"EFFECT OF PINCHING PRACTICES AND PACLOBUTRAZOL ON GROWTH, FLOWER YIELD AND POT PRESENTABILITY OF POTTED ANNUAL – *Zinnia elegans*"

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By

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CERTIFICATE

Miss. MALEPATI S.N.V.S.SRIPRIYA BHARGAVI has satisfactorily prosecuted the course of research and that the thesis entitled **"EFFECT OF PINCHING PRACTICES AND PACLOBUTRAZOL ON GROWTH, FLOWER YIELD AND POT PRESENTABILITY OF POTTED ANNUAL – *Zinnia elegans"*** submitted is the result of original research work and is of sufficiently highstandard to warrant its presentation to the examination.

I certify that neither the thesis nor its part thereof has been previously submittedby her for a degree of any University.

Place: Rajendranagar, Hyderabad.
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(Dr. N. SEENIVASAN)
Chairman

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF PINCHING PRACTICES AND PACLOBUTRAZOL ON GROWTH, FLOWER YIELD AND POT PRESENTABILITY OF POTTED ANNUAL – *Zinnia elegans"*** submitted in partial fulfillment of the requirements for the degree of Master of Science in Horticulture (Floriculture and Landscape Architecture) of Sri Konda Laxman Telangana State Horticultural University, Mulugu, Siddipet, is a record of the bonafide research work carried out by **Miss. MALEPATI.S.N.V.S. SRIPRIYA BHARGAVI** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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(MALEPATI.S.N.V.S. SRIPRIYA BHARGAVI)

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LIST OF SYMBOLS AND ABBREVIATIONS

%	:	Per cent
@	:	at the rate of
/	:	Per
&	:	And
^{o}C	:	Degree Celsius
CD	:	Critical Difference
Conc.	:	Concentration
Cm	:	Centimeter
Cv.	:	Cultivar
DAT	:	Days after transplanting
dSm^{-1}	:	Desi Siemen per meter
EC	:	Electrical conductivity
et al.	:	And others
Etc.	:	Etcetera
Fig.	:	Figure
FCRD	:	Factorial Completely Randomized Design
g	:	Gram
i.e.	:	that is
Max.	:	Maximum
Mg	:	Milligram
NS	:	Non- significant
No.	:	Number
Min.	:	Minimum
IAA	:	Indole Acetic Acid
PGR	:	Plant Growth Regulators
Mm	:	Millimeter

M	:	Meter
R.H.	:	Relative Humidity
P	:	Pinching levels
R	:	Paclobutrazol concentrations
S.E (m)±	:	Standard Error of Mean
Sig.	:	Significant
SKLTSHU	:	Sri Konda Laxman Telangana State Horticultural University
Var.	:	Variety

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ABSTRACT

The present investigation "Effect of pinching practices and paclobutrazol on growth, flower yield and pot presentability of potted annual – *Zinnia elegans"* was carried out at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Hyderabad during November 2020 to January 2021.

The experiment was laid out in Factorial Completely Randomized Design with twelve treatments and three replications. The main objective of the experiment was to identify the effect of pinching and paclobutrazol on growth, flower yield and pot presentability of *Zinnia elegans*. The treatments consisted of three levels of pinching *viz.*, P_1: Single pinching, P_2: double pinching and P_3: no pinching with four concentrations of paclobutrazol *viz.*, R_1: 50 ppm paclobutrazol, R_2: 100 ppm paclobutrazol, R_3: 150 ppm paclobutrazol and R_4: No spray.

Among pinching levels, no pinching (P_3) recorded the maximum values for leaf width (4.54, 4.60 cm), leaf length (7.50, 7.52 cm), leaf area (29.24, 29.85 cm^2), flower longitivity (21.34) and minimum number of days for flower bud initiation (13.69), days to 50 percent flowering (21.49), number of days taken to full bloom (23.82). Double pinching (P_2) registered maximum values of stem diameter (0.59, 0.62 cm), number of nodes (27.22, 31.13), number of branches per plant (20.35, 23.56), plant spread (E-W) (20.58, 24.18 cm), plant spread (N-S) (21.04, 23.10 cm), number of flowers per plant (18.91), fresh weight of flowers (44.68 g), dry weight of flowers per plant (9.41 g), pot presentabilty (80.34) and B:C ratio (1.34) and minimum values for plant height (20.16, 23.84 cm) and internodal length (2.51, 2.61 cm) at 45 DAT and at the end of flowering season respectively and also for fresh weight of shoot (84.12 g), dry weight of shoot (32.47 g) and flower diameter (5.17 cm).

Among paclobutrazol concentrations, no spray (R_4) recorded maximum mean values for leaf width (4.40, 4.50 cm), leaf length (7.19, 7.22 cm), leaf area (26.96, 27.35 cm^2) at 45 DAT and at the end of flowering season respectively also, for fresh weight of shoot (81.65g), dry weight of shoot (31.45g) and minimum values for days to flower bud initiation (28.10), days to 50 percent flowering (33.74), number of days taken to full bloom (38.23). paclobutrazol 150 ppm (R_3) recorded maximum stem diameter (0.57, 0.61 cm) and minimum plant height(24.25, 25.79 cm), internodal length (3.05, 3.11 cm) and flower diameter (5.56 cm).paclobutrazol 100 ppm (R_3) recorded maximum values for number of nodes (24.57,27.37), number of branches per plant (16.33, 18.30), plant spread (E-W) (18.95, 20.78 cm), plant spread (N-S) (19.32, 20.35 cm) at 45 DAT and at the end of flowering season respectively and also for maximum number of flowers per plant (14.66), pot presentability (82.90) and B:C ratio (1.17).

Among treatment combinations, double pinching with 150 ppmpaclobutrazol (P_2R_3) registered minimum mean values for plant height (18.93,21.55 cm) at 45 DAT and end of flowering season respectively. Double pinching with 100 ppm of paclobutrazol (P_2R_2) recorded maximum number of nodes (29.66, 34.20), number of branches per plant (22.65, 25.56), plant spread (E-W) (21.46, 25.78 cm), plant spread (N-S) (22.35, 24.52 cm) at 45 DAT and at the end of flowering season respectively and also for number of flowers per plant (20.61) and B:C ratio 1.40. Double pinching with no spray (P_2R_4) reported maximum mean values for fresh weight of shoot (94.62g) and dry weight of shoot (37.33g). Interaction effect for some parameters like stem diameter, internodal length, leaf length, leaf width and leaf area, days to flower bud initiation, days to 50 percent flowering, number of days taken to full bloom, flower diameter, longitivity, fresh and dry weight of flower per plant were found non-significant

In conclusion, maximum positive effect on growth, yield, pot presentability and higher net realization parameters were registered by double pinching among pinching levels and 100 ppm paclobutrazol (R_3) among paclobutrazol concentrations. While, the interaction, double pinching with 100 ppm paclobutrazol (P_2R_3) was found preferable for growth, yield, pot presentability and higher net realization which was followed by double pinching with 50 ppm paclobutrazol (P_2R_1).

Chapter - I

Introduction

CHAPTER I

INTRODUCTION

Floriculture is one of the most potential components of the Horticulture Industry, being important from aesthetic, social and economic points of view. Floriculture deals with cut or loose flowers, ornamental plants, potted plants, dried flowers, essential oils and landscape gardening.

Potted plants are of considerable commercial importance for instant gardening and for indoor, as well as, outdoor decoration. These can be easily carried to places, which need to be landscaped immediately. The potted plantindustry is growing enormously. Potted plants may be either ornamental foliage or flowering. They are also planted and arranged or placed where they will thrive for auseful purpose.

Zinnia is a genus of annual and perennial flowering plant belonging to Asteraceae (Compositae) family with about 20 species. *Zinnia elegans (syn. Zinnia violacea)* is the most popular and well known annual among the genus. Zinnia flowers exhibit bright, uniform color sturdy stems with disease resistant plants and long vase life. The chromosome number of *Zinnia elegans* is 2n =24.

