
| **C.D. at 5%** | 2.15 | 2.49 | 1.60 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 65.71 | 65.08 | 65.39 |
| $D_2$- 8.5 g *a.i.* | 63.23 | 62.95 | 63.09 |
| $D_3$- 11.5 g *a.i.* | 59.22 | 58.66 | 58.94 |
| $D_4$- 14.5 g *a.i.* | 55.73 | 54.98 | 55.35 |
| **S.Em.±** | 0.846 | 0.980 | 0.647 |
| **C.D. at 5%** | 2.48 | 2.87 | 1.84 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 1.465 | 1.697 | 1.121 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.458 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.793 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.915 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 1.585 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 4.16 | 4.86 | 4.52 |

**Table 4.10: Effect of time and dose of paclobutrazol application on days taken to fruit maturity of mango cv. Kesar**

| Treatments | days taken to fruit maturity | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 194.70 | 195.46 | 195.08 |
| $S_2$- 1$^{st}$ August | 199.30 | 200.03 | 199.67 |
| $S_3$- 15$^{th}$ August | 205.38 | 206.10 | 205.74 |
| **S.Em.±** | 2.861 | 2.438 | 1.879 |
| **C.D. at 5%** | 8.39 | 7.15 | 5.36 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 206.55 | 207.41 | 206.98 |
| $D_2$- 8.5 g *a.i.* | 202.90 | 203.50 | 203.20 |
| $D_3$- 11.5 g *a.i.* | 196.60 | 197.24 | 196.92 |
| $D_4$- 14.5 g *a.i.* | 193.12 | 193.97 | 193.55 |
| **S.Em.±** | 3.303 | 2.815 | 2.170 |
| **C.D. at 5%** | 9.69 | 8.26 | 6.19 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 5.721 | 4.876 | 3.759 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 1.535 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 2.658 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 3.069 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 5.316 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 4.96 | 4.21 | 4.60 |

**4.3.5.2 Effect of dose**

Similarly, different dose of paclobutrazol application exerted significant effect on days taken to fruit maturity during the year 2019-20, 2020-21 and in pooled (Table

4.10). Minimum days taken to fruit maturity from flower bud initiation (193.12, 193.97 and 193.55) was observed in dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$) and it was at par with dose of paclobutrazol @ 11.5 g *a.i.* ($D_3$) during the year 2019-20, 2020-21 and in pooled. While, maximum days taken to fruit maturity (206.55, 207.41 and 206.98) was registered in dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.3.5.3 Interaction Effect

The data presented in Table 4.10 revealed that the interaction effect of time and dose of paclobutrazol application were non significant on days taken to fruit maturity in mango during the year 2019-20, 2020-21 and in pooled.

## 4.4 EFFECT ON YIELD AND YIELD ATTRIBUTES PARAMETERS

### 4.4.1 Number of fruits per tree

The data revealed that the different time and dose of paclobutrazol application was significantly increased the number of fruits per tree. The data on number of fruits per tree are presented in Table 4.11 and also designed in Fig.4.9

#### 4.4.1.1 Effect of time

Results indicated that the time of paclobutrazol application had significant effect on number of fruits per tree during both the years as well as in pooled data. The maximum number of fruits per tree (102.23, 108.09 and 105.16) was recorded at paclobutrazol application on 15$^{th}$ July ($S_1$). Whereas, the minimum number of fruits per tree (88.28, 94.30 and 91.29) was recorded at paclobutrazol application on 15$^{th}$ August ($S_3$) during the years 2019-20 and 2020-21, respectively.

#### 4.4.1.2 Effect of dose

Similarly, the different dose of paclobutrazol application also exerted significant effect on number of fruits per tree. highest number of fruits per tree (103.09, 109.88 and 106.48) was observed in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) followed by dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) during the years 2019-20 and 2020-21, respectively. Likewise, lowest number of

fruits per tree (86.43, 92.07 and 89.25) was noted in dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during both the year and in pooled, respectively.

**Table 4.11: Effect of time and dose of paclobutrazol application on number of fruit per tree of mango cv. Kesar**

| Treatments | Number of fruit per tree | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 102.23 | 108.09 | 105.16 |
| $S_2$- 1$^{st}$ August | 94.36 | 101.19 | 97.77 |
| $S_3$- 15$^{th}$ August | 88.28 | 94.30 | 91.29 |
| **S.Em.±** | 2.606 | 2.186 | 1.701 |
| **C.D. at 5%** | 7.64 | 6.41 | 4.85 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 86.43 | 92.07 | 89.25 |
| $D_2$- 8.5 g *a.i.* | 93.79 | 98.71 | 96.25 |
| $D_3$- 11.5 g *a.i.* | 96.51 | 104.11 | 100.31 |
| $D_4$- 14.5 g *a.i.* | 103.09 | 109.88 | 106.48 |
| **S.Em.±** | 3.009 | 2.524 | 1.964 |
| **C.D. at 5%** | 8.83 | 7.40 | 5.60 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 5.212 | 4.372 | 3.402 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 1.389 |
| **C.D. at 5%** | | | 3.96 |
| **Y× S** | | | |
| **S.Em.±** | | | 2.405 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 2.777 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 4.811 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 9.51 | 7.48 | 8.50 |

#### 4.4.1.3 Interaction Effect

On the basis of statistical analysis, there was non-significant difference between time and dose of paclobutrazol application with respect to number of fruit per tree during the year 2019-20, 2020-21 and in pooled.

### 4.4.2 Fruit yield (kg/tree)

For the fruit yield (kg/tree), the variation in different time and dose of paclobutrazol application was observed significant during the year 2019-20, 2020-21 and pooled. The data on fruit yield (kg/tree) are presented in Table 4.12 and also designed in Fig.4.10

#### 4.4.2.1 Effect of time

The effect of different time of paclobutrazol application on fruit yield (kg/tree) was differed significantly during the year 2019-20, 2020-21 and pooled. Significantly, maximum fruit yield (23.35, 23.79 and 23.57 kg/tree) was obtained at the paclobutrazol application on 15$^{th}$ July ($S_1$). While, minimum fruit yield (19.49, 20.29 and 19.89 kg/tree) was noted at the paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and in pooled, respectively.

#### 4.4.2.2 Effect of dose

In case of dose of paclobutrazol application, the result was also found significant for fruit yield (kg/tree) and maximum fruit yield (24.73, 25.65 and 25.19 kg/tree) was observed in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$). While, dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) gave the lowest fruit yield (19.69, 20.13 and 19.91 kg/tree) during the year 2019-20 and 2020-21 and in pooled, respectively.

#### 4.4.2.3 Interaction Effect

The interaction effect between time and dose of paclobutrazol application was also observed non significant on fruit yield (kg/tree) during the year 2019-20, 2020-21 and in pooled.

**Table 4.12: Effect of time and dose of paclobutrazol application on fruit yield of mango cv. Kesar**

| Treatments | Fruit yield (kg/tree) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 23.35 | 23.79 | 23.57 |
| $S_2$- 1$^{st}$ August | 20.97 | 21.56 | 21.27 |
| $S_3$- 15$^{th}$ August | 19.49 | 20.29 | 19.89 |
| **S.Em.±** | 0.640 | 0.497 | 0.405 |
| **C.D. at 5%** | 1.88 | 1.46 | 1.15 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 20.93 | 21.47 | 21.20 |
| $D_2$- 8.5 g *a.i.* | 24.73 | 25.65 | 25.19 |
| $D_3$- 11.5 g *a.i.* | 19.74 | 20.28 | 20.01 |
| $D_4$- 14.5 g *a.i.* | 19.69 | 20.13 | 19.91 |
| **S.Em.±** | 0.739 | 0.574 | 0.468 |
| **C.D. at 5%** | 2.17 | 1.68 | 1.33 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 1.280 | 0.994 | 0.810 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.331 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.573 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.662 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 1.146 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 10.42 | 7.87 | 9.20 |

### 4.4.3 Fruit yield (t/ha)

The variation in fruit yield (t/ha) was observed significant due to different time and dose of paclobutrazol application during the year 2019-20, 2020-21 and pooled

which are presented in Table 4.13 and graphically depicted in Fig. 4.11

**4.4.3.1 Effect of time**

There were significant differences in fruit yield (t/ha) of mango as results of various time of paclobutrazol application on 15$^{th}$ July ($S_1$) recorded higher fruit yield (6.49, 6.61 and 6.55 t/ha). Whereas, lowest fruit yield (5.42, 5.64 and 5.53 t/ha) during the year 2019-20, 2020-21 and in pooled was noted at time of paclobutrazol application on 15$^{th}$ August ($S_3$).

**4.4.3.2 Effect of dose**

It is apparent from the data that dose of paclobutrazol application had significant effect on fruit yield (t/ha) of mango and higher fruit yield (6.87, 7.12 and 7.00 t/ha) was found better with dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$). Whereas, lower fruit yield (5.47, 5.59 and 5.53 t/ha) was found in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and in pooled, respectively.

**4.4.3.3 Interaction Effect**

It is obvious from the data analyzed that an interaction between time and dose of paclobutrazol application failed to produce any significant effect on fruit yield (t/ha) of mango during the year 2019-20, 2020-21 and in pooled.

**4.4.4 Fruit weight (g)**

**4.4.4.1 Effect of time**

Effect of time of application of paclobutrazol on fruit weight was found non significant during the year 2019-20, 2020-21 and pooled. Similarly, higher fruit weight (230.01, 221.66 and 225.84 g) was noted at time of paclobutrazol application on 15$^{th}$ July ($S_1$). On the other hand, lower fruit weight (220.83, 216.96 and 218.89 g) was recorded at the paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.14

**Table 4.13: Effect of time and dose of paclobutrazol application on fruit yield of mango cv. Kesar**

| Treatments | Fruit yield (t/ha) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 6.49 | 6.61 | 6.55 |
| $S_2$- 1st August | 5.83 | 5.99 | 5.91 |
| $S_3$- 15th August | 5.42 | 5.64 | 5.53 |
| **S.Em.±** | 0.178 | 0.138 | 0.113 |
| **C.D. at 5%** | 0.52 | 0.40 | 0.32 |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 5.81 | 5.96 | 5.89 |
| $D_2$- 8.5 g *a.i.* | 6.87 | 7.12 | 7.00 |
| $D_3$- 11.5 g *a.i.* | 5.48 | 5.63 | 5.56 |
| $D_4$- 14.5 g *a.i.* | 5.47 | 5.59 | 5.53 |
| **S.Em.±** | 0.205 | 0.159 | 0.130 |
| **C.D. at 5%** | 0.60 | 0.47 | 0.37 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.356 | 0.276 | 0.225 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.092 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.159 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.184 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.318 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 10.42 | 7.87 | 9.20 |

### 4.4.4.2 Effect of dose

In case of dose of paclobutrazol application, the result was found significant for fruit weight and higher fruit weight (264.20, 259.11 and 261.65 g) was observed in

dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$). While, dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) gave the lowest fruit weight (191.07, 182.75 and 186.91 g) during the year 2019-20 and 2020-21 and in pooled, respectively. The data are presented in Table 4.14

#### 4.4.4.3 Interaction Effect

The interaction effect between time and dose of paclobutrazol application was also observed non significant on fruit weight during the year 2019-20, 2020-21 and in pooled.

### 4.4.5 Fruit length (cm)

#### 4.4.5.1 Effect of time

Effect of time of paclobutrazol application on fruit length was found non significant as influenced by different time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. Similarly, maximum fruit length (9.93, 9.89 and 9.91 cm) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$). On the other hand, minimum fruit length (9.74, 9.70 and 9.72 cm) was recorded during on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.15

#### 4.4.5.2 Effect of dose

It is revealed from the data that dose of paclobutrazol application had significant effect on fruit length of mango and maximum fruit length (10.38, 10.34 and 10.36 cm) was noted in dose paclobutrazol application @ 8.5 g *a.i.* ($D_2$). While, minimum fruit length (9.46, 9.41 and 9.43 cm) was found in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and in pooled, respectively. The data are presented in Table 4.15

#### 4.4.5.3 Interaction Effect

On the basis of statistical analysis, there was non-significant difference between time and dose of paclobutrazol application with respect to fruit length during the year 2019-20 and 2020-21 and in pooled.

**Table 4.14: Effect of time and dose of paclobutrazol application on fruit weight of mango cv. Kesar**

| Treatments | Fruit weight (g) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 230.01 | 221.66 | 225.84 |
| $S_2$- 1$^{st}$ August | 224.66 | 214.01 | 219.33 |
| $S_3$- 15$^{th}$ August | 220.83 | 216.96 | 218.89 |
| **S.Em.±** | 3.548 | 3.082 | 2.350 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 241.71 | 233.37 | 237.54 |
| $D_2$- 8.5 g *a.i.* | 264.20 | 259.11 | 261.65 |
| $D_3$- 11.5 g *a.i.* | 203.68 | 194.94 | 199.31 |
| $D_4$- 14.5 g *a.i.* | 191.07 | 182.75 | 186.91 |
| **S.Em.±** | 4.097 | 3.559 | 2.714 |
| **C.D. at 5%** | 12.02 | 10.44 | 7.73 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 7.096 | 6.165 | 4.700 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 1.919 |
| **C.D. at 5%** | | | 5.47 |
| **Y× S** | | | |
| **S.Em.±** | | | 3.323 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 3.838 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 6.647 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 5.46 | 4.91 | 5.20 |

**Table 4.15: Effect of time and dose of paclobutrazol application on fruit length of mango cv. Kesar**

| Treatments | Fruit length (cm) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 9.93 | 9.89 | 9.91 |
| $S_2$- 1$^{st}$ August | 9.83 | 9.79 | 9.81 |
| $S_3$- 15$^{th}$ August | 9.74 | 9.70 | 9.72 |
| **S.Em.±** | 0.142 | 0.118 | 0.092 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 9.81 | 9.76 | 9.78 |
| $D_2$- 8.5 g *a.i.* | 10.38 | 10.34 | 10.36 |
| $D_3$- 11.5 g *a.i.* | 9.70 | 9.66 | 9.68 |
| $D_4$- 14.5 g *a.i.* | 9.46 | 9.41 | 9.43 |
| **S.Em.±** | 0.164 | 0.136 | 0.107 |
| **C.D. at 5%** | 0.48 | 0.40 | 0.30 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.283 | 0.236 | 0.184 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.075 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.130 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.151 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.261 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 4.99 | 4.18 | 4.60 |

**Table 4.16: Effect of time and dose of paclobutrazol application on fruit breadth of mango cv. Kesar**

| Treatments | Breadth of fruit (cm) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 6.99 | 6.86 | 6.93 |
| $S_2$- 1st August | 6.93 | 6.79 | 6.86 |
| $S_3$- 15th August | 6.84 | 6.72 | 6.78 |
| **S.Em.±** | 0.100 | 0.076 | 0.063 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 6.92 | 6.77 | 6.84 |
| $D_2$- 8.5 g *a.i.* | 7.18 | 6.98 | 7.08 |
| $D_3$- 11.5 g *a.i.* | 6.92 | 6.81 | 6.86 |
| $D_4$- 14.5 g *a.i.* | 6.66 | 6.61 | 6.63 |
| **S.Em.±** | 0.115 | 0.088 | 0.073 |
| **C.D. at 5%** | 0.34 | 0.26 | 0.21 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.200 | 0.152 | 0.126 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.051 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.089 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.103 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.178 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 5.01 | 3.88 | 4.49 |

### 4.4.6 Fruit breadth (cm)

#### 4.4.6.1 Effect of time

Similarly, the result noted to variation in fruit breadth was also found non significant as influenced by different application time of paclobutrazol during the year 2019-20, 2020-21 and pooled. However, maximum fruit breadth (6.99, 6.86 and 6.93 cm) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$). Whereas, a minimum fruit breadth (6.84, 6.72 and 6.78 cm) was recorded on 15$^{th}$ August ($S_3$) during both the year and pooled. The data are presented in Table 4.16

#### 4.4.6.2 Effect of dose

In case of dose of application of paclobutrazol found significant effect on fruit breadth during the year 2019-20, 2020-21 and in pooled. However, maximum fruit breadth (7.18, 6.98 and 7.08 cm) was noted in dose paclobutrazol application @ 8.5 g *a.i.* ($D_2$) which was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) and @ 11.5 g *a.i.* ($D_3$) during both the year and in pooled. Whereas, minimum fruit breadth (6.66, 6.61 and 6.63 cm) was recorded in dose paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and pooled. The data are conferred in Table 4.16

#### 4.4.6.3 Interaction Effect

The interaction effect of all treatments like time and dose of paclobutrazol application combinations on fruit breadth were found non significant during the year 2019-20, 2020-21 and pooled.