Zinnia elegance is commonly known as Youth–and–age plant, common zinnia and elegant zinnia. It is a symbol of endurance, goodness and friendship and the genus was named after a German botanist Johann Gottfried Zinn. It is said to be originated in Mexico and some parts of South and Central America.

Zinnias are dwarf, short garden plants (31.0 – 46.0 cm in height) (Metcalf & Sharma, 1971). They look lavishly elegant with wide range of flower forms available in single, semi double and double forms with wide range of colours like white, pink, cream, red, purple, green, yellow, orange, salmon, bronze. The beautiful flower heads are round in form and are borne at the top of the branches. They consist of disc florets which are bisexual and ray florets which are female.

Leaves are simple, opposite usually sessile, linear to ovate with rounded tips. Leaf colour ranges from pale to medium green.

Zinnias have ability to withstand hot summer and are a popular flower for summer and rainy season. Most of them are prolific bloomers, making them excellent for landscape gardening. It is the first flower that was successfully grown in space.

Zinnias can be used as a cut flower, as a potted plant, as a dried flower, in butterfly gardens to attract butterflies, as a companion plant with vegetables as they deter cucumber beetles, tomato worms & whiteflies, it also has nematicidal properties and also used to prepare dyes and paints. Some species of the Zinnia genus have been studied for their potential biological actions, such as antifungal, antioxidant, hepato protective, antibacterial, antiviral, antimalarial, cytotoxic (demonstrated on cancer cell lines), and insecticidal (Burlec *et al*, 2019). Cut flower remains fresh for 5 – 7 days and even till 20 days with regular changeof water.

As most of the annuals, zinnia is also propagated through seeds. It does not grow well in cool climate as it needs warmth to germinate and grow faster. They can be grown in open as well as in protected conditions.

After 30 - 50 days of sowing, flower buds start appearing. Zinnia is qualitative short day plant and flower is initiated well when given 5 short days having at least 12 hours light period (Kim *et al.,* 2009). After zinnias flower, old flowers are removed (a process called “dead heading”) to encourage more flowers to form.

Being a minor flower crop, its cultivation has not received much attention in recent years. In the view of its importance and ease of cultivation, it is necessary to generate scientific information to farming community and landscapists. Lack of proper research, information on agronomic practices and knowledge about quality seed also paved for the lack of attention on this plant. Hence, there is a need to have more research on this crop.

Growth retardants and pinching practices are often used during growing stage to increase the compact plant growth mainly in potted plants. The main objective of them is to slow stem stretch while allowing the plant to grow. Growth retardants are known to produce compact plants, increase the number of flowers and delay or hasten flowering (Bayaskar *et al*. 2019). On the other hand, pinching encourages side bud to grow so that, flower yield may be increased.

The morphology and physiology of the plant is greatly influenced by the plant growth retardants. They mainly modify the plant characters when applied in very minute quantity. It influences the physiological processes within the plant which effects the growth and yield of the plant. It slows cell division and cell elongation of shoot tissue and regulates plant height physiologically without formative effects. Because of their specific properties in regulating shoot growth, the plant retardants have become the most widely used group of bioregulators in horticultural practices.

Bushy appearance adds value to the potted plants by producing more number of flowering branches which can be achieved by pinching. Due to apical dominance, the apical stem dominates the lateral stem. Apical bud produces an auxin called IAA which increases vertical plant growth and inhibits the growth of lateral branches hindering the bushy appearance of the potted plant and also decreases the pot presentability.

In most of the potted plants, the presentability depends on the bushy appearance which can be manipulated by checking the vertical growth of the plant and encouraging lateral shoot by means of pinching terminal bud. Removal of apical portion of shoot, removes the source of apical dominance and assimilates are diverted into lateral buds and branching (Cline, 1991). When apical bud is pinched, the IAA concentration levels are lowered that allows the lateral buds to grow and produce new shoots and branches.

Paclobutrazol is probably the most widely used PGR in the production of floriculture crops because of its wide range of efficacy and moderate to long-lasting response. It is a member of triazole family of plant growth regulators paclobutrazol

impedes gibberellin biosynthesis through blocking ent-kaurenesynthesis in the metabolic pathway of gibberellin production, resulting in reduced amounts of active gibberellins and consequent reduction in stem elongation (Tesfahun, 2018).

Keeping in the view of above information, the research programme entitled, **"EFFECT OF PINCHING PRACTICES AND PACLOBUTRAZOL ON GROWTH, FLOWER YIELD AND POT PRESENTABILITY OF POTTED ANNUAL – *Zinnia elegans"*** is planned with following objectives:

1. To study the influence of pinching practices on growth, flower yield and pot presentability of potted annual- *Zinnia elegans*
2. To study the influence of paclobutrazol on growth, flower yield and pot presentability of potted annual- *Zinnia elegans*
3. To evaluate the best combination of pinching and paclobutrazol on growth, flower yield and pot presentability of potted annual- *Zinnia elegans*

Chapter - II

Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

Zinnias have good potential to be used as flowering potted plants. They have attractive capitula with a wide variety of colours, shape and size, long blooming period, drought tolerance, easy propagation, fast growth, minimal labor requirements, rusticity, and are a quick source of novelty for the floriculture industry with the aid of growth retardants (Pinto, 2003).

In recent past, use of plant growth retards has become more popular in regulating the plant growth and yield aspects. Paclobutrazol is one of the growth retardants commonly used. It has anti-gibberellic activity.

Furthermore, pinching is also an important practice for obtaining compact stature of plants. Previous work has been done to evaluate the effect of pinching and zinnia responded well with pinching.

In this chapter, all the available and relevant literature pertaining to effect of pinching practices and paclobutrazol spray on growth, flower yield and pot presentability of zinnia has been reviewed under following heading.

2.1 To study the influence of pinching practices on growth, flower yield and pot presentability of potted annual- *Zinnia elegans*

2.2 To study the influence of paclobutrazol on growth, flower yield and pot presentability of potted annual- *Zinnia elegans*

2.3 To evaluate the best combination of pinching and paclobutrazol on growth, flower yield and pot presentability of potted annual- *Zinnia elegans.*

2.1 Influence of pinching practices on growth, flower yield and pot presentability of potted annual - Zinnia elegans.

Pinching is the process of removal of apical bud along with few leaves. Pinching delays the flowering but increases the number of flowers. Work on pinching has been done on zinnia but limited information regarding the double pinching was meager. Enhanced pot presentability with more number of flowers and compact plant

growth can be achieved with pinching in zinnia.

On zinnia

Atrachi (2010) executed an to evaluate the effect of pinching on growth and flowering of zinnia and documented that pinching increased the shoot number (26.41), total inflorescence number/ plant (17.52), inflorescence diameter (7.04 cm) and inflorescence dry weight (2.09 g) and inflorescence longevity (45.58 days).

Ullah *et al.* (2019) conducted an experiment on effect of zinnia to different pinching methods like single pinch, double pinch and no pinch and proclaimed that maximum days to flowering (64.83), number of branches (20), number of flowers plant^{-1} (16.11), fresh flower weight (14.03 g), flower diameter (13.86 cm), and stem girth (15 mm) were noticed in plants subjected to double pinching and minimum were noticed in control. Whereas, lowest plant height (58.42 cm) was documented in plants treated with double pinching.

Ali *et al.* (2021) studied the effect of pinching (at 2,4 and 6 leaf stage) on growth of zinnia and revealed that zinnia plants treated with 100 mg.L^{-1} and pinched at 6 leaves stage recorded maximum days to flowering (48.3), flower persistency (11.8), branches (6.5), leaves and flowers plant-1(12.2) and stem thickness (7.7 cm).