## 4.5 EFFECT ON QUALITY PARAMETERS

### 4.5.1 TSS ($^0$Brix)

#### 4.5.1.1 Effect of time

Effect of paclobutrazol application on TSS was found non significant as influenced by different time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. Similarly, higher TSS (18.57, 18.77 and 18.67 $^0$Brix) was noted at the paclobutrazol application on 15$^{th}$ July ($S_1$). On the other hand, lower TSS

(18.03, 18.37 and 18.20 $^{0}$Brix) was recorded at the paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.17

**Table 4.17: Effect of time and dose of paclobutrazol application on TSS of mango cv. Kesar**

| Treatments | TSS ($^{0}$Brix) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 18.57 | 18.77 | 18.67 |
| $S_2$- 1$^{st}$ August | 18.31 | 18.57 | 18.44 |
| $S_3$- 15$^{th}$ August | 18.03 | 18.37 | 18.20 |
| **S.Em.±** | 0.215 | 0.183 | 0.141 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 18.51 | 18.69 | 18.60 |
| $D_2$- 8.5 g *a.i.* | 18.81 | 19.09 | 18.95 |
| $D_3$- 11.5 g *a.i.* | 18.18 | 18.47 | 18.32 |
| $D_4$- 14.5 g *a.i.* | 17.73 | 18.03 | 17.88 |
| **S.Em.±** | 0.248 | 0.211 | 0.163 |
| **C.D. at 5%** | 0.73 | 0.62 | 0.46 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.430 | 0.365 | 0.282 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.115 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.200 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.230 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.399 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 4.07 | 3.41 | 3.75 |

**Table 4.18: Effect of time and dose of paclobutrazol application on titrable acidity of mango cv. Kesar**

| Treatments | Titrable acidity (%) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 0.29 | 0.29 | 0.29 |
| $S_2$- 1$^{st}$ August | 0.29 | 0.29 | 0.29 |
| $S_3$- 15$^{th}$ August | 0.30 | 0.30 | 0.30 |
| **S.Em.±** | 0.004 | 0.005 | 0.003 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 0.30 | 0.30 | 0.30 |
| $D_2$- 8.5 g *a.i.* | 0.29 | 0.29 | 0.29 |
| $D_3$- 11.5 g *a.i.* | 0.29 | 0.29 | 0.29 |
| $D_4$- 14.5 g *a.i.* | 0.29 | 0.29 | 0.29 |
| **S.Em.±** | 0.005 | 0.005 | 0.004 |
| **C.D. at 5%** | NS | NS | NS |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.009 | 0.009 | 0.006 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.003 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.005 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.005 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.009 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 5.07 | 5.64 | 5.36 |

**4.5.1.2 Effect of dose**

Similarly, in case of dose, application of different dose of paclobutrazol exerted significant effect on TSS during the year 2019-20, 2020-21 and in pooled. However, higher TSS (18.81, 19.09 and 18.95 $^{0}$Brix) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during both the year and in pooled, but it was at par with dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) during year 2019-20 and 2020-21. Whereas, lower TSS (13.68, 13.85 and 13.77 $^{0}$Brix) was recorded in dose of paclobutrazol @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and pooled. The data are conferred in Table 4.17

**4.5.1.3 Interaction Effect**

Meanwhile, the interaction between time and dose of paclobutrazol application on TSS was found non significant during both the years and as well as in pooled.

**4.5.2 Titrable acidity (%)**

**4.5.2.1 Effect of time**

Similarly, the result pertaining to variation in titrable acidity was also found non significant as influenced by different application time of paclobutrazol during the year 2019-20, 2020-21 and pooled. However, minimum titrable acidity (0.29, 0.29 and 0.29 %) was noted on 15$^{th}$ July ($S_1$) and on 1$^{st}$ August ($S_2$). However, a maximum titrable acidity (0.30, 0.30 and 0.30 %) were recorded at application of paclobutrazol on 15$^{th}$ August ($S_3$) during both the year and in pooled. The data are presented in Table 4.18

**4.5.2.2 Effect of dose**

In case of dose of application of paclobutrazol exerted non significant effect on titrable acidity during the year 2019-20, 2020-21 and in pooled. However, titrable acidity (0.29, 0.29 and 0.29 %) was noted in the dose paclobutrazol application @ 8.5 g *a.i.* ($D_2$), @ 11.5 g *a.i.* ($D_3$) and @ 14.5 g *a.i.* ($D_4$). While, higher titrable acidity (0.30, 0.30 and 0.30 %) was reported in the dose paclobutrazol application @ 5 g *a.i.* ($D_1$). The data are conferred in Table 4.18

**4.5.2.3 Interaction Effect**

It is obvious from the data analyzed that an interaction between time and dose of paclobutrazol application failed to produce any significant effect on titrable acidity of mango during the year 2019-20, 2020-21 and in pooled.

### 4.5.3 Reducing sugar (%)

#### 4.5.3.1 Effect of time

Effect of paclobutrazol application on reducing sugar was found non significant as influenced by different time of application during the year 2019-20, 2020-21 and pooled. Similarly, higher reducing sugar (5.13, 5.37 and 5.25 %) was noted at the paclobutrazol application on 15$^{th}$ July ($S_1$). On the other hand, lower reducing sugar (5.02, 5.23 and 5.13 %) was recorded at the paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.19

#### 4.5.3.2 Effect of dose

The data revealed that, application of different dose of paclobutrazol noted significant effect on reducing sugar during the year 2019-20, 2020-21 and in pooled. However, higher reducing sugar (5.25, 5.52 and 5.38 %) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) which was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during both the year and in pooled. Whereas, lower reducing sugar (4.84, 5.06 and 4.95 %) was recorded in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and pooled. The data are conferred in Table 4.19

#### 4.5.3.3 Interaction Effect

The data presented in Table 4.19 revealed that the interaction effect of time and dose of paclobutrazol application were non significant on reducing sugar in mango during the year 2019-20, 2020-21 and in pooled.

### 4.5.4 Non-reducing sugar (%)

#### 4.5.4.1 Effect of time

Similarly, the result pertaining to variation in non-reducing sugar was also

found non significant as influenced by different application time of paclobutrazol during the year 2019-20, 2020-21 and pooled. However, higher non-reducing sugar (10.24, 10.30 and 10.27 %) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$). While, lower non-reducing sugar (9.93, 10.06 and 10.00 %) was recorded at paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.20

**4.5.4.2 Effect of dose**

The experimental finding shows that different dose of paclobutrazol application evaluated significant effect on non-reducing sugar during the year 2019-20, 2020-21 and in pooled. Furthermore, higher non-reducing sugar (10.31, 10.40 and 10.36 %) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$). Whereas, lower non-reducing sugar (9.83, 9.92 and 9.88 %) was recorded in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during both the year and pooled. The data are conferred in Table 4.20

**4.5.4.3 Interaction Effect**

The interaction effect of different application of time and dose of paclobutrazol application on non-reducing sugar was also found non significant during both the years and as well as in pooled.

**4.5.5 Total sugar (%)**

**4.5.5.1 Effect of time**

Effect of time of paclobutrazol application on total sugar was found non significant as influenced by different time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. Similarly, higher total sugar (15.37, 15.67 and 15.52 %) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$). On the other hand, lower total sugar (14.96, 15.29 and 15.12 %) was founded at paclobutrazol application on 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.21

**Table 4.19: Effect of time and dose of paclobutrazol application on reducing sugar of mango cv. Kesar**

| Treatments | Reducing sugar (%) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 5.13 | 5.37 | 5.25 |
| $S_2$- 1$^{st}$ August | 5.07 | 5.29 | 5.18 |
| $S_3$- 15$^{th}$ August | 5.02 | 5.23 | 5.13 |
| **S.Em.±** | 0.055 | 0.042 | 0.035 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 5.17 | 5.40 | 5.29 |
| $D_2$- 8.5 g *a.i.* | 5.25 | 5.52 | 5.38 |
| $D_3$- 11.5 g *a.i.* | 5.04 | 5.20 | 5.12 |
| $D_4$- 14.5 g *a.i.* | 4.84 | 5.06 | 4.95 |
| **S.Em.±** | 0.063 | 0.049 | 0.040 |
| **C.D. at 5%** | 0.18 | 0.14 | 0.11 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.109 | 0.085 | 0.069 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.028 |
| **C.D. at 5%** | | | 0.08 |
| **Y× S** | | | |
| **S.Em.±** | | | 0.049 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.056 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.098 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 3.72 | 2.78 | 3.27 |

**Table 4.20: Effect of time and dose of paclobutrazol application on non-reducing sugar of mango cv. Kesar**

| Treatments | Non- reducing sugar (%) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15th July | 10.24 | 10.30 | 10.27 |
| $S_2$- 1st August | 10.09 | 10.16 | 10.12 |
| $S_3$- 15th August | 9.93 | 10.06 | 10.00 |
| **S.Em.±** | 0.167 | 0.136 | 0.108 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 10.17 | 10.24 | 10.21 |
| $D_2$- 8.5 g *a.i.* | 10.31 | 10.40 | 10.36 |
| $D_3$- 11.5 g *a.i.* | 10.02 | 10.14 | 10.08 |
| $D_4$- 14.5 g *a.i.* | 9.83 | 9.92 | 9.88 |
| **S.Em.±** | 0.193 | 0.157 | 0.124 |
| **C.D. at 5%** | NS | NS | NS |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.334 | 0.272 | 0.215 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.088 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.152 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.176 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.305 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 5.74 | 4.63 | 5.21 |

**Table 4.21: Effect of time and dose of paclobutrazol application on total sugar of mango cv. Kesar**

| Treatments | Total sugar (%) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 15.37 | 15.67 | 15.52 |
| $S_2$- 1$^{st}$ August | 15.16 | 15.45 | 15.30 |
| $S_3$- 15$^{th}$ August | 14.96 | 15.29 | 15.12 |
| **S.Em.±** | 0.169 | 0.165 | 0.118 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 15.34 | 15.64 | 15.49 |
| $D_2$- 8.5 g *a.i.* | 15.56 | 15.92 | 15.74 |
| $D_3$- 11.5 g *a.i.* | 15.06 | 15.35 | 15.20 |
| $D_4$- 14.5 g *a.i.* | 14.67 | 14.97 | 14.82 |
| **S.Em.±** | 0.195 | 0.190 | 0.136 |
| **C.D. at 5%** | 0.57 | 0.56 | 0.39 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.338 | 0.329 | 0.236 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.096 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.167 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.193 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.334 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 3.87 | 3.69 | 3.78 |

### 4.5.5.2 Effect of dose

The experimental finding shows that different time of paclobutrazol application found significant effect on total sugar during the year 2019-20, 2020-21

and in pooled. Furthermore, higher total sugar (15.56, 15.92 and 15.74 %) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) which was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$) during both the year and in pooled, but it was at par with dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) during the year 2019-20. Whereas, lower total sugar (14.67, 14.97 and 14.82 %) was recorded in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during both the year and pooled. The data are conferred in Table 4.21

#### 4.5.5.3 Interaction Effect

Similarly, the interaction effect of different application time and dose of paclobutrazol on total sugar was also found non significant during both the years and as well as in pooled.

### 4.5.6 Pulp-skin ratio

#### 4.5.6.1 Effect of time

Similarly, the result pertaining to variation in pulp-skin ratio was also found non significant as influenced by different application time of paclobutrazol during the year 2019-20, 2020-21 and pooled. However, higher pulp-skin ratio (4.36, 4.22 and 4.29) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and pooled. Whereas, lower pulp-skin ratio (4.17, 4.08 and 4.13) was recorded at paclobutrazol application on 15$^{th}$ August ($S_3$) during both the year and pooled. The data are presented in Table 4.22

#### 4.5.6.2 Effect of dose

Similarly, In case of dose, application of different dose of paclobutrazol reported significant effect on pulp-skin ratio during the year 2019-20, 2020-21 and in pooled. However, higher pulp-skin ratio (4.46, 4.36 and 4.41) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) which was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$). Whereas, lower pulp-skin ratio (4.12, 4.00 and 4.06) was recorded in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and pooled. The data are conferred in Table 4.22

**4.5.6.3 Interaction Effect**

The data presented in Table 4.22 revealed that the interaction effect of time and dose of paclobutrazol application were non significant on pulp-skin ratio in mango during the year 2019-20, 2020-21 and in pooled.

**4.5.7 Shelf life (days)**

**4.5.7.1 Effect of time**

Effect of time of paclobutrazol application on shelf life was found non significant as influenced by different time of paclobutrazol application during the year 2019-20, 2020-21 and pooled. Similarly, maximum shelf life (13.82, 13.96 and 13.89 days) was noted at paclobutrazol application on 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and pooled. On the other hand, minimum shelf life (13.05, 13.31 and 13.18 days) was founded at paclobutrazol application on 15$^{th}$ August ($S_3$) during the year 2019-20, 2020-21 and pooled. The data are presented in Table 4.23

**4.5.7.2 Effect of dose**

Similarly, the experimental finding shows that different time of paclobutrazol application exerted significant effect on shelf life during the year 2019-20, 2020-21 and in pooled. Furthermore, higher shelf life (14.29, 14.45 and 14.37 days) was noted in dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) which was at par with dose of paclobutrazol application @ 5 g *a.i.* ($D_1$). Whereas, lower shelf life (12.75, 12.92 and 12.85 days) was recorded in dose of paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during both the year and in pooled. The data are conferred in Table 4.23

**4.5.7.3 Interaction Effect**

Similarly, the interaction effect of different application of time and dose of paclobutrazol application on shelf life of mango was also found non significant during both the years and as well as in pooled.

**Table 4.22: Effect of time and dose of paclobutrazol application on pulp-skin ratio of mango cv. Kesar**

| Treatments | Pulp-skin ratio | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 4.36 | 4.22 | 4.29 |
| $S_2$- 1$^{st}$ August | 4.30 | 4.18 | 4.24 |
| $S_3$- 15$^{th}$ August | 4.17 | 4.08 | 4.13 |
| **S.Em.±** | 0.070 | 0.061 | 0.047 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 4.34 | 4.18 | 4.26 |
| $D_2$- 8.5 g *a.i.* | 4.46 | 4.36 | 4.41 |
| $D_3$- 11.5 g *a.i.* | 4.19 | 4.10 | 4.15 |
| $D_4$- 14.5 g *a.i.* | 4.12 | 4.00 | 4.06 |
| **S.Em.±** | 0.081 | 0.071 | 0.054 |
| **C.D. at 5%** | 0.24 | 0.21 | 0.15 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.140 | 0.123 | 0.093 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.038 |
| **C.D. at 5%** | | | 0.11 |
| **Y× S** | | | |
| **S.Em.±** | | | 0.066 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.076 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.132 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 5.68 | 5.11 | 5.41 |

**Table 4.23: Effect of time and dose of paclobutrazol application on shelf life of mango cv. Kesar**

| Treatments | Shelf life (days) | | |
|---|---|---|---|
| | **2019-20** | **2020-21** | **Pooled** |
| **Time of paclobutrazol application (S)** | | | |
| $S_1$- 15$^{th}$ July | 13.82 | 13.96 | 13.89 |
| $S_2$- 1$^{st}$ August | 13.47 | 13.65 | 13.56 |
| $S_3$- 15$^{th}$ August | 13.05 | 13.31 | 13.18 |
| **S.Em.±** | 0.301 | 0.269 | 0.202 |
| **C.D. at 5%** | NS | NS | NS |
| **Dose of paclobutrazol application (D)** | | | |
| $D_1$- 5.0 g *a.i.* | 13.69 | 13.86 | 13.77 |
| $D_2$- 8.5 g *a.i.* | 14.29 | 14.45 | 14.37 |
| $D_3$- 11.5 g *a.i.* | 13.05 | 13.30 | 13.18 |
| $D_4$- 14.5 g *a.i.* | 12.75 | 12.92 | 12.85 |
| **S.Em.±** | 0.347 | 0.311 | 0.233 |
| **C.D. at 5%** | 1.02 | 0.91 | 0.66 |
| **Interaction (S×D)** | | | |
| **S.Em.±** | 0.601 | 0.539 | 0.404 |
| **C.D. at 5%** | NS | NS | NS |
| **Year** | | | |
| **S.Em.±** | | | 0.165 |
| **C.D. at 5%** | | | NS |
| **Y× S** | | | |
| **S.Em.±** | | | 0.285 |
| **C.D. at 5%** | | | NS |
| **Y× D** | | | |
| **S.Em.±** | | | 0.329 |
| **C.D. at 5%** | | | NS |
| **Y× S×D** | | | |
| **S.Em.±** | | | 0.571 |
| **C.D. at 5%** | | | NS |
| **C.V. %** | 7.74 | 6.84 | 7.30 |

## 4.6 EFFECT ON ECONOMICS

To study the economics of various treatments combinations, the mean yield data of mango fruit with reference to different treatments of combination were worked

out and are presented in Table 4.24 and also depicted in Fig. 4.12

The gross realization and net realization in rupees per hectare were worked out by taking into account the prevailing price during the harvesting. The cost of cultivation per hectare was worked out for different treatments.

As per Table 4.24, the treatment of paclobutrazol application at 15$^{th}$ July with 8.5 g *a.i.* ($S_1D_2$) were found to be best with maximum net returns (₹ 2,10,697 ha$^{-1}$) of fruit yield and BCR (1.86). Whereas, the minimum net returns (₹ 1,669 ha$^{-1}$) on fruit yield and BCR (1.01) was noted in treatment of paclobutrazol application at 15$^{th}$ August with 14.5 g *a.i.* ($S_3D_4$).

**Table 4.24: Economic of treatments combinations of time and dose of paclobutrazol application on mango cv. Kesar**

| Treatment combination | Fruit yield (t $ha^{-1}$) | Fixed Cost (₹ $ha^{-1}$) | Variable Cost (₹ $ha^{-1}$) | Total cost (₹ $ha^{-1}$) | Gross Returns (₹ $ha^{-1}$) | Net return (₹ $ha^{-1}$) | BCR |
|---|---|---|---|---|---|---|---|
| $S_1D_1$ | 6.37 | 1,63,118 | 49,600 | 2,12,718 | 3,82,439 | 1,69,721 | 1.80 |
| $S_1D_2$ | 7.60 | 1,63,118 | 82,400 | 2,45,518 | 4,56,215 | 2,10,697 | 1.86 |
| $S_1D_3$ | 6.30 | 1,63,118 | 1,11,200 | 2,74,318 | 3,78,153 | 1,03,835 | 1.38 |
| $S_1D_4$ | 5.91 | 1,63,118 | 1,40,000 | 3,03,118 | 3,54,703 | 51,585 | 1.17 |
| $S_2D_1$ | 5.80 | 1,63,118 | 49,600 | 2,12,718 | 3,48,289 | 1,35,571 | 1.64 |
| $S_2D_2$ | 6.83 | 1,63,118 | 82,400 | 2,45,518 | 4,09,791 | 1,64,273 | 1.67 |
| $S_2D_3$ | 5.40 | 1,63,118 | 1,11,200 | 2,74,318 | 3,23,807 | 49,489 | 1.18 |
| $S_2D_4$ | 5.60 | 1,63,118 | 1,40,000 | 303,118 | 3,35,817 | 32,699 | 1.11 |
| $S_3D_1$ | 5.49 | 1,63,118 | 49,600 | 2,12,718 | 3,29,332 | 1,16,614 | 1.55 |
| $S_3D_2$ | 6.56 | 1,63,118 | 82,400 | 2,45,518 | 3,93,370 | 1,47,852 | 1.60 |
| $S_3D_3$ | 4.98 | 1,63,118 | 1,11,200 | 2,74,318 | 2,98,693 | 24,375 | 1.09 |
| $S_3D_4$ | 5.08 | 1,63,118 | 1,40,000 | 3,03,118 | 3,04,787 | 1,669 | 1.01 |

Mango price = 60 ₹ kg-1

# CHAPTER: V

# DISCUSSION

An effort has been made in this chapter to discuss critically the important findings of the present study on the “Effect of soil applied Paclobutrazol treatments at different time on growth, flowering, fruiting, yield and quality of mango *(Mangifera indica* L.*)* cv. Kesar" along with probable reasons for the treatment behavior. In the chapter of experimental results, both significant and non-significant variation where noted in growth, flowering, fruiting, yield and yield attributes and quality due to the effect of different treatments of time and dose of paclobutrazol application. The discussion, for the sake of convenience, has been made under the following headings.

5.1 Effect on growth parameters

5.2 Effect on flowering parameters

5.3 Effect on fruiting parameters

5.4 Effect on yield and yield attribute parameters

5.5 Effect on quality parameters

5.6 Effect on economics

## 5.1 EFFECT ON GROWTH PARAMETERS

### 5.1.1 Effect of time

The data revealed that application time of paclobutrazol had produced non significant effect on growth parameters *viz*., number of shoots per terminal and length of new shoots during both the years and as well in pooled.

### 5.1.2 Effect of dose

Significantly, minimum number of shoots per terminal (1.41, 1.27 and 1.34) and length of new shoot (10.86, 10.29 and 10.58 cm) were recorded with dose of

paclobutrazol application @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and pooled, respectively. However, it was found at par with dose of paclobutrazol application @11.5 g *a.i.* ($D_3$) in number of new shoots per erminal during the year 2019-20, 2020-21 and pooled, respectively.

Paclobutrazol significantly reduced the outbreak of new vegetative flush of October-November in mango. Likewise, number of shoots per terminal and shoot length was also reduced by paclobutrazol treatments. Thus, paclobutrazol exerted the significant effect in reduction of vegetative growth in terms of number of shoots per terminal and shoot length. The effect of paclobutrazol was more profound at higher concentration concluded by Padhiar (1999).

An application of paclobutrazol had effectively controlled the emergence of this vegetative flush of October-November by interrupting the biosynthesis of gibberellins. Because paclobutrazol is a gibberellins bio-synthesis inhibitor. The considerable reduction in vegetative growth in the trees treated with paclobutrazol had been reported by Hoda *et al*. (2001) in mango cv. Langra. Similar findings were also observed by Kulkarni, (1989) in mango cvs. Banganpalli, Dashehari and Peddarasam; Kurein and Iyer (1993); Desai (1994) in mango cv. Alphanso; Burondkar *et al*. (2000); Nafeez *et al*. (2010) in mango and pal *et al*. (2017) in different mango cultivars.

### 5.1.3 Interaction effect of time and dose

The data from present investigation as reported in previous chapter revealed that the interaction effect between time and dose of paclobutrazol application were found non significant on growth parameters *viz*., number of shoots per terminal and length of new shoot in mango during 2019-20, 2020-21 and pooled.

## 5.2 EFFECT ON FLOWERING PARAMETERS

### 5.2.1 Effect of time

The data from investigation revealed that time of paclobutrazol application during the year 2019-20, 2020-21 and pooled exerted significant influence on flowering parameters *viz*., days to flowering bud initiation, days to 50% flowering and days to full bloom during the year 2019-20, 2020-21 and pooled.

Significantly, minimum days to flower bud initiation (48.00, 49.37 and 48.68), days to 50% flowering (62.40, 63.58 and 62.99) and days to full bloom (73.64, 74.83 and 74.23) were recorded at the soil application of paclobutrazol on 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and in pooled, respectively. However, it was found at par with application of paclobutrazol on 1$^{st}$ August ($S_2$) in days to flower bud initiation during the year 2020-21 and in days to 50% flowering and days to full bloom during the years 2019-20 and 2020-21 and pooled, respectively.

Application of paclobutrazol in mid of July suppressed the vegetative growth and induced early and profuse flowering during investigation. In other words, the flower inductive cycle which is a part of phenological and physiological cycle of mango tree may commence earlier in the season, but flowering is prevented by the inhibitor until the build-up of sufficient promoter to counteract the inhibitor. Paclobutrazol thus, appears to help in achieving this stage much earlier because of its inhibitory activity. This hypothesis looks particularly attractive while considering the flower-inhibitory role of gibberellins in trees together with the anti-gibberellins activity of paclobutrazol those found by Kulkarni (1989) and Padhiar (1999) in mango. The result of present investigation induced earliness in flowering, advanced fruit maturity and provided opportunities to have the commercial advantages of early marketing in season. These results are in confirmation with results obtained by Kulkarni (1989) in mango; Joshi *et al.* (1998) in mango cv. Ratna; Shinde (2015) in mango; Medina- Urrtia and Buenrostro- Nava (1995) in Mexican lime and Bonomo *et al*. (1989) in golden delicious apple.

### 5.2.2 Effect of dose

The variation due to different dose of paclobutrazol application on various flowering parameters *viz*., days to flower bud initiation, days to 50% flowering and days to full was found significant during both the years and pooled.

Significantly, minimum days to flower bud initiation (45.17, 46.90 and 46.04), days to 50% flowering (61.44, 62.20 and 61.82) and days to full bloom (69.61, 70.90 and 70.26) were registered with an application of paclobutrazol @ 14.5 g *a.i.* (D4) during the year 2019-20, 2020-21 and in pooled. However, it was found at par with dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) in days to 50% flowering during 2019-20 and in days to full bloom during 2019-20 and 2020-21

According to Kurian and Iyer (1993) paclobutrazol can enhance the total phenolic content of terminal buds and alter the phloem to xylem ratio of the stem, which is important in restricting the vegetative growth and enhancing flowering by altering assimilate partitioning and patterns of nutrient supply for new growth. The soil-applied paclobutrazol treatments had an impact on reduction of vegetative growth, resulting in a higher intensity of flowering. Higher Total Non-structural Carbohydrates (TNC) in the shoots of the paclobutrazol treated trees 2 weeks before flowering have been reported by Yeshitela *et al.* (2004) in mango cv. Tommy Atkins.

Flowering earliness in paclobutrazol treated plants was reported by Kulkarni (1989). He also ascribed that the flower-inductive factor might commence earlier in the season. It is also probable that the application of paclobutrazol caused an early reduction of endogenous gibberellins levels within the shoots, causing them to reach maturity earlier of the trees. This finding is similar to that of Sarker and Rahim (2012), where paclobutrazol induced flowering 85 days after treatment application. The total activity of auxin-like substances increased the higher starch reserve, total carbohydrates and higher C: N ratio in the shoots favour flower bud initiation in mango (Jogdande and Choudhari, 2001). Regular, profuse and early bearing was also reported to be found due to paclobutrazol application in mango cv. Banganapalli grown at Andaman and Nicobar Islands, India by Singh and Ranganath (2006). Similar kinds of results were observed by Khader (1991) in mango cv. Dashehari; Tongumpai *et al.* (1997) in mango; Nartvaranant *et al.* (2000) in Alphanso mango; Cardenas and Rojas (2003) in mango cv. Tommy Atkins; Sanjay and Jaynt (2003) in mango cv. Dashehari; Patil and Talathi (2005) in mango cv. Parbhani Bhushan; Singh and Singh (2006) in mango cv. Gulabkhas; Kumari and Mankar (2008) in mango cv. Langra and Mistry and Patel (2009) in Alphanso mango.

### 5.2.3 Interaction effect of time and dose

It is obvious from the data analyzed that an interaction between time and dose of paclobutrazol application failed to produce any significant effect on flowering parameters *viz*., days to flower bud initiation, days to 50% flowering and days to full bloom of mango during the year 2019-20, 2020-21 and in pooled.

## 5.3 EFFECT ON FURITING PARAMETERS

### 5.3.1 Effect of time

The data revealed that application of different treatment of time of paclobutrazol application had produced significant effect on fruiting parameters *viz*., number of fruit set per shoot at pea stage, number of fruit set per shoot at marble stage, fruit retention percentage per shoot and fruit drop percentage per shoot during both the years and pooled.

Significantly, maximum number of fruit per shoot at pea stage (10.16, 10.41 and 10.28), number of fruit per shoot at marble stage (3.81, 3.96 and 3.89), fruit retention percentage per shoot (40.56, 41.83 and 41.19), fruit drop percentage per shoot (59.44, 58.17 and 58.81) and minimum days to fruit maturity (194.70, 195.46 and 195.08) were recorded at the soil application of paclobutrazol on 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and in pooled. However, it was found at par with time of paclobutrazol application on 1$^{st}$ August ($S_2$) pooled in terms of number of fruit per shoot at pea stage and days to fruit maturity during the year 2019-20, 2020-21 and pooled, number of fruit per shoot at marble stage during the year 2019-20 and 2020-21 and fruit retention percentage per shoot and fruit drop percentage per shoot during the year 2019-20.