Other asteraceae crops:

Yassin and pappiah (1990) investigated the effect of different pinching dates on growth and flowering of chrysanthemum and reported that pinching at

30 DAT resulted in maximum reduction of plant height (36.60 cm) and produced more number of branches per plant (19.80) as compared to control (46.00cm and 14.80 plant^{-1} respectively).

Srivastava *et al.* (2002) conducted an experiment on effect of pinching in regulating the flowering and reported that maximum number of flowers per plant (58.18) and flower yield (30.99 tonnes/ha) is obtained due to pinching at 40

DAT as compared to no pinching (42.80 and 22.40 tonnes/ha respectively) in African marigold Cv. Pusa Narangi gainda.

Khandelwal *et al.* (2003) conducted an experiment on effect of pinching on growth and yield and concluded that pinching at 20 days after planting resulted in reduction in plant height (78.82 cm) and produced more number of branches per plant (58.03) as compared to control (109.90 cm and 38.62 respectively) in African marigold.

Sehrawat *et al*. (2003) conducted studies on regulation of flowering by pinching and noticed that pinching at 30 DAT significantly decreased plant height (63.52 cm) as compared to control (80.20 cm) in African marigold.

Tomar *et al*. (2004) revealed that maximum number of flowers per plant (48.34) was obtained due to double pinching, followed by single pinching (32.86) as compared to control (17.63) in African marigold.

According to the findings of Chauhan *et al*. (2005), pinching resulted reduction in plant height (17.60 cm) and more number of branches (11.22) per plant when the plants were pinched at 30 DAT compared to no pinching (27.66 cm and 9.64 respectively) in marigold Cv. Pusa Narangi gainda.

Srivastava *et al.* (2005) evaluated the effect of pinching for regulating the flowering in marigold and evinced that pinching at 40 DAT delayed in flowering, increased flowers per plant and improved flower quality as compared to no pinching and pinching at 20 and 30 DAT marigold cv. Pusa Basanti Gainda.

Sunitha *et al.* (2007) carried out an experiment in African marigold Cv. Orange Double on the effect of pinching and his results revealed that maximum plant height with no pinching (98.8 cm) as compared to pinching (87.3 cm),while the number of primary branches per plant were maximum in pinched plant (12.0) as compared to no pinching (9.9).

Shinde *et al.* (2010) studied the effect of different pinching treatments on growth, flowering and yield and revealed that maximum number of

branches (15.13), plant spread (33.64 cm) at N-S and (33.24 cm) at E-W direction, number of flowers per plant (47.49), yield of flowers per plant (13.18 tonn) was

reported under pinching at 60DAT in chrysanthemum at IIHR Bengaluru conditions.

Dorajeerao and Mokashi (2012) analysed the influence of pinching time and cited that number of flowers per plant (37.4), flower yield per plot (3.92kg) and plant height (117.58cm) were recorded maximum in pinching at 20 DAS in chrysanthemum.

Habiba *et al*. (2012) experimented the influence of terminal bud pinching on growth and yield and showed that the tallest (37.7 cm) and the shortest plant (33.4 cm) were obtained without pinching and with pinching, respectively. Maximum number of leaves (30.1) and flowers (58.7) per plant were recorded in pinching; and minimum number of leaves (26.8) and flowers (37.9) per plant were from without pinching in chrysanthemum.

Rajesh *et al*. (2012) worked on China aster (*Callistephus chinensis.)* Cv. Poornima to study the effect of pinching and showed that pinching reduced the plant height and delayed flowering. Pinched plant recorded more yield than unpinched plant. Wider spacing with pinched plants given more number (60.90), weight (381.05 g. $plot^{-1}$) and diameter (5.90 cm) of flowers.

Ravneet *et al*. (2012) concluded that maximum plant height (67.99 cm), size of flower (7.06 cm) was more in no pinching. While, number of secondary branches (47.17), days taken to flower bud initiation (47.17 days), duration of flowering (101.05 days), weight of flower (9.92g), number of flowers per plant (51.81), flower yield (238.14 q/ha) was highest in treatment with pinching at 40 DAT in marigold.

Kumar *et al*. (2013) studied the flowering behavior of annual chrysanthemum with pinching and reported that pinching at 30 DAT and disbudding was found promising in improving plant height (98.96cm), spread of

plant, number of primary branches and number of secondary branches.

Based on the observations of Badge *et al*. (2014), Among the different pinching treatments, pinching at 15 DAT was found to be the best for improving growth parameters and flower yield in summer African marigold.

Rajyalakshmi and rajashekar (2014) conducted a research on effect of pinching on growth and flowering of African marigold Cv. Pusa Narangi Gainda and observed that number of flowers were maximum in pinched plants (28.25) as compared to no pinching (23.55).

Sailaja *et al.* (2014) evaluated different pinching treatments on growth and quality characters and found that the vegetative growth parameters in terms of plant height (45.68 cm), diameter of the flower (5.17 cm) and vase life of flowers (9.37 days) was found maximum under the control treatment of pinching. However, number of primary branches was recorded maximum in (21.03) single pinching at 30 DAT.

Sushma *et al.* (2014) documented that among different pinching treatments, pinching at 30 and 45 DAT had recorded more reduction in plant height whereas, maximum number of branches plant^{-1}, diameter of stem, plant spread, number of flowers plant^{-1}, flower yield plant^{-1} and ha^{-1} were recorded with pinching at 30 DAT in gaillardia.

According to the observations of Meena *et al.* (2015), pinching at 30 DAT had produced maximum diameter of stem (1.36cm), pinching at 60DAT gave higher seed yield per flower (0.55g), seed yield per plant (19.01g), seed yield per plot (283.61g) followed by pinching at 30 DAT.

Mohanty *et al.* (2015) conducted an experiment to study about various pinching levels and revealed that maximum plant spread (E-W) (32.23cm), (N-S) (32.91cm), number of leaves per plant (223.26), number of primary branches per plant (16.66), number of secondary branches per plant (48.45) were maximum in single pinching whereas, number of days taken to first flowering (70.75 days) were highest in double pinching in African marigold.

Ona *et al.* (2015) conducted an experiment about the effect of different pinching types revealed that the maximum chlorophyll content (12.8%) and leaf area (36.7 cm^2) were obtained from double pinching and the minimum chlorophyll content (11.3%) and leaf area (25.3 cm^2) was observed from nopinching. Maximum number of flowers (21.4) was found from double pinching and minimum (9.8) was from no pinching.

Sasikumar *et al.* (2015) documented that maximum plant spread (34 cm), number of branches per plant (9.33), days to first flowering (60 days), flowering duration (23 days), number of flowers per plant (24), single flower weight (93.90 g), flower yield per plant (388.30 g), flower yield per unit area (13.13t/ha), seed yield per plant (13.01 g) were recorded in pinched plants, while maximum plant height (67 cm), flower diameter (6.23cm) were observed in plants with no pinching in marigold.

Parhi *et al.* (2016) investigated on the effect of three levels of pinching in African marigold cv. Sirakole on different characters and described that shoot pinching at 30 days after planting improved number and weight of flowers per plant (39.34, 187.29 g), yield of flowers per hectare (13873.0 kg) and also number and weight of seeds per plant (6867.75, 10.13 g) in marigold.

Salve *et al.* (2016) studied response of pinching on chrysanthemum varieties on Nagpur conditions of Maharashtra and reported that pinching at 30 DAP was found to be best for primary growth parameters like plant height (43.81cm), number of branches (20.73), stem diameter (0.75cm) and spread of plant (36.69cm), number of flowers per plant (112.85), flower yield per plant (372.16 g), flower yield per hectare (275.66 q).

Baskaran and Abirami (2017) marked out that maximum plant spread(47.2 cm), number of branches (13.7), duration of flowering (36.7 days), number of flowers per plant (56.6), size of flower (6.18 cm), weight of single flower (7.08g), flower yield per plant (347.8 g) and seed yield per plant (20.23g) were observed in the double pinching treatment. The flower yield was maximum in double pinching with three times more yield than the control in African marigold.