Plants soil drenched with paclobutrazol on 15$^{th}$ October resulted in the highest fruit set as well as fruit retention per panicle up to harvest. Trees soil drenched with paclobutrazol, which had higher reserves enhanced fruit set compared to the lowest fruit set in the untreated tree with low reserves because of excessive vegetative growth. Padhiar (1999); Murti *et al.* (2001) and Yeshitela *et al.* (2004) in mango cv. Tommy Atkins corroborate the present findings.

### 5.3.2 Effect of dose

Similarly, the variation due to different dose of paclobutrazol application on various fruiting parameters *viz*., number of fruit set per shoot at pea stage, number of fruit set per shoot at marble stage, fruit retention percentage per shoot and fruit drop percentage per shoot during both the years and pooled.

Significantly, the maximum number of fruit per shoot at pea stage (10.27, 10.61 and 10.44), number of fruit per shoot at marble stage (3.90, 4.03 and 3.97), fruit

retention percentage per shoot (44.27, 45.02 and 44.65) and fruit drop percentage per shoot (55.73, 54.98 and 55.35) were recorded at the dose of soil application of paclobutrazol @ 14.5 g *a.i.* ($D_4$) during the year 2019-20, 2020-21 and in pooled. However, it was found at par with dose of paclobutrazol application @ 8.5 g *a.i.* ($D_2$) during the year 2019-20 and 2020-21 and dose of paclobutrazol application @ 11.5 g *a.i.* ($D_3$) during both the year and in pooled in terms of number of fruit per shoot at pea stage and days to fruit maturity.

In the present experiment also with the application of paclobutrazol (Cultar) there was significant increase in the production of hermaphrodite flowers which ensured an increase in higher fruit set within a panicle at pea size stage and marble size stage in mango which was improved fruit retention and reduce fruit drop. Improved or increased fruit set in higher dose of paclobutrazol treated trees under different Indian agro climatic conditions has been reported in Dashehari by Ram and Tripathi (1993); Burondkar and Gunjate, (1993) in mango cvs. Alphonso, Ratna, Kesar, Pairi, Goa Mankur, Amrapali, Doodh Penda; Kurien and lyer (1993) in mango cv. Alphonso and Desai (1994).

Paclobutrazol treated trees had higher food reserves enhanced the highest fruit set compared to the lowest fruit set in the untreated tree with low reserves because of excessive vegetative growth Yeshitela *et al.* (2004).

Soil drenching of paclobutrazol given to regulate cropping tended to reduce the vegetative growth by antagonize the action of gibberellins may be the reason of advancement in flowering and reduction in duration of final harvest. Similar kinds of results were noted by Mouco *et al.* (2005) in cv. Haden; Padhiar (1999) in different cultivars under South Gujarat condition; Kumbhar *et al.* (2009) in Kesar mango and Patel *et al.* (2016) in mango cv. Alphanso.

### 5.3.3 Interaction effect of time and dose

The data from present investigation as reported in previous chapter revealed that the interaction effect between time and dose of paclobutrazol application were also found non significant on fruiting parameters *viz*., number of fruit set per shoot at pea stage, number of fruit set per shoot at marble stage, fruit retention percentage per shoot and fruit drop percentage per shoot during both the years and pooled.

## 5.4 EFFECT ON YIELD AND YIELD ATTRIBUTES PARAMETERS

### 5.4.1 Effect of time

The data from investigation revealed that time of paclobutrazol application during the year 2019-20, 2020-21 and pooled shown significant influence on yield and yield attributing parameters *viz*., number of fruit per tree, fruit yield (kg/tree), fruit yield (t/ha), fruit weight, fruit length and fruit breadth during the year 2019-20, 2020-21 and pooled.

Significantly, higher number of fruit per tree (102.23, 108.09 and 105.16), fruit yield (23.25, 23.79 and 23.57 kg/tree), fruit yield (6.49, 6.61 and 6.55 t/ha), fruit weight (230.01, 221.66 and 225.84 g), fruit length (9.93, 9.89 and 9.91 cm) and breadth of fruit (6.99, 6.86 and 6.93 cm) were recorded at the soil application of paclobutrazol @ 15$^{th}$ July ($S_1$) during the year 2019-20, 2020-21 and pooled, respectively.

Results showed that the application of various treatments had significantly increased the production of flowers which ensured an increase in fruit production through higher fruit set within a panicle at pea stage, marble stage and mature stage in the mango cv. Kesar. Improved fruit set in paclobutrazol treated trees under different Indian agro-climatic conditions had been reported by Ram and Tripathi (1993) and Desai (1994). Higher fruit retention resulted into higher production of mature fruits at harvest per panicle and hastened the maturity by 20-25 days than the normal harvest period. It is obvious that early flowering resulted into early maturity of fruits in paclobutrazol treated trees. Application of paclobutrazol had increased the yield in terms of number of fruits and fruit yield (kg/tree) and fruit yield (t/ha) in Kesar mango.

Moreover, the effect of paclobutrazol on increasing the chlorophyll content of leaves, besides influencing the $CO_2$ assimilation might manifest higher photosynthetic efficiency leading to higher accumulation of carbohydrates, that might have influence on higher fruit bud initiation, flowering, fruit set and yield (Richardson and Quinlan, 1986).

A significantly higher fruit set and fruit retention in the paclobutrazol treated plants had a favorable impact on culminating higher final fruit number and yield per plant. Paclobutrazol has been reported to exert influence on partitioning the photosynthates to the sites of flowering and fruit production consequent to the reduction of vegetative growth revealed by Reddy and Kurian (2008). In this context, Kurian *et al.* (2001) reported that paclobutrazol appeared to favorably alter the source sink relationship of mango to support fruit growth with a reduction in vegetative growth and though the increases number of fruit to compete more for nutrients and minerals, resulted that reducing fruit weight and also fruit length and breadth of fruit. Similar kinds of results were found by Hodda *et al.* (2001) in mango cv. Langra; shinde (2015) in mango cv. Alphnso and Chaudhary (2017) in mango cv. Sonpari.

**5.4.2 Effect of dose**

Similarly, the data revealed that application of different treatment dose of paclobutrazol application had produced significant effect on yield and yield attributing parameters *viz*., number of fruit per tree, fruit yield (kg/tree), fruit yield (t/ha), fruit weight, fruit length and fruit breadth during the year 2019-20, 2020-21 and pooled.

Significantly, higher number of fruit per tree (103.09, 109.88 and 106.48) were recorded in the soil application of paclobutrazol @ 14.5 g *a.i.* ($D_4$), fruit yield (24.73, 25.65 and 25.19 kg/tree), fruit yield (6.67, 7.12 and 7.00 t/ha), fruit weight (264.20, 259.11 and 261.65 g), fruit length (10.38, 10.34 and 10.36 cm) and breadth of fruit (7.18, 6.98 and 7.08 cm) were recorded in the soil application of paclobutrazol @ 8.5 g *a.i.* ($D_2$) during the year 2019-20, 2020-21 and pooled, respectively.

This increased production could be the cumulative effect of profuse flowering, increased fruit set and retention at marble and maturity stage per panicle in the year of investigation. An increase in production was also achieved in Alphonso at Vengurle, in Maharashtra by Burondkar and Gunjate (1993) in mango cvs. Alphonso, Ratna, Kesar, Pairi, Goa Mankur, Amrapali, Doodh Penda; Kulkarni (1989) in mango cvs. Banganapalli, Dashehari and peddarasam at Andhra Pradesh and Desai (1994) in mango cv. Alphanso at Valsad, in Gujarat by application of paclobutrazol.

Reduction in fruit size at higher concentration may be due to higher number of fruit retention and more fruits per panicle as well as tree which might have caused competition among the fruits and also source-sink relationship during different growth and development stages. Reduction of fruit size like fruit weight, length and breadth in different cultivars of mango was also reported by Kulkarni (1989) in mango cvs. Banganpalli, Dashehari and Peddarasam; Hiller and Rudge (1991) in mango; Burondker *et al.* (2000); Sanjay and Jayant (2003) in mango cv. Dashehari; Winston (2004) in mango cv. Kinsingtone Pride; Golla *et al.* (2017) in mango cv. banganpalli; Kumar *et al.* (2019) in mango cv. Alphanso and Subbaiah *et al.* (2019) which support present findings.

### 5.4.3 Interaction effect of time and dose

Similarly, the data from present investigation as observed in previous chapter revealed that the interaction effect between time and dose of paclobutrazol application were also found non significant on yield and yield attributing parameters *viz*., number of fruit per tree, fruit yield (kg/tree), fruit yield (t/ha), fruit weight, fruit length and fruit breadth during the year 2019-20, 2020-21 and pooled.

## 5.5 EFFECT ON QUALITY PARAMETERS

### 5.5.1 Effect of time

The data revealed that application of different time of paclobutrazol application had produced non significant effect on quality parameters *viz*., TSS, titrable acidity, reducing sugar, non-reducing sugar, total sugar, pulp-skin ratio and shelf life in fruit were noted due to time of paclobutrazol application during the years 2019-20, 2020-21 and in pooled.

In the present experiment, chemical composition of fruits revealed that time of paclobutrazol application neither improved nor impaired the TSS, titrable acidity, reducing sugar, non-reducing sugar, total sugars and pulp-skin ratio in the Kesar mango during the year of investigation. The present findings are in accordance with Kulkarni (1988) in mango cvs. Banganapalli, Dashehari and Peddarasam; Burondkar and Gunjate (1993) in mango cvs. Alphonso, Ratna, Kesar, Pairi, Goa Mankur, Amrapali, Doodh Penda; Desai (1993) in mango cv. Alphanso and Padhiar (2000) in

mango cvs. Kesar, Rajapuri, Dashehari and Totapuri. The treatments had no significant effect on the shelf life of fruits in mango cv. Kesar.

### 5.5.2 Effect of dose

The result of different dose of paclobutrazol application was found significant for quality parameters *viz*., TSS, reducing sugar, total sugar, pulp-skin ratio and shelf life during the year 2019-20, 2020-21 and pooled.

Significantly, higher TSS (18.81, 19.09 and 18.95 $^{o}$Brix), reducing sugar (5.52, 5.52 and 5.38 %), total sugar (15.56, 15.92 and 15.74 %), pulp-skin ratio (4.96, 4.36 and 4.41 %) and shelf life (14.29, 14.45 and 14.37 days) were observed in the soil application of paclobutrazol @ 8.5 g *a.i.* ($D_2$) during the year 2019-20, 2020-21 and pooled except titrable acidity and non-reducing sugar percentage, respectively.

From the present investigation observed that dose of paclobutrazol application paclobutrazol @ 8.5 g *a.i.* showed superior performances in respect of all above qualitative characters as compare to others. Paclobutrazol improved fruit quality observed by Kumar *et al.* (2019) in mango cv. Alphanso; Hoda *et al*. (2001) in mango cv. Langra; Yeshitela *et al.* (2004) in mango cv. Tommy Atkins; Singh and Ranganath (2006) in mango cv. Kew; Reddy *et al.* (2014) in mango cv. Totapuri and Chaudhari (2017) in mango cv. Sonpari. Vijayalakshmi and Srinivasan (2000) reported that paclobutrazol in Alphonso mangoes in India had the greatest effect enhancing all the qualitative parameters (ascorbic acid, total sugar, reducing sugar and TSS, except for acidity) in harvested fruits. Soil treatment with paclobutrazol improved the fruit quality attributes by Singh and Singh, (2006); Sarker and Rahim (2012) in mango cv. Bari Aam-3 (Amrapali) were also in the conformity with the results obtained.

### 5.5.3 Interaction effect of time and dose

It is obvious from the data analyzed that an interaction between time and dose of paclobutrazol application failed to produce any significant effect on quality parameters *viz*., TSS, Reducing sugar, total sugar, pulp-skin ratio and shelf life during the year 2019-20, 2020-21 and pooled.

## 5.6 EFFECT ON ECONOMICS

Economic is the main deliberation which helps in taking a decision regarding the adoption of a new technology. The net income in rupees per hectare was worked out from fruit yield, their average price and the inputs used during the period of experimentation.

From the study, it is apparent that the highest net returns (₹ 2,10,697 $ha^{-1}$) and BCR (1.86) were recorded under treatment of paclobutrazol application at 15$^{th}$ July with 8.5 g *a.i.* ($S_1D_2$). These results clearly indicated that the paclobutrazol application at 15$^{th}$ July with 8.5 g *a.i.* were economically most beneficial for mango production.

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# APPENDIX -I

**Appendix-I: Meteorological data recorded during crop season of the year 2019 to 2021.**

| Week | Std. week No. | Temperature ($^0$C) | | RH (%) | | Sun shine (hrs.) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Max. | Min. | | |
| July 2019 | 28 | 35.6 | 27.5 | 80 | 51 | 1.9 | 0.5 |
| | 29 | 34.5 | 26.2 | 87 | 58 | 3.3 | 63.7 |
| | 30 | 31.9 | 25.5 | 91 | 79 | 1.0 | 114.3 |
| | 31 | 28.3 | 24.5 | 96 | 95 | 0.0 | 213.3 |
| August 2019 | 32 | 28.9 | 25.5 | 96 | 92 | 0.0 | 180.6 |
| | 33 | 30.6 | 25.3 | 96 | 84 | 1.3 | 22.9 |
| | 34 | 32.4 | 24.8 | 90 | 73 | 5.3 | 3.9 |
| | 35 | 30.9 | 25.5 | 96 | 88 | 0.9 | 49.6 |
| September 2019 | 36 | 31.1 | 25.4 | 94 | 86 | 1.4 | 248.0 |
| | 37 | 29.8 | 25.3 | 96 | 85 | 0.0 | 180.5 |
| | 38 | 32.6 | 25.1 | 89 | 77 | 3.6 | 24.6 |
| | 39 | 31.0 | 24.3 | 93 | 84 | 2.7 | 196.2 |
| October 2019 | 40 | 32.5 | 23.9 | 87 | 65 | 7.4 | 36.8 |
| | 41 | 34.9 | 23.4 | 80 | 49 | 8.9 | 0.0 |
| | 42 | 35.2 | 22.7 | 77 | 43 | 8.9 | 1.0 |
| | 43 | 32.6 | 24.8 | 64 | 52 | 4.2 | 0.0 |
| | 44 | 34.0 | 23.7 | 80 | 54 | 5.7 | 4.4 |
| November 2019 | 45 | 33.3 | 22.0 | 70 | 46 | 6.1 | 0.0 |
| | 46 | 32.6 | 20.3 | 82 | 51 | 7.8 | 11.2 |
| | 47 | 32.5 | 17.9 | 80 | 39 | 5.9 | 0.0 |
| | 48 | 31.3 | 19.2 | 70 | 43 | 5.9 | 0.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| December 2019 | 49 | 31.6 | 19.4 | 66 | 44 | 3.7 | 0.0 |
| | 50 | 29.5 | 15.7 | 74 | 36 | 6.9 | 0.0 |
| | 51 | 28.7 | 14.7 | 74 | 39 | 7.5 | 0.0 |
| | 52 | 28.2 | 12.6 | 56 | 32 | 5.5 | 0.0 |
| January 2020 | 01 | 26.7 | 13.2 | 76 | 44 | 3.2 | 0.0 |
| | 02 | 27.9 | 14.7 | 69 | 42 | 3.4 | 0.0 |
| | 03 | 25.4 | 9.7 | 79 | 30 | 4.0 | 0.0 |
| | 04 | 29.6 | 13.2 | 73 | 33 | 4.1 | 0.0 |
| | 05 | 27.2 | 11.7 | 70 | 30 | 4.4 | 0.0 |
| February 2020 | 06 | 28.9 | 12.4 | 72 | 30 | 5.1 | 0.0 |
| | 07 | 27.2 | 11.7 | 70 | 30 | 5.0 | 0.0 |
| | 08 | 28.9 | 12.4 | 72 | 27 | 5.1 | 0.0 |
| | 09 | 33.8 | 17.3 | 74 | 24 | 5.8 | 0.0 |
| March 2020 | 10 | 33.3 | 15.0 | 77 | 29 | 5.6 | 0.0 |
| | 11 | 34.3 | 17.3 | 76 | 17 | 7.1 | 0.0 |
| | 12 | 33.0 | 16.9 | 48 | 30 | 7.5 | 0.0 |
| | 13 | 36.5 | 16.9 | 72 | 27 | 7.6 | 0.0 |
| April 2020 | 14 | 35.5 | 20.8 | 71 | 19 | 8.8 | 0.0 |
| | 15 | 39.0 | 21.0 | 74 | 17 | 9.9 | 0.0 |
| | 16 | 41.1 | 22.1 | 53 | 24 | 10.2 | 0.0 |
| | 17 | 40.9 | 24.9 | 59 | 25 | 10.1 | 0.0 |
| | 18 | 40.2 | 25.8 | 79 | 27 | 10.2 | 0.0 |
| May 2020 | 19 | 41.6 | 24.7 | 76 | 28 | 10.1 | 0.0 |
| | 20 | 41.1 | 25.6 | 84 | 26 | 10.1 | 0.0 |
| | 21 | 41.0 | 26.0 | 78 | 31 | 10.1 | 0.0 |
| | 22 | 42.4 | 26.3 | 86 | 39 | 11.1 | 0.0 |