According to the findings of Masram *et al*. (2017), number of primary branches per plant (30.45), spread at 50% flowering (61.21 cm), was maximum in pinching at 30 DAP and minimum in no pinching. Days to flower bud initiation from transplanting (72.77), days to opening of flower from bud emergence (11.80), days to 50% flowering from transplanting (98.61), days to first harvesting from transplanting (113.48), flowering span (75.10) wasrecorded maximum in double pinching at 30 & 45 DAT and recorded minimumin no pinching.

Moon *et al.* (2017) conducted an experiment about the effect of different pinching dates reported that maximum number of flowers per plant (75.95), yield per plant (304.08 g), per plot (4.56 kg) and per hectare (112.62 q) was recorded in single pinching at 30 DAT. Regarding to quality parameters like weight of flower (4.03 g), and shelf life of flower (3.90 days) were also found maximum in single pinching at 30 DAT. Also, diameter of flower (7.76 cm), length of pedicel (16.02 cm) and longitivity of intact flower (16.45 days) were recorded maximum in single pinching at 30 DAT in gaillardia.

Jindal *et al.* (2018) marked out that days to first flowering (58.56 days), number of days to first flower bud showed colour (68.31 days) were maximum for plants pinched at 25 DAT days to 50% flowering (99.41 days) and minimum diameter of flower (4.68 cm), length of flower stalk (6.21cm), shelf life (3.42 days), longitivity of flower (5.21 days) were reported in plants pinched at 50 DAT.

Khan *et al.* (2018) investigated on the effect of pinching on growth and flower production of marigold and results showed that maximum number of branches (12.41), days to 50% flowering (54.9), flower diameter (4.58 cm), and number of flowers (9.93) was observed in pinched plants and minimum plant height (22.85 cm) when compared to control.

According to the findings of Sathappan (2018), pinching decreased plant height (65.39cm) and increased number of laterals/plant (9.73), number of leaves/plant (284.40), days taken to flower appearance (52.60 days), number of flowers/plant (19.46), single flower weight (9.16g), flower yield per plant (178.58g) in African marigold.

Based on the results recorded by Nathan *et al.* (2019), pinching at 15 days after transplanting increased the growth and flower yield parameters *viz.*, plant height, number of primary branches, number of productive branches, stem girth, inter nodal length, number of leaves, chlorophyll content index (CCI) and dry matter content, number of flowers per plant flower yield plant^{-1} Flower yield per plot and flower yield per hectare of Gomphrena.

Singh *et al.* (2019) observed that maximum plant spread, number of branches, duration of flowering, number of flowers per plant, size of flower, weight of single flower, flower yield per plant were recorded in double pinchingin marigold.

Thumar *et al*. (2020) studied the effect of pinching on plant growth and concluded that pinching after 25 DAT increased plant spread in E-W (45.14 cm), N-S (44.23 cm), no. of branches/plant at 60 DAP (20.33) and 90 DAP (33.69). Whereas no pinching resulted increased plant height at 60 DAP (46.65 cm) and 90 DAP (50.41 cm). Pinching at 50 DAT resulted in maximum stem diameter (0.69 cm) and no. of suckers/ plant (17.19) in chrysanthemum.

Ehsanullah *et al.* (2021) conducted an experiment on different pinching levels and his results revealed that highest plant height (60 cm) was observed inno pinching and the lowest (45 cm) was recorded in pinching the plants thrice. Days to first flowering (57 days) was observed in no pinching and delay in flowering (68 days) was recorded in pinching the plants thrice. The maximum number of leaves (235), plant spread (30 cm) number of flower (45) were recorded in pinching the plants thrice and the minimum number of leaves (200), plant spread (17 cm), number of flowers (28) were observed in no pinching in *Chrysanthemum indicum*.

Jena *et al.* (2021) conducted an experiment on effect of different pinching levels on growth and flowering of annual chrysanthemum and revealed that double pinching increased plant spread (63.31 cm), number of leaves per plant (1655.82), number of flowers per plant (248.82), number of flower per plot (1046.20), number of flowers per hectare (15099768.52) and delayed the days to appearance of first flower bud (26.12) and decreased the flower diameter (4.39 cm) in chrysanthemum.

Other crops:

Wainwright and Irwin (1987) stated that pinching of antirrhinum grownin pots recorded maximum plant height in control (50.7 cm) when compared tothe plants pinched at 3rd, 5th and 7th leaf stage.

Pathania *et al.* (2000) studied the effect of pinching on flower regulationin carnation and recorded that maximum plant height (62.10 cm) was observedin unpinched plants when compared to plants with pinched twice pinching (39.27 cm).

Kumar *et al.* (2002) carried out an experiment on carnation to find out the effect of pinching and observed that pinching (once at 4 weeks aftertransplanting and twice at 4 and 8 weeks after transplanting) resulted into delayin bud initiation (99.74 days), flower opening (129.93 days) and peak flowering (154.53 days) in comparison to control.

According to the findings of Singh *et al.* (2005), maximum flower size (5.7 cm) with single pinch while plant spread (25.0 cm) and maximum numberof branches per plant (8.5) was recorded in double pinching in carnation.

Dalal *et al*. (2006) worked on effect of pinching on carnation and found that highest number of shoots per plant (9.00), flowers per plant (7.88) and persq m (283.68) and days to appearance of first bud (169.01 days) was recorded with double pinching. Lowest plant height was recorded in plants with no pinching (65.66 cm) in carnation.

Ryagi *et al.* (2007) studied the effect of pinching levels and observed that number of internodes (17.27), number of days to flowering (147.70), stalk girth (85mm) and vase life was maximum in double pinching in carnation.

Karunananda *et al.* (2010) documented that maximum shoot production was observed in double pinching (30.60 cm) than single (20.66 cm) and no (12.0 cm) pinching treatments. Plant height was maximum in no pinching (41.25 cm)

when compared to single (34.90cm) and double pinching (26.32cm) in poinsettia.

2.2. Influence of paclobutrazol on growth, flower yield and pot presentability of potted annual - *Zinnia elegans*.

Paclobutrazol is available in the form of Cultar (25% a.i. as soluble concentrations). It has been identified in recent years as a highly active broad spectrum growth retardant showing particular promise on a range of ornamentals, grasses, cereals and on top fruits.

It had an active ingredient which blocks the conversion of ant-kaurene to kaurinoic acid – a precursor of gibberelin responsible for profuse vegetativegrowth and thereby suppresses vegetative growth resulting in dwarf plants without providing any artificial support (Dalzie and Lawrence, 1984 and Graebe, 1987).

On zinnia:

Pinto *et al.* (2003) studied about the effect of paclobutrazol on development and quality in zinnia and concluded that paclobutrazol (0.5, 0.75and 1.0 mg a.i./pot) reduced plant height and side branches length compared tothe control. Plant height showed a negative linear response to the increasing concentration of paclobutrazol. Paclobutrazol (1.0 mg a.i./pot) increased foliage and flowers harvest index whereas plant spread diameter and canopy shape were improved with paclobutrazol (0.75 mg a.i./pot).

Based on the observations of Sittinam (2004), paclobutrazol in potting mix greatly reduced shoot height, shoot canopy, internode length, leaf width, leaf length, flower size, number of flowers and root mass.

Pinto *et al.* (2005) studied about the effect of growth retardantants on development of ornamental quality of potted zinnia and concluded thatpaclobutrazol (0.5; 0.75 and 1.0 mg a.i. per pot) suppressed 'Lilliput' growth and did not affect flower diameter and production cycle, whereas plants were not short enough to meet market quality standards.

Hojati *et al*. (2009) studied the effect of paclobutrazol on vegetative growth and flowering of zinnia and concluded that Paclobutrazol at 30 ppmresulted in the

maximum leaf chlorophyll content.

Asgarian *et al*. (2013) investigated the paclobutrazol effect on plant growth the results indicated paclobutrazol at 10, 20, 30 mg/L caused a significant reduction in height of zinnia plant and lateral branch length. All paclobutrazol treatments caused significant increase in fresh and dry weight of aerial parts and roots, lateral branches and number of flowers. Paclobutrazol 30 mg/L caused a maximum increase in flower number.

Other asteraceae crops

Banko *et al.* (1988) concluded that plant height , plant spread, internodal length, plant dry weight was minimum with paclobutrazol application in begonia, vinca and zinnia.

Burrows *et al.* (1992) releaved that PBZ application resulted in thicker leaves, reduced stem diameter, and roots with an increased diameter and an unusual segmented appearance. The narrower stems had an increased development of secondary xylem, but had a marked reduction in the number of sclerenchyma bundle caps. Increased root diameter was due to an increase in the number of rows and diameter of cortical cells. In PBZ-treated plants, root cortical cell length was 50-70% less than in untreated plants, and this reduction apprared to be associated with the segmentation of roots. PBZ inhibited secondary vascular development in the roots in chrysanthemum.

Gilbertz *et al.* (1992) assessed the effect of different paclobutrazol concentrations on zinnia and concluded that paclobutrazol @ 60 mg per litre resulted in minimum plant height (18 cm) and maximum days to flowering (60 days) in chrysanthemum.

Based on the observations of Singh *et al.* (1999), the plant height was reduced, flowering was delayed with the increasing concentrations of paclobutrazol with root dip method. Whereas flower longitivity was increased by the increasing concentration *i.e.*, 10, 20, and 40 ppm however 60 ppm concentration lowered flower longitivity.

Masu (2004) studied the effects of various treatment on emergence of first flower and found that paclobutrazol @ 100 ppm when applied through root dip method of application took significanatly maximum number of days taken

for emergence of first flower (56.25 days), number of days for 50% flowering (65.75 days), maximum flower yield per plant (571.01g) as compared to control which recorded minimum number of days taken for emergence of first flower (39.50 days), number of days for 50% flowering (48.50 days). While maximum leaf area index was 9.83, 15.75 and 20.20 cm^2/plant respectively at 60, 90 DAT and at harvest.

Parmar (2004) reported that maximum number of branches (28.5), flowers per plant (133.25), flower yield per plant (571.01g), weight of single flower and minimum days to flower bud initiation (27.9 days), vase life (7 days) were obtained when paclobutrazol was soil drenched @ 40mg/lit on chrysanthemum.

According to the observations of Mishra *et al.* (2011), length of flower stalk and flower size significantly decreased with increased concentrations of paclobutrazol. Contrarily, flower longevity not influenced adversely with increased concentration of paclobutrazol, whether applied as root dip or soildrench or foliar spray. Flower yield was significantly higher at 25 ppm paclobutrazol in china aster.

Hongpakdee (2014) documented that plant height (15.25 cm), canopy width (16.70 cm) was minimum with paclobutrazol @ 200 mg/l. Total dry weight (13.21 g), total flower dry weight (5.01 g), total leaf area (442.83 cm^2)was maximum in control in marigold.

Lenzi *et al*. (2015) revealed that paclobutrazol was effective incontrolling plant height in all the studied cultivars without producing any toxicity symptoms. Neither effect of PBZ on number and size of inflorescences, nor on flowering time was observed.

Vaghasia *et al*. (2016) concluded that maximum number of branches per plant (31.33), fresh weight of plant (284.85 g), dry weight of plant (30.33 g), number of flowers per plant (28.79) was observed in paclobutrazol @ 0.5 ml per litre was applied. Days required to first flower bud (76.40 days), days requiredfor opening

of first flower (83.70 days), days to 50 per cent flowering (118.72 days), fresh weight of flowers per plant (93.43 g), were maximum when paclobutrazol @ 0.4 ml per litre was applied in chrysanthemum.

AL-obedy *et al.* (2017) concluded that paclobutrazol caused a decrease in inflorescence diameter, scape length. Plants treated with paclobutrazol at 120mg/ L gave higher number of inflorescence/ plant, inflorescence diameter, scape diameter, vase life in gerbera.

According to the research conducted by Chauhan *et al.* (2021), days to bud appearance (89.37 days), first opening of flower (109.68 days), 50% flowering (123.62 days), was maximum in treatment paclobutrazol @120 ppm, whereas, flower diameter (3.02cm) is maximum in control. Number of flowersper plant was maximum in paclobutrazol @ (18.41). Flower longitivity (16.78 days) was highest in paclobutrazol @ 90 ppm in chrysanthemum.

Salih *et al.* (2020) concluded that the treatment of paclobutrazol at 1000 mg l^{-1} concentration gave lowest plant height: pot ratio and highest plant diameter (1.25 and 56.60 cm, respectively) in chrysanthemum.

Sahu *et al*. (2021) evinced that maximum vase life (6.56 days), shelf life (5.79 days) was observed in plants treated with paclobutrazol @ 50 ppm. While, flower diameter (5.99 cm), fresh weight of flower (9.11 g) was observed in treatment with 150 ppm of paclobutrazol in marigold.

Other crops:

Mohd *et al.* (1990) indicated that increasing paclobutrazol concentration resulted in increasing numbers of branches/plant and numbers of flowers/plant and decreases in plant height and flower size. The 150 ppm paclobutrazol treatment resulted in the highest number of branches/plant (15.00) and number of flowers/plant (140.00) and lowest plant height (51.4 cm) and flower size (4.2 cm) when compared with control in cosmos.

According to the findings of Lee *et al.* (1990), PBZ significantly reduced peduncle length, foliage height and width, leaf area, and total fresh and dryweights,

and markedly increased leaf thickness and chlorophyll content, but had no effect on number of days to flowering, number of leaves or root fresh weight. Compact pot plants could be produced by single drench applications of paclobutrazol at 0.25-0.5 mg/pot.

Cox (1991) assessed the effect of paclobutrazol (PBZ) on 'Mustang' geranium (Pelargonium × hortorum L.H. Bailey) and found that PBZ caused excessive growth suppression but plants flowered earlier (95 days) than untreated controls (111 days).

Banon *et al.* (2002) documented that paclobutrazol can be used to control the growth of carnation and improved its commercial quality. In spring, drench applications were more effective than spray in reducing plant growth, althoughthe best quality plants were obtained with the 0.51 mg spray application. In winter, the drench of 0.25 mg paclobutrazol per plant produced plants of better quality than the control. Leaf colours darkened slightly with all spray treatments and with substrate drench doses ≥ 0.45 mg in carnation.

Based on the observations of Karaguzel *et al.* (2004), the stem diameter (6.4 cm), inflorescence length (14.2 cm) was maximum in treatment foliar spray with 2.5 mg a.i/plant. Days to flowering (125.3 days) was highest in mediadrench with 2.5 mg a.i/ plant. Number of flowers per plant was highest in foliar spray of 1.25 mg a.i/plant in lupinus.

Mansuroglu *et al.* (2009) documented that paclobutrazol had no significant effect on the time from sowing to flowering. Plant height (39.8 cm), internode length of main and secondary inflorescences (1.3 cm) , pedicel length (1.2 cm) and the number of secondary inflorescence (7.1) significantly reduced at 500 mg·L-1 concentration of paclobutrazol. Flower number (29.0) on main inflorescence at concentration of 250 mg· L^{-1} in *Consolida orientalis.*

Currey *et al.* (2010) summarized that days to flower and flower bud number were unaffected by paclobutrazol. Plant height at flowering for bulbs dipped in paclobutrazol solutions was 15% to 26% shorter compared with untreated bulbs. Additionally, dipping bulbs in 120 mg. L^{-1} paclobutrazol resulted in plants that met

target height specifications for commercially grown Easter lily.