# APPENDIX -II

**Appendix-II: Mean weekly weather parameters during the experiment period (July 2020 to May 2021)**

| Week | Std. week No. | Temperature ($^0$C) | | RH (%) | | Sun shine (hrs.) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Max. | Min. | | |
| July 2020 | 28 | 31.7 | 26.7 | 94 | 89 | 2.1 | 267.6 |
| | 29 | 31.3 | 25.5 | 95 | 80 | 1.5 | 118.7 |
| | 30 | 32.5 | 25.9 | 94 | 82 | 2.9 | 30.1 |
| | 31 | 33.1 | 26.4 | 94 | 76 | 3.7 | 37.6 |
| August 2020 | 32 | 32.2 | 26.3 | 86 | 83 | 0.9 | 53.8 |
| | 33 | 31.3 | 25.9 | 93 | 92 | 0.0 | 203.4 |
| | 34 | 28.6 | 25.5 | 96 | 87 | 0.7 | 224.4 |
| | 35 | 29.3 | 24.9 | 93 | 87 | 2.5 | 133.7 |
| September 2020 | 36 | 30.2 | 24.5 | 93 | 59 | 8.3 | 250.7 |
| | 37 | 33.9 | 25.9 | 84 | 73 | 4.0 | 0.0 |
| | 38 | 32.9 | 24.5 | 90 | 70 | 4.5 | 112.6 |
| | 39 | 33.2 | 25.6 | 89 | 56 | 6.5 | 23.5 |
| October 2020 | 40 | 32.5 | 24.8 | 83 | 51 | 9.0 | 0.0 |
| | 41 | 34.0 | 24.2 | 84 | 35 | 8.3 | 19.1 |
| | 42 | 36.7 | 25.2 | 73 | 55 | 5.5 | 0.0 |
| | 43 | 35.8 | 26.0 | 78 | 36 | 9.1 | 29.8 |
| | 44 | 35.6 | 21.7 | 69 | 28 | 8.7 | 0.0 |
| November 2020 | 45 | 35.1 | 18.3 | 68 | 27 | 8.6 | 0.0 |
| | 46 | 34.8 | 17.1 | 71 | 31 | 8.6 | 0.0 |
| | 47 | 33.9 | 17.5 | 64 | 33 | 7.7 | 0.0 |
| | 48 | 30.8 | 14.9 | 66 | 32 | 8.2 | 0.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| December 2020 | 49 | 31.3 | 19.2 | 70 | 43 | 5.9 | 0.0 |
| | 50 | 31.6 | 19.4 | 66 | 44 | 3.7 | 0.0 |
| | 51 | 29.5 | 15.7 | 74 | 36 | 6.9 | 0.0 |
| | 52 | 28.7 | 14.7 | 74 | 39 | 7.5 | 0.0 |
| January 2021 | 01 | 28.2 | 12.6 | 56 | 32 | 5.5 | 0.0 |
| | 02 | 25.3 | 12.0 | 64 | 33 | 3.9 | 0.0 |
| | 03 | 28.3 | 13.2 | 70 | 38 | 4.4 | 0.0 |
| | 04 | 29.0 | 10.8 | 70 | 31 | 6.5 | 0.0 |
| | 05 | 28.3 | 9.5 | 72 | 24 | 5.9 | 0.0 |
| February 2021 | 06 | 30.5 | 10.2 | 71 | 22 | 6.6 | 0.0 |
| | 07 | 31.1 | 10.9 | 64 | 19 | 8.0 | 0.0 |
| | 08 | 31.5 | 13.7 | 71 | 28 | 8.5 | 0.0 |
| | 09 | 34.6 | 16.8 | 63 | 23 | 10.2 | 0.0 |
| March 2021 | 10 | 35.2 | 17.2 | 60 | 18 | 10.3 | 0.0 |
| | 11 | 37.6 | 17.6 | 60 | 18 | 9.8 | 0.0 |
| | 12 | 37.5 | 20.3 | 80 | 17 | 10.1 | 0.0 |
| | 13 | 37.4 | 21.0 | 60 | 15 | 9.5 | 0.0 |
| April 2021 | 14 | 40.1 | 20.7 | 60 | 17 | 10.0 | 0.0 |
| | 15 | 40.1 | 21.8 | 59 | 19 | 9.9 | 0.0 |
| | 16 | 40.9 | 22.6 | 86 | 17 | 9.5 | 0.0 |
| | 17 | 40.3 | 25.2 | 73 | 23 | 8.8 | 0.0 |
| | 18 | 39.9 | 25.4 | 69 | 24 | 10.2 | 0.0 |
| May 2021 | 19 | 36.3 | 25.8 | 77 | 33 | 3.4 | 1.7 |
| | 20 | 38.2 | 26.2 | 79 | 41 | 9.3 | 0.0 |
| | 21 | 36.3 | 25.8 | 77 | 31 | 3.4 | 47.8 |
| | 22 | 38.2 | 26.2 | 79 | 40 | 3.2 | 3.6 |

# APPENDIX -III

**Appendix-III: Fixed cost of cultivation of Mango and other economical details**

**Fixed cost (₹ ha$^{-1}$)**

| Sr. No. | Particulars | Cost (`₹ ha$^{-1}$) |
|---|---|---|
| **A.** | **Material cost** | |
| 1. | Plant materials (total 300 plants required) @ ₹ 80 plant$^{-1}$ | 24,000 |
| 2. | Manures and fertilizers | |
| | i.e. Farm Yard Manure @ 100 kg plant$^{-1}$ (100 kg * 300 = 30000 kg * ₹ 1 kg$^{-1}$) | 30,000 |
| | Urea @ 2.04 kg plant$^{-1}$ (2.04 kg * 300 = 612 * ₹ 5.9 kg$^{-1}$) | 3,610 |
| | Single Super Phosphate @ 1.25 kg plant$^{-1}$ (1.25 kg * 300 = 375 * ₹ 8.4 kg$^{-1}$) | 3,150 |
| | Murate of Potash @ 1.67 kg plant$^{-1}$ (1.67 kg * 300 = 501 * ₹ 12.5 kg$^{-1}$) | 6,262 |
| 4. | Pesticides | 2,200 |
| | Hexaconazol @ 2.0 ml/lit.<br>Required quantity- 2.0 ml/lit. i.e. for 500 lit. of water/ha, so 1.0 lit./ha x ₹ 550 x 4 (Four-time application**)** = 1,800 | |
| 5. | Box charge [total 1700 box (10 kg) required @ ₹ 5 box$^{-1}$] | 8,500 |
| 6. | Cello tape (total cello tape 10 @ ₹ 30 tape$^{-1}$) | 400 |
| | **Total material cost** | **78,122** |
| **B.** | **Labour cost** | |
| 1. | Land preparation (6 L * ₹ 178) | 1,068 |
| 2. | Digging of pits (30 L * ₹ 178) | 5,340 |
| 3. | Planting (8 L * ₹ 178) | 1,424 |
| 4. | Basin preparation (15 L * ₹ 178) | 2,670 |
| 5. | Application of manures and fertilizers (15 L * ₹ 178) | 2,670 |
| 6. | Irrigation (8 L * ₹ 178) | 1424 |
| 7. | paclobutrazol application (i.e. 18 L * ₹ 178) | 3204 |
| 8. | Hand weeding 2 times (10 L per time i.e. 20 L * ₹ 178) | 3,560 |
| 10. | Plant protection 4 times (2 L per time i.e. 8 L * ₹ 178) | 1,424 |
| 11. | Harvesting (30 L * ₹ 178) | 5,340 |
| 12. | Grading and Packaging (6 L * ₹ 178) | 1,068 |
| | **Total labour cost** | **29,192** |
| **C.** | **Farm implementation** | |
| 1. | Interculturing 2 times ((3 hrs. @ ₹ 600.00 hr$^{-1}$) | 3,600 |
| 2. | Pesticide application charge through tractor @ 24 hrs (₹ 400.00 hr$^{-1}$) | 9,600 |
| | **Total farm implementation** | **13,200** |
| **D.** | **Miscellaneous cost** | |
| 1. | Electricity bill (total 824 hrs. @ ₹ 4 hrs.$^{-1}$) | 3,296 |
| 2. | Land revenue for 22 months @ ₹ 700 ha$^{-1}$ | 1283 |
| 3. | Rental value of land | 25,000 |
| 4. | Supervision charges 10 % of total field cost | 26,295 |
| | **Total miscellaneous cost** | **55,874** |
| | **Total fixed cost (A + B + C + D)** | **163118** |
| | | |

| Sr. No. | Materials | Price |
|---|---|---|
| **1.** | FYM | ₹ 1 $kg^{-1}$ |
| **2.** | Urea | ₹ 5.9 $kg^{-1}$ |
| **3.** | Single Super Phosphate | ₹ 8.4 $kg^{-1}$ |
| **4.** | Muriate of potash | ₹ 12.5 $kg^{-1}$ |
| **5.** | Hexaconazol | ₹ 550 $lit.^{-1}$ |
| **6.** | Labour charge | ₹ 178 $day^{-1}$ |
| **7.** | Box | ₹ 5 $box^{-1}$ |
| **8.** | Cello tape | ₹ 30 $tape^{-1}$ |

# APPENDIX -IV

## Appendix-IV: Variable cost of Paclobutrazol as per treatment (one hectare)

| **Factor B: different dose of paclobutrazol application** | **Cost (₹ /ha)** |
|---|---|
| **1.** $D_1$ - Paclobutrazol @ 5 g *a.i.* (22 ml/10 lit.)<br>Required quantity- 22 ml/10 lit. i.e. for 2800 lit. of water /ha, so 6.2 lit./ha * ₹4000 * 2 (Two-time application**)** = 48464 | 49,600 |
| **2.** $D_2$ - Paclobutrazol @ 8.5 g *a.i.* (37 ml/10 lit.)<br>Required quantity- 37 ml/10 lit. i.e. for 2800 lit. of water /ha, so 10.3 lit./ha * ₹4000 * 2 (Two-time application**)** = 82400 | 82,400 |
| **3.** $D_3$ - Paclobutrazol @ 11.5 g *a.i.* (50 ml/10 lit.)<br>Required quantity- 50 ml/10 lit. i.e. for 2800 lit. of water /ha, so 13.9 lit./ha * ₹4000 * 2 (Two-time application**)** = 111200 | 1,11,200 |
| **4.** $D_3$ - Paclobutrazol @ 14.5 g *a.i.* (63 ml/10 lit.)<br>Required quantity- 63 ml/10 lit. i.e. for 2800 lit. of water /ha, so 17.5 lit./ha * ₹4000 * 2 (Two-time application**)** = 140000 | 1,40,000 |

| **Sr. No.** | **Materials** | **Price** |
|---|---|---|
| **1.** | Paclobutrazol | ₹ 4,000 $lit^{-1}$ |