Brito *et al.* (2016) concluded that there was a significant effect of paclobutrazol on plant growth. The application of paclobutrazol at 300 and 600mg L^{-1} reduces the height of sunflower plants by 50% without affecting biomass of fresh weight and dry shoots, roots and capitulum. Increasing rates of paclobutrazol changed the morphology of the shoots of sunflower plants and raised the SPAD index.

Barrios *et al.* (2019) on his findings, concluded that paclobutrazol applied at 4 and 6 mg/pot resulted in smaller plants (as reflected by growth index) by 29%, 34%, respectively, compared with the control. Drench application of 6mg/pot paclobutrazol can be used for producing smaller plants when compared with non treated plants for swamp sunflower under greenhouse conditions.

2.1 Interaction effect of pinching and paclobutrazol on growth, flower yield and pot presentability of potted annual- *Zinnia elegans* On zinnia

According to the findings of Sharaf-Eldien et al. (2017), the PBZ increased stem diameter (1.00 cm), number of branches (7.39) in 150 ppm of paclobutrazol and flowers/plant (9.17) in 100 ppm of paclobutrazol. Fresh (123g and 58.65 g) and dry (60.14 g and 14.20 g) weights of vegetative parts and flowers/plant were maximum for control, PBZ decreased plant height (58.53 cm),leaf area (19.46 cm2) , flower diameter (32.79 cm). Pinching treatments caused an increase in the stem diameter (0.96 cm), number of branches (8.37) and flowers/plant (7.93), while decreased plant height (60.87 cm), fresh (112.83 g and 54.14 g) and dry (31.35 g and 13.06 g) weight of vegetative parts and flowers/plant and flower diameter. Concerning the interaction, shortest plantheight (56.17 cm) was obtained with pinching and 150 ppm PBZ treatment, the largest number of branches (9.28) and flowers/plant (9.22) were obtained with pinching and 100 ppm PBZ treatment. It may be concluded that the pinching and treated with PBZ at 100 or 150 ppm gave a good feature for potted *Zinnia elegans* plants

Other asteraceae crops:

Ahmade (2019) assessed the effect of pinching and paclobutrazol on chrysanthemum and the results indicated that twice pinching gave a significant

reduction in the plant height (29.86 cm), the inflorescence diameter (45.78 mm)and the plant dry weight (60.68 g). But increased the branches number (28.81), the period from planting to inflorescence bud formation (112.71 days) and the total number of inflorescences (78.93), the plant aesthetic value (7.27 degree) and the plant aesthetic period (32.27 days). On other hand, spraying plants with paclobutrazol at 20 mg l^{-1} caused a significant decreased in plant height (24.42 cm) and the plant dry weight (53.86 g), the plant aesthetic value (8.31), and the plant aesthetic period (34.10 days). In general, plants which twice pinching and sprayed with paclobutrazol at a concentration 20 mg.l-1 significantly reduced the plant height (21.76 cm), the inflorescence diameter (42.03 mm), and the plant dry weight (48.73 g) but increased the branches number (30.77) branches.$plant^{-1}$,the period from planting to inflorescence bud formation (111.00 days), the total number of inflorescences (85.16 inflo.$plant^{-1}$) , the plant aesthetic value (8.66 degree), and the plant aesthetic period (38.27 days) in chrysanthemum.

Santi *et al*. (2021) documented that maximum total leaf area (1016.79 cm^{-2}), canopy width (35.97 cm), dry weight per plant (18.99 g) , days to flower bud initiation (31.25), number of flowers per plant (7.77) were observed in double pinching. Among the paclobutrazol treatments, maximum total leaf area (1088.59 cm^{-2}), canopy width (35.21cm) was observed in the treatments with 15 ppm of paclobutrazol whereas dry weight per plant (18.99g) , days to flower bud initiation (28.89) in 45 ppm of paclobutrazol and number of flowers per plant (6.96) were observed in 30 ppm of paclobutrazol. Interaction effect of pinching with 45 ppm of paclobutrazol can be used as the method of choice to produce high-quality plants with proportional size, compact, produce more flowers and last longer vase life in marigold.

Other crops:

Wang *et al.* (2006) indicated that paclobutrazol and top removal delayed flowering, short internode, dwarfing, the compact form and prolonged flowering period. The latest flowering time of plants was secondary top removal, the best ornamental effect was the paclobutrazol of the concentration of 1000 mg/L.

Aboudahab *et al.* (2013) concluded that pinching the plants twice decreased the branch length (57.17 cm) and the dry weight of branch; meanwhile it increased the stem diameter (2.69 cm), number of branches (3.75), fresh (138.75 g) and dry weights (47.25 g) of shoots. Paclobutrazol at 400 ppm caused an increase in the stem diameter (2.93 cm). The concentration of 500 ppm of paclobutrazol decreased the fresh and dry weights of the shoots, but it increasedthe number of branches/plant (3.89). The combination between paclobutrazol at 500 ppm and pinching twice decreased the length of branches (64.10 cm), but enhanced the stem diameter (3.40 cm), number of braches/plant (4.00). From the aforementioned results, it could be recommended the use of pinching the plants for two times alone or with the treatment of paclobutrazol at 500 ppm in order to produce a compact plant of high vegetative growth characters for using as a pot plants on Cestrum nocturnum .

Priyanka *et al*. (2015) concluded that seedlings recorded maximum number of secondary side shoots (20.58), leaves (177.42), flower clusters (16.17), flowers (23.58)/plant when grown in soil from natural habitat and FYM with double pinching and with the application of 75 ppm paclobutrazol and seed raised plants showed early visible bud formation and flowering when grown in all growing media without pinching and application of 75 ppm paclobutrazol. However, the cutting raised plants recorded maximum number, of secondary side shoots (16.00), leaves (171.67), flower clusters (17.83), flowers/plant (24.42) when grown in soil from natural habitat and FYM with double pinching and with the application of 75 ppm paclobutrazol. Seed raised plants showed better resultsin case of plant height, length of primary side shoots and plant spread than cutting raised plants while cutting raised plants recorded early visible bud formation and flowering and maximum number of flower clusters/plant than seed raised plants.

Chapter - III

Material and methods

CHAPTER III

MATERIALS AND METHODS

The present investigation **"Effect of pinching practices and paclobutrazol on growth, flower yield and pot presentability of potted annual – *Zinnia elegans"*** was carried out at PG Students Research Farm, College of Horticulture, Rajendranagar, Hyderabad during November 2020 to February 2021. The details of the location, the materials used, the techniques adopted and observations recorded during the period of experimentation are presented in this chapter under the following headings and sub headings.

Location

Experimental details

Cultivation details

Observations recorded

Statistical analysis

LOCATION

The experimental site is located at College of Horticulture, Rajendranagar, Hyderabad. The experimental site falls under semi-arid tropical climate with an average rainfall of 615.6 mm located at an altitude of 542.3 m above mean sea level at latitude of 17.90˚ North and longitude of 78.23˚ East. The mean monthly meteorological data *i.e.* rainfall, mean minimum and maximum temperature, relative humidity recorded during the period of experimentation is presented in Appendix - I.

EXPERIMENTAL DETAILS

Plant material

The dreamland mix zinnia is from IAHS, Bangalore. It is a hybrid *Zinnia elegans* series which exhibits much less instance of Xanthomonas and Alternaria disease problems under warm conditions than other varieties. Early flowering with large, showy blooms are it's other characteristics.

Design and experimental layout

The treatment details in the experiment are presented below.

Crop name **:** Zinnia

Botanical name **:** *Zinnia elegans*

Family **:** Asteraceae

Season **:** *Rabi*, 2020

Time of planting **:** November 2nd fortnight

Experimental design **:** FCRD

Number of treatments **:** 12

Number of factors 02

Number of replications 03

Total number of Pots **:** 10 pots per treatments

3.2.3 DETAILS OF TREATMENTS

Table- 3.1. Treatment details

S.NO	FACTORS	LEVELS
1.	Pinching	P_1- Single pinching
		P_2- Double pinching
		P_3- No pinching
2.	Paclobutrazol Concentrations	R_1- Paclobutrazol @ 50 ppm
		R_2- Paclobutrazol @ 100 ppm
		R_3- Paclobutrazol @ 150 ppm
		R_4- No Spay

The experiment was conducted in Factorial Completely Randomized Design with three replication and two factors, **Factor 1**- Pinching levels and **Factor 2**- Paclobutrazol levels. There were 3 levels of P (Pinching) and 4 levelsof R (Paclobutrazol levels) were being tried as given in treatment details (Table 3.1).

Table- 3.2. Treatment combinations

Notations	Treatment combinations	Factor-1	Factor-2
T_1	P_1R_1	Single pinch	Paclobutrazol @ 50 ppm
T_2	P_1R_2	Single pinch	Paclobutrazol @ 100 ppm
T_3	P_1R_3	Single pinch	Paclobutrazol @ 150 ppm
T_4	P_1R_4	Single pinch	No spray
T_5	P_2R_1	Double pinch	Paclobutrazol @ 50 ppm
T_6	P_2R_2	Double pinch	Paclobutrazol @ 100 ppm
T_7	P_2R_3	Double pinch	Paclobutrazol @ 150 ppm
T_8	P_2R_4	Double pinch	No spray
T_9	P_3R_1	No pinch	Paclobutrazol @ 50 ppm
T_{10}	P_3R_2	No pinch	Paclobutrazol @ 100 ppm
T_{11}	P_3R_3	No pinch	Paclobutrazol @ 150 ppm
T_{12}	P_3R_4	No pinch	No spray

3.2.4. Materials used

Paclobutrazol growth retardant

Paclobutrazol, a plant growth retardant is used for growing zinnia as a pot plant. Paclobutrazol is a known antagonist to the plant hormone gibberellins. Itacts by inhibiting gibberellin biosynthesis, reducing internodal growth to givestouter stems. It is applied twice at 50ppm, 100ppm and 150ppm at 7^{th} and 21^{st}day after pinching.

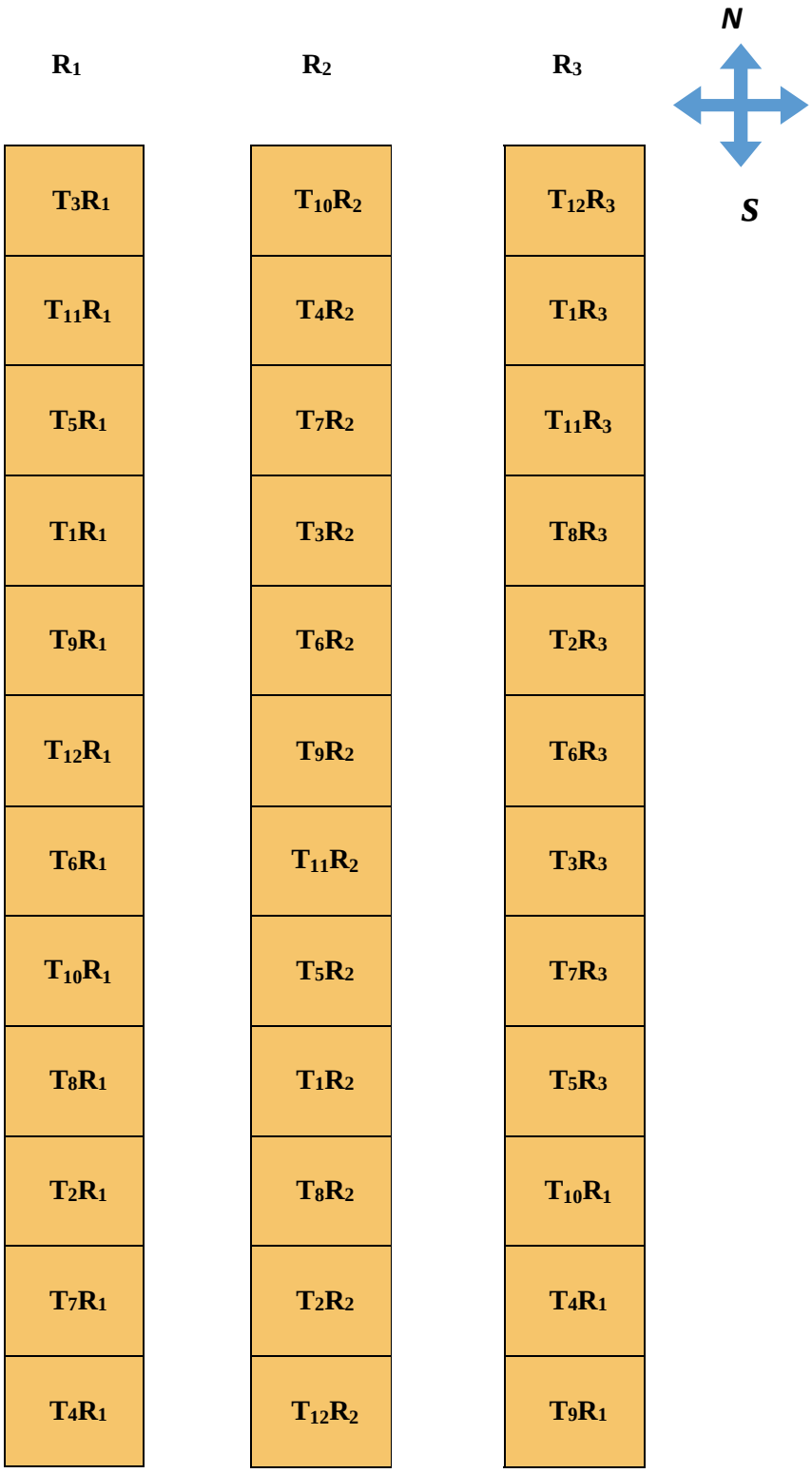

PLATE 1 - PLAN AND LAYOUT OF EXPERIMENTAL PLOT

Preparation of spray solution

The required quantity of paclobutrazol was measured to prepare 3 litre solution. The measured quantity of paclobutrazol was first dissolved in water and then made to required quantity of spray fluid. The completely mixed spray solution was sprayed to pot plants until their leaves were completely wet to the point of runoff.

CULTIVATION DETAILS

The following operations were carried out for the cultivation of cropduring the course of investigation.

Nursery

Seeds were sown in the protrays with 1:3 ratio of cocopeat and vermicompost as media in it, later on, fine shower of water was applied with rose can.

Preparation of experimental site

The experimental plot was made free of weeds, stones and then leveledwith spade so that the pots can rest on the surface evenly. The pots were arranged according to the treatments designed. Each treatment was done in three replicates and each replicate consisted of ten pots and each pot was planted with one zinnia plant. A gap of 60 cm space was left between the treatments.

Preparation of potting media

Potting media is prepared with red earth, vermicompost, FYM and cocopeat. They were thoroughly mixed in the ratio of 1:1:1:1 and filled in thepots.

Transplanting

Holes were drilled on the bottom side of the pots for drainage and they are lightly covered with stones and a layer of dried leaves. Potting mixture was now filled in the pots. Among all, healthy plants were selected and carefully transplanted into the pots with one plant per each pot. Plantlets were transplanted after 21st day from the day they were planted in protrays.