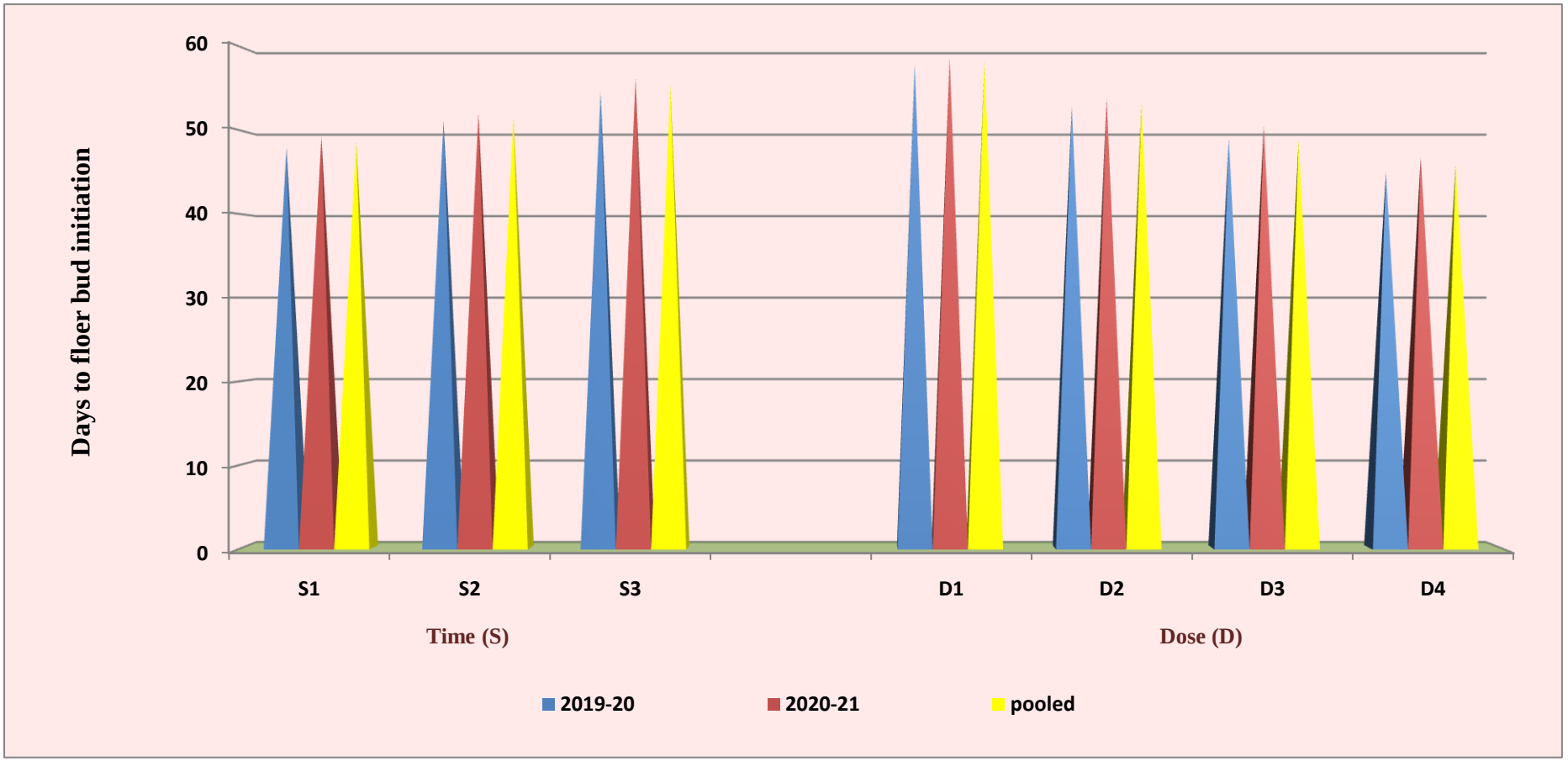


**Fig. 4.1: Effect of time and dose of paclobutrazol application on days to flower bud initiation**

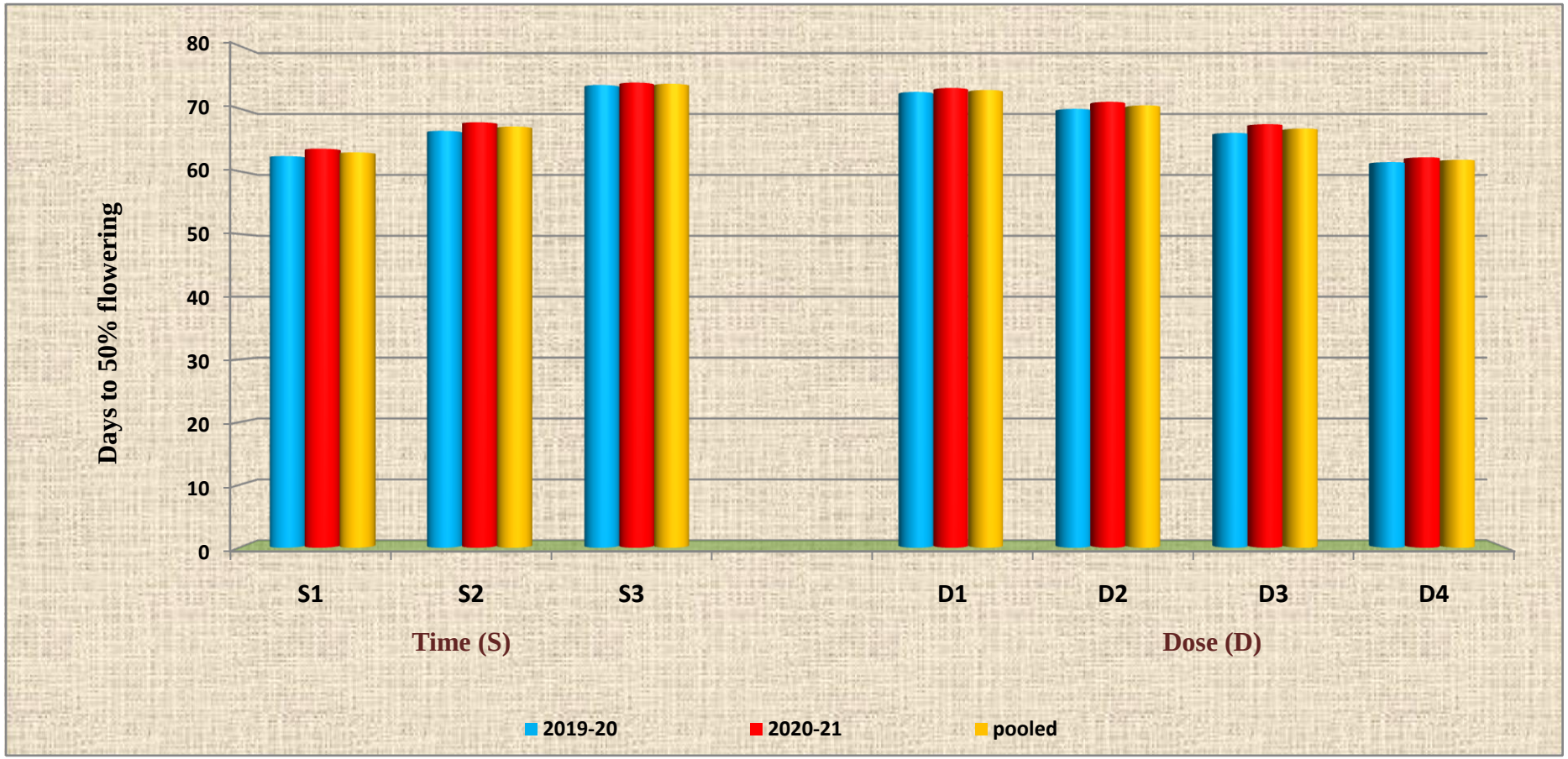


**Fig. 4.2: Effect of time and dose of paclobutrazol application on days to 50% flowering**

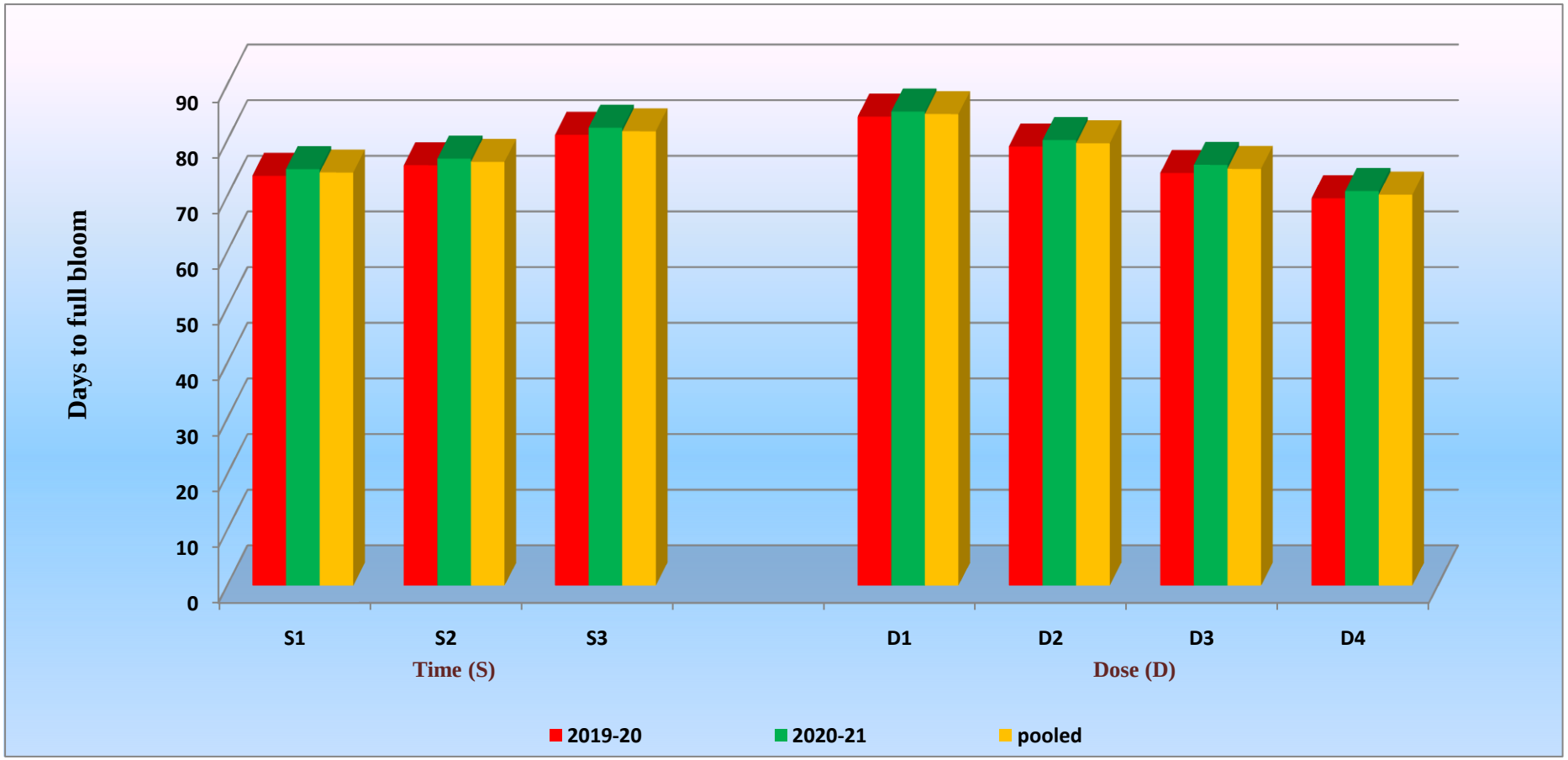


**Fig. 4.3: Effect of time and dose of paclobutrazol application on days to full bloom**

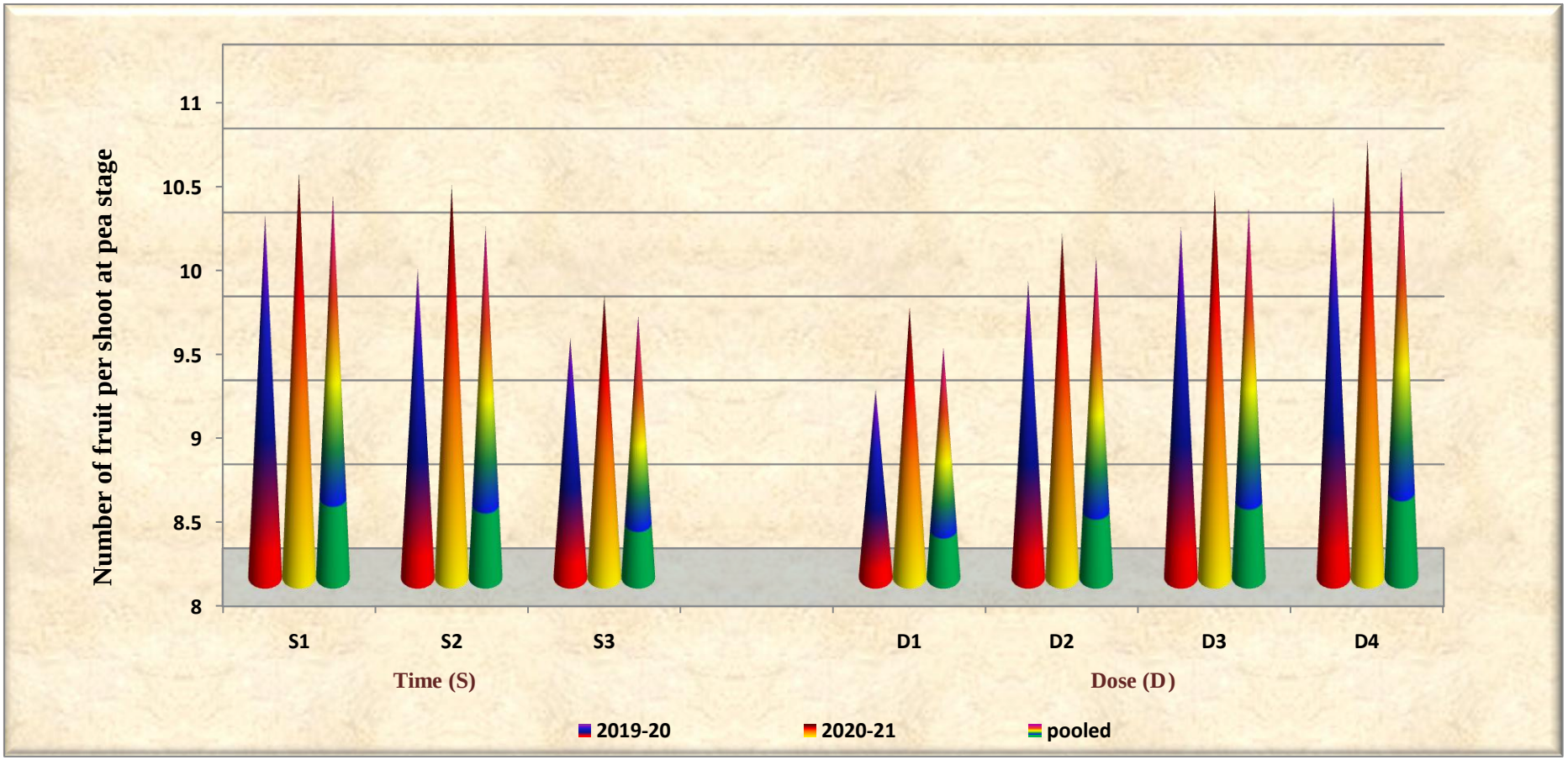


**Fig. 4.4: Effect of time and dose of paclobutrazol application on fruit set per shoot at pea stage**

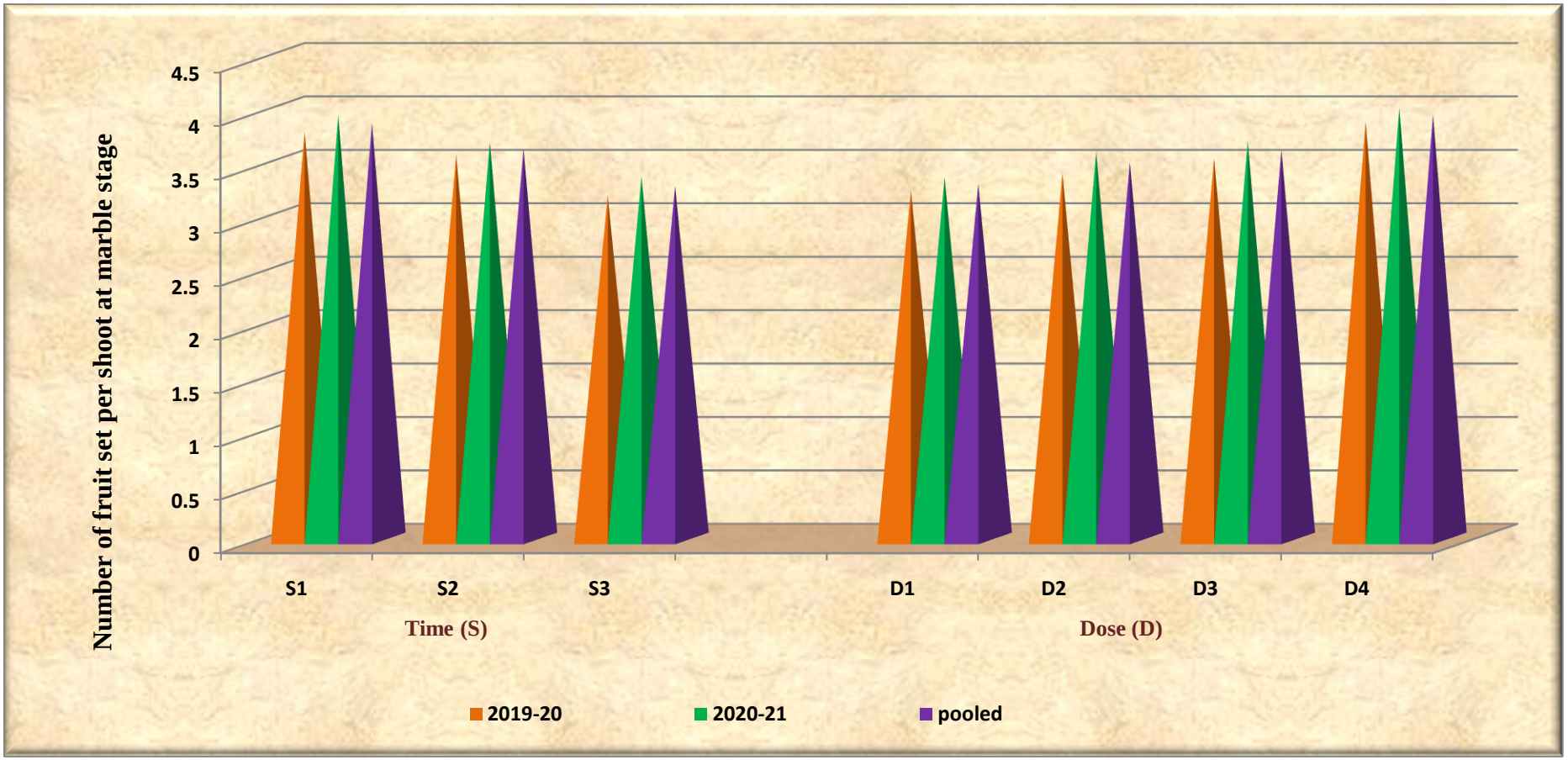


**Fig. 4.5: Effect of time and dose of paclobutrazol application on fruit set per shoot at marble stage**


**Fig. 4.6: Effect of time and dose of paclobutrazol application on fruit retention (%) per shoot**

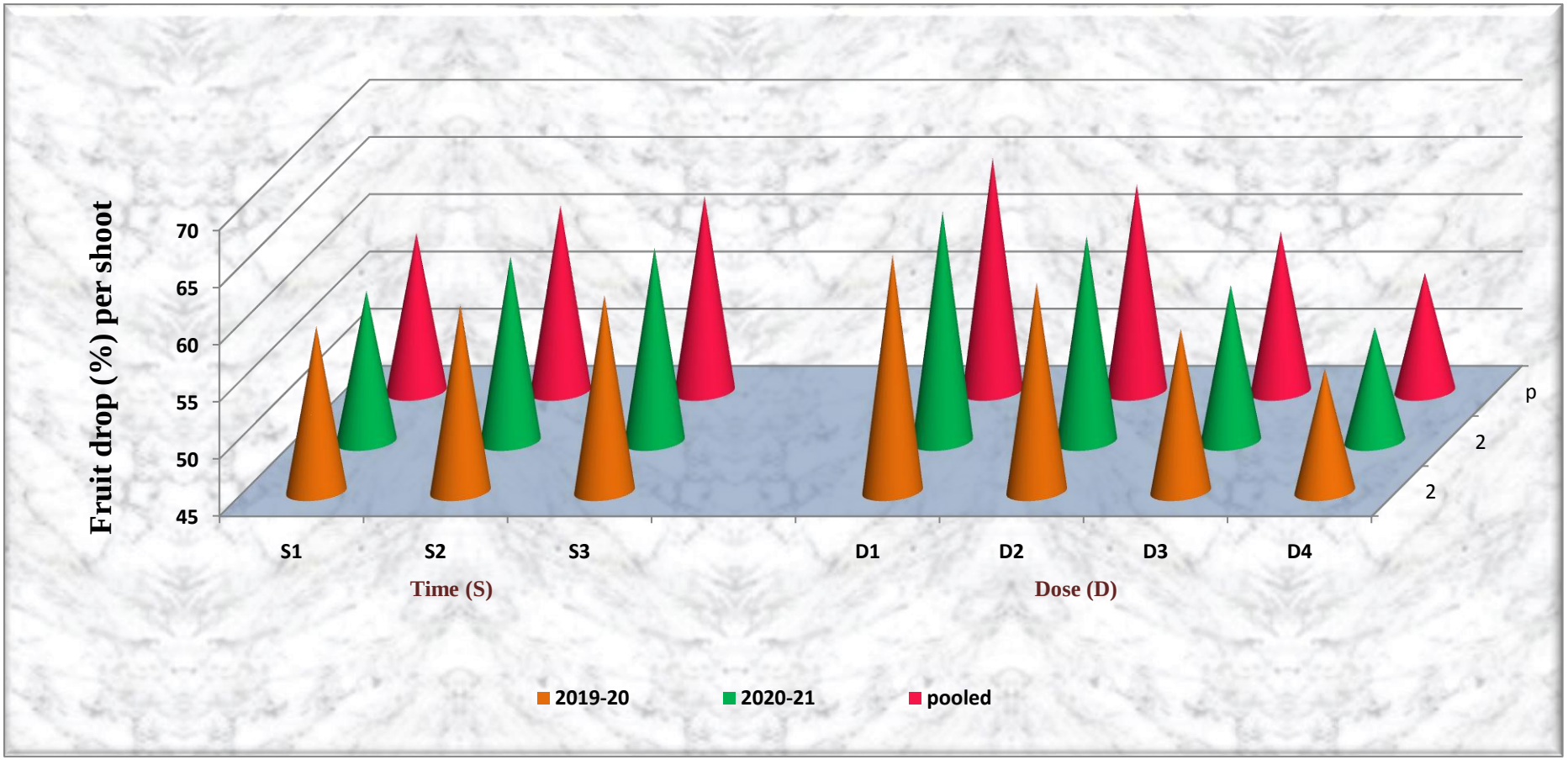


**Fig. 4.7: Effect of time and dose of paclobutrazol application on fruit drop (%) per shoot**

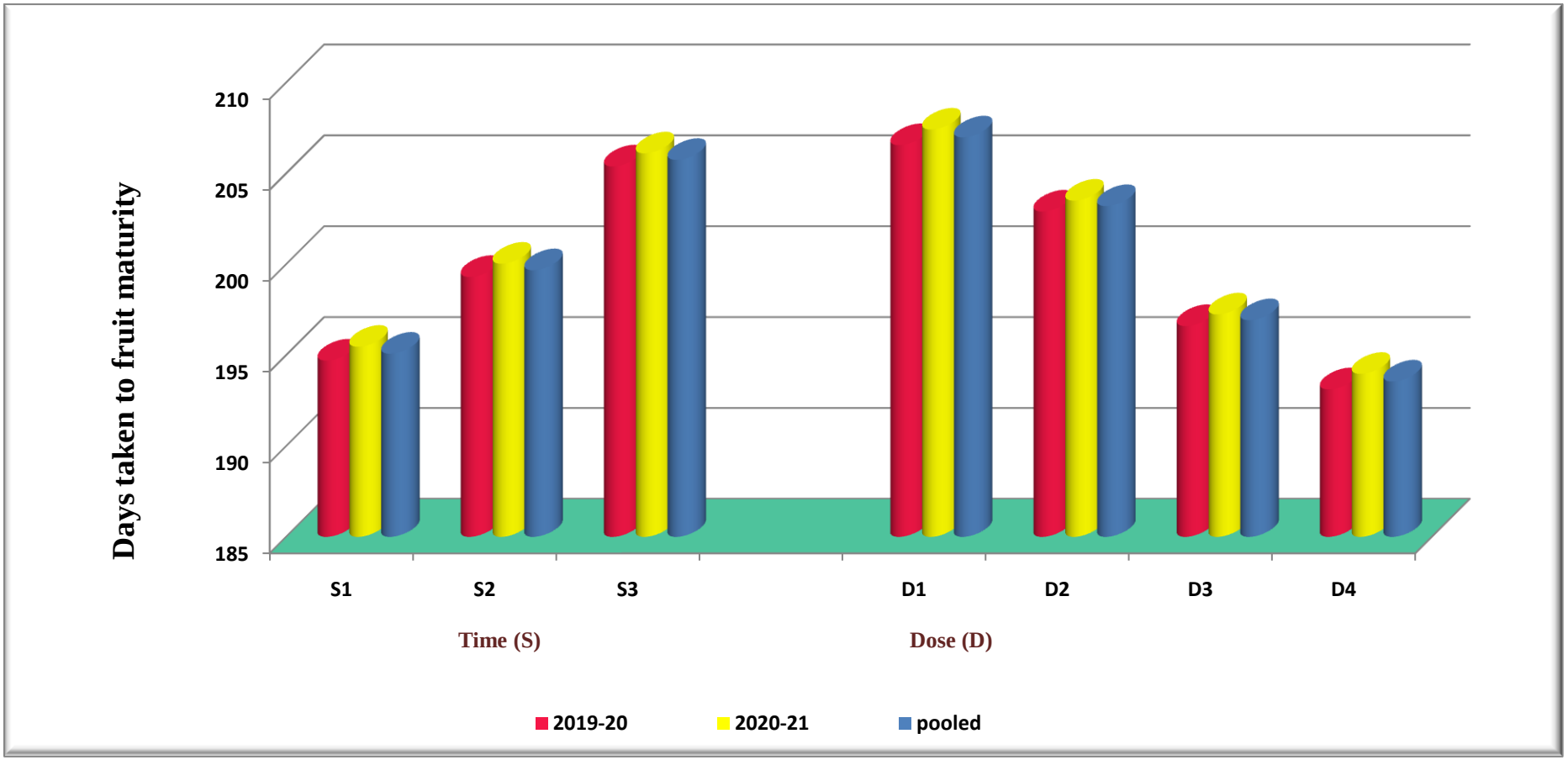


**Fig. 4.8: Effect of time and dose of paclobutrazol application on Days taken to fruit maturity**


**Fig. 4.9: Effect of time and dose of paclobutrazol application on Number of fruit per tree**

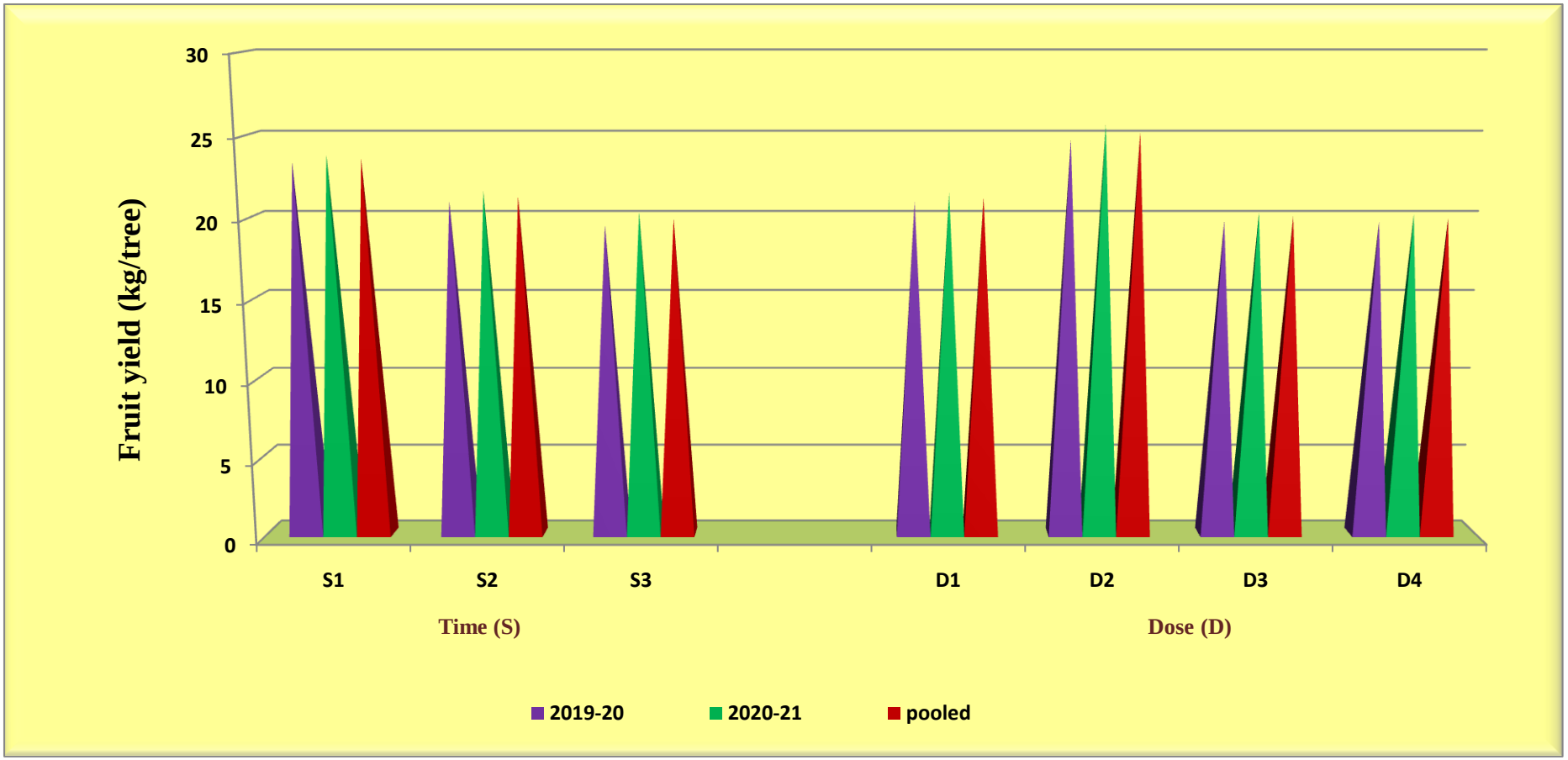