Pinching

Plants with single and double pinch treatments were pinched at 3-4th pairof leaf stage and the plants with no pinch treatments were left unpinched. Plants with

ZINNIA PLANTLETSAT NURSERY STAGE

MEDIA USED FOR FILLING POTS

MIXING THE MEDIAAND FILLING POTS

TRANSPLANTING

PLOT VIEW AFTER TRANSPLANTING

PLATE 2 - PREPARATION OF POTTING MEDIA AND TRANSPLANTNG

PLATE 3- OVER ALL VIEW OF EXPERIMENTAL PLOT

double pinch were pinched second time when the branches of single pinch have 3-4 pairs of leaves.

Paclobutrazol spray

Paclobutrazol solution was prepared at three different concentrations of 50 ppm, 100 ppm and 150 ppm and sprayed respectively to the treatments twice at 7^{th} and 21^{st} days after pinching.

Weeding and Irrigation

Hand weeding is done time to time to avoid any unnecessary weed growth. Pots were watered immediately after transplanting and the soil was kept moist and frequent irrigation was provided to check moisture stress.

Fertilizer application

Plants were fertilized occasionally with 19:19:19 @ 2g/l which is a water soluble fertilizer. Approximately, 500 ml of fertilizer solution was applied per pot.

Plant protection

It includes effective management practices to protect the plants from pests and diseases. Spraying of chloropyriphos (20% EC) at the rate of 1.5 ml/liter of water was done against hairy caterpillar infestation and carbofuron granules are applied on the soil to prevent the infestation of grasshoppers.

OBSERVATIONS RECORDED

Observations on growth parameters

Plant height (cm)

Plant heights of five plants were measured at 45 days after transplanting and at the end of the flowering from the ground level to the tip of the plant and averages were worked out. It was expressed in centimeters.

Stem diameter (cm)

The diameter of the stem was measured at 45 days after transplanting and at the end of the flowering by using vernier callipers and expressed in centimeters.

Number of nodes

Number of nodes per each plant was counted at 45 days after transplanting and at the end of the flowering.

Internodal length (cm)

Length of the branches between two successive nodes was calculated at 45 days after transplanting and at the end of the flowering.

Number of branches per plant

The number of branches arising from the main stem was counted at 45 days after transplanting and at the end of the flowering.

Plant spread (cm)

It was measured by adding the North-South and East-West directions of the tagged plants was counted at 45 days after transplanting and at the end of the flowering and the mean of the plant spread was expressed in centimeters.

Leaf width (cm)

The width of the leaf was measured at 45 days after transplanting and atthe end of the flowering and expressed in centimeters (cm).

Leaf length (cm)

The length of the leaf was measured at 45 days after transplanting and atthe end of the flowering and expressed in centimeters (cm).

Leaf area (cm^2)

Fully expanded leaves were selected randomly from individual plant for recording observation. Observations are recorded with the help of electronic leaf area meter and its value is expressed in cm^2.

Fresh weight of shoot (g)

The fresh weight of shoot of shoot was measured by using an electric balance and the result was computed in grams.

Dry weight of shoot (g)

The weight of shoot after drying was measured by using an electric balance and the result was computed in grams.

Observations on flowering and yield attribute

Days to flower bud initiation (Days)

The number of days taken from the date of planting to the date of appearance of the flower bud was counted as days taken to flower bud initiation.

Days to 50% flowering (Days)

The number of days taken to 50% of the plants to produce first flower in each pot was recorded by counting the days from the date of planting and expressed in days.

Number of days taken o full bloom (Days)

Days required for full bloom were counted from planting up to stage when 100% flower buds on a plant were fully opened.

Number of flowers per plant

Total number of flowers per plant was recorded by counting all the fully opened flowers produced by individual plant during flowering period.

Flower diameter (cm)

Fully opened flowers from each plant are selected and diameter was measured by using Vernier calipers and expressed in centimeters.

Fresh weight of flowers per plant (g)

The fresh weight of fully opened flowers per plant was measured by using an electric balance immediately after plucking and the result was computed in grams.

Dry weight of flowers per plant (g)

The weight of dried flowers per plant was measured by using an electric balance and the result was computed in grams.

Flower longitivity on plant (Days)

Duration of flowering was recorded from full bloom to the flower begin to shed off and their average was worked out.

Pot presentability (Score)

Pot presentability was evaluated on the basis of point system modifiedafter Conover (1986). The parameters studied and points allotted to each parameter out of a maximum of 100 points are as follows:

Table- 3.3 Pot presentability

	Parameters	Maximum point	Description	Score
	A) flowering			
1	Number of flowers per pot	20	>20 flowers per pot	20
			20-15 flowers per plant	18
			10-15 flowers per plant	15
			5-10 flowers per plant	12
			< 5 flowers per plant	10
2	Flower size (cm)	10	2.0- 4.0 cm	10
			4.0-6.0 cm	8
			6.0 -8.0 cm	6
			8.0-10.0 cm	4
3	Colour	10	Flower with clear colour and no fading, no residue	10
			Slight fading and dull colour	8
			Very dull and faded	6
	B)Shape			
4	Stem and foliages	20	Plant self supportive with very strong stems having foliage healthy and free of any infestation of insect- pests, diseases and bruises	20
			Plants less supportive with relatively less strong stems, foliage somewhat healthy and having little pest and disease infestation and bruises	15
			Plant not self-supportive, having less strong stems with unhealthy foliage and considerable infestation of pests and diseases and bruises.	10

	C) Form			
5	Plant height	10	Plants in balance with pot neither too tall, nor too small, generally 2.5 times to the height of the pot.	10
			Plants too large or too small to the height of the pot	6
6	Plant spread	10	Plant spread in balance with pot, neither too large nor too small, generally equal to the height of the plant	10
			Plant spread too large or small to the height of the plant	6
7	Plant Appearance as a whole plant	20	Fresh appearance, no indication of senescence, mechanical and insect damage in flowers/ stems/shoots/ foliage	20
			Fresh appearance but slight indication of senescence	15
			Dull appearance and considerable indication of senescence	10
	Total Score	**100**		

Benefit-cost ratio:

Economics of beetroot crop was calculated on the basis of cost of cultivation under corresponding treatments. The common expenditure incurred as per treatment and then added fertilizers cost as per treatments. Benefit cost ratio was calculated by using following formula.

$$\text{BC ratio} = \frac{\text{Net Monetary Returns (Rs.)}}{\text{Total cost of cultivation (Rs.)}}$$

Statistical Analysis

The observation recorded on various growth and flowering parameters were subjected to analysis of variance using FCRD. Statistical significance was tested with 'F' value at 5% level of probability and whenever the F value was found significant critical difference was worked out at five percent level of probability.

Chapter - IV

Results and Discussion

Chapter IV

RESULTS AND DISCUSSION

The results and discussion of the present investigation entitled **"Effect of pinching practices and palobutrazol on growth, flower yield and pot presentability of potted annual – *Zinnia elegans"*** was conducted during *Rabi* season from November 2020 to February 2021 at College of Horticulture, Rajendranagar, Hyderabad. The data recorded during the investigation on growth, flowering, yield parameters and pot presentability were subjected to statistical analysis by using Factorial CRD design and discussed. In support of the tabular representation of data, graphical presentation has also been presented in this chapter to provide better comprehension of characters.

4.1 Growth parameters

4.2 Flowering and yield parameters

4.3 Pot presentability

4.4 Benefit cost ratio

4.1 GROWTH PARAMETERS

The data on growth characters such as plant height, stem diameter, number of nodes, internodal length, number of branches per plant, plant spread, leaf width, leaf length and leaf area were recorded at 45 DAT and at the end of flowering season. The data on fresh and dry weight of shoot were recorded at the end of flowering season only.

1 Plant height (cm)

Plant height is one of the prominent characteristics influencing the overall appearance of potted plants. The mean data pertaining to plant height as influenced by pinching and paclobutrazol concentrations at 45 DAT and at the end of flowering season is presented in Table 4.1. and Fig 1.

Significant variation on plant height was observed among different pinching

levels in zinnia. Among different levels