**Fig. 4.10: Effect of time and dose of paclobutrazol application on Fruit yield (kg/tree)**

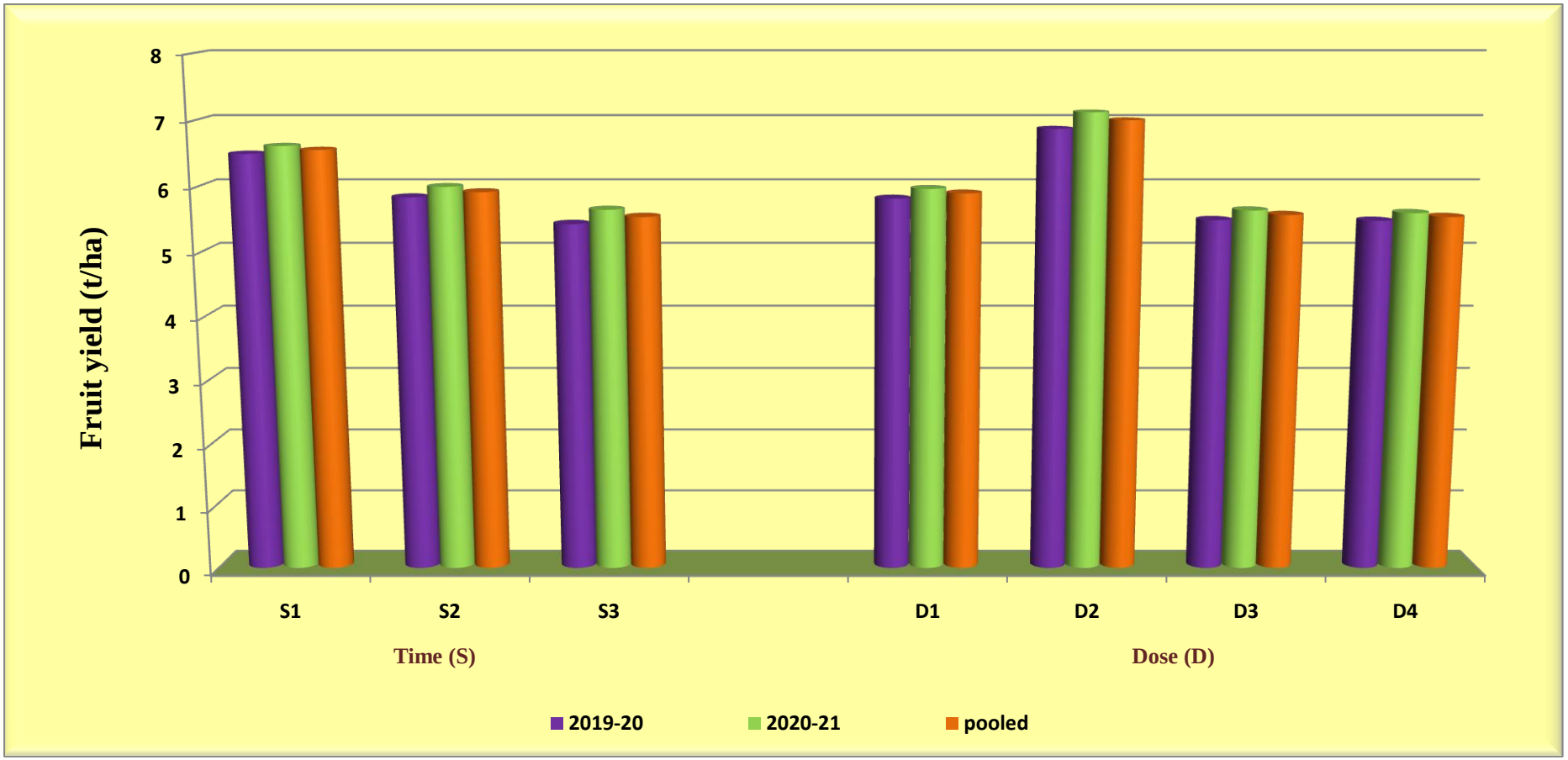


**Fig. 4.11: Effect of time and dose of paclobutrazol application on Fruit yield (t/ha)**

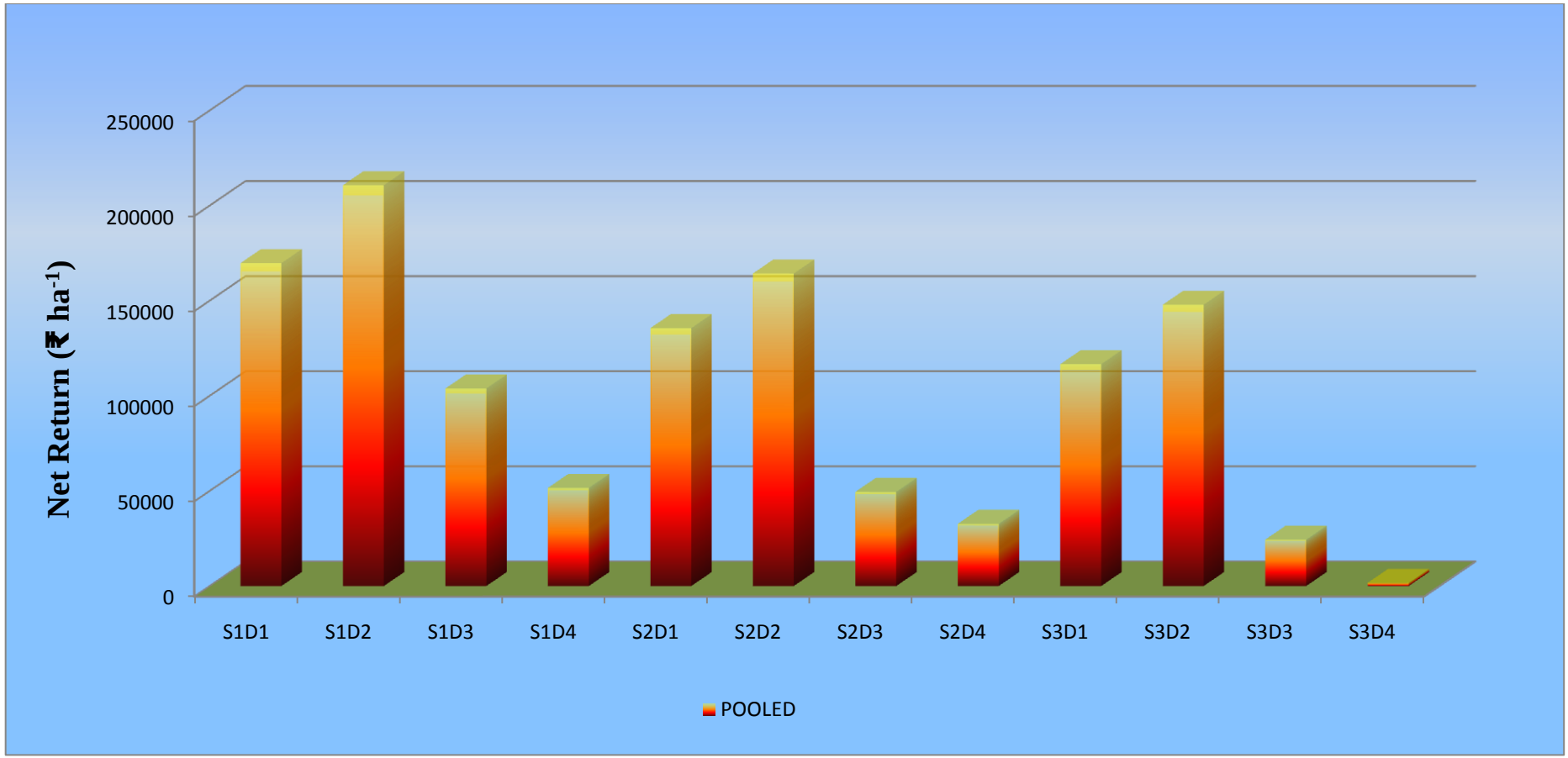


**Fig. 4.12: Effect of time and dose of paclobutrazol application on net return (₹ ha$^{-1}$) of mango cv. Kesar**

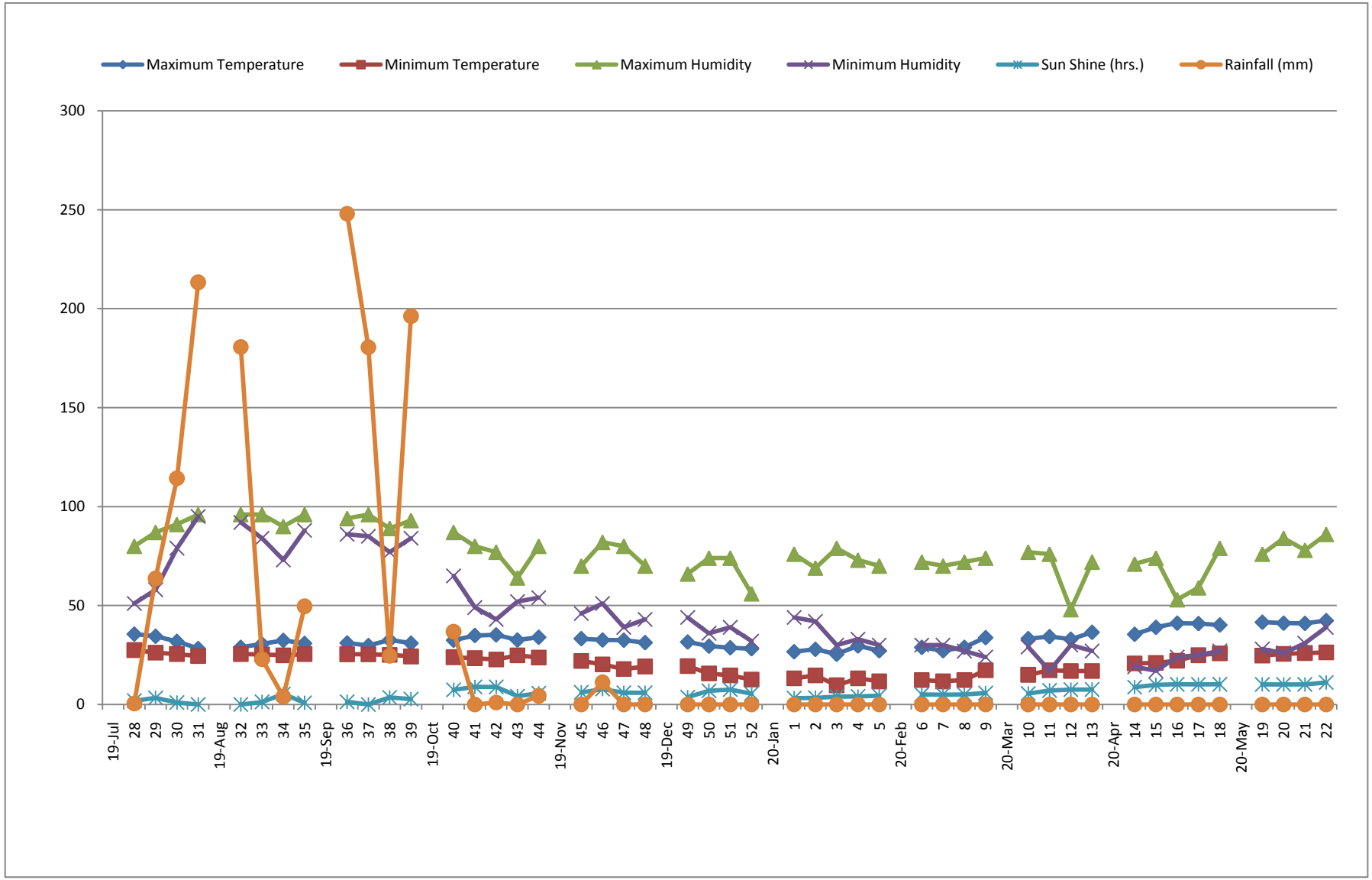


**Fig. 3.1 Mean weekly weather parameters during the experiment period (July 2019 to May 2020)**

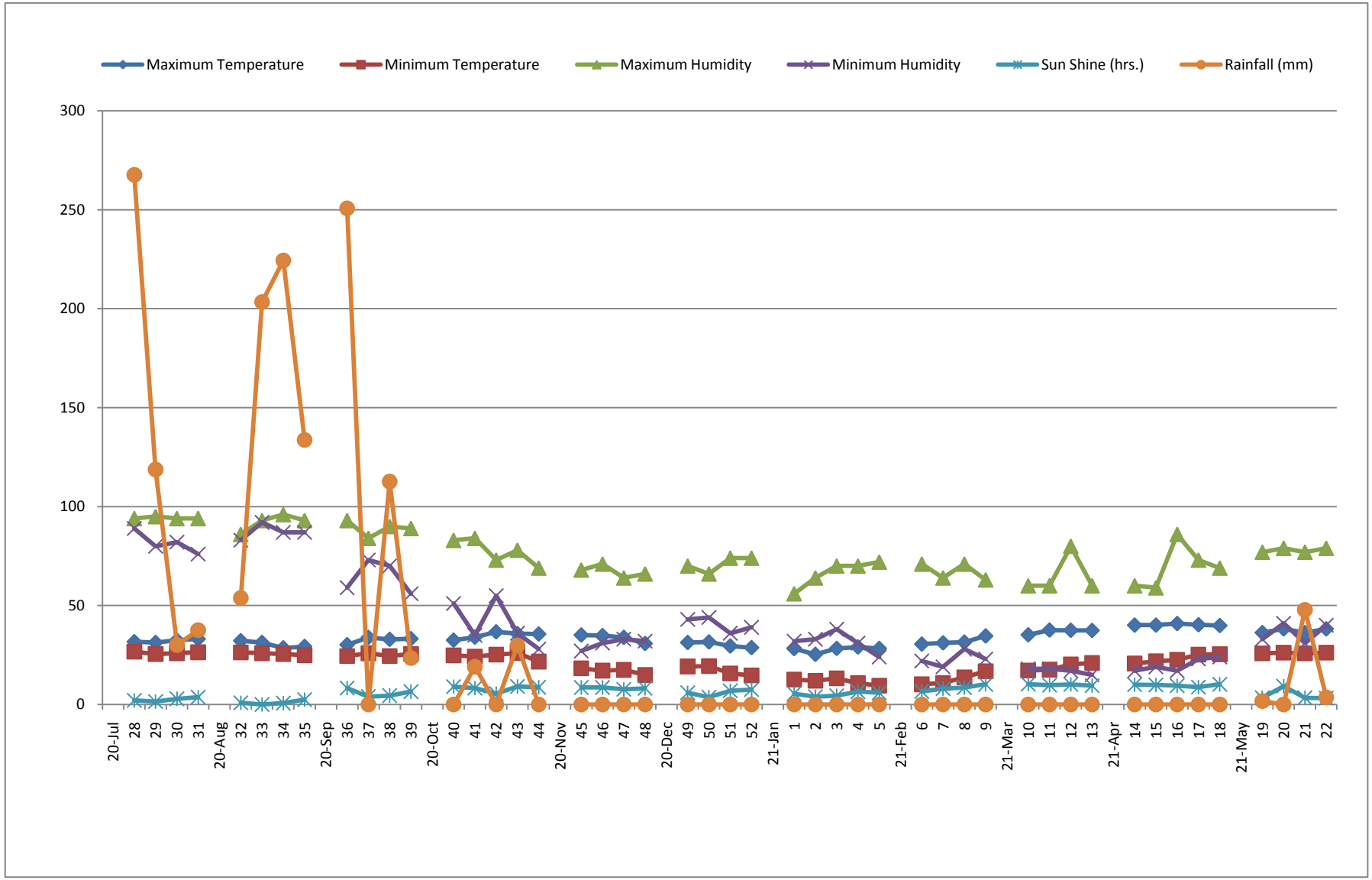


**Fig. 3.2 Mean weekly weather parameters during the experiment period (July 2020 to May 2021)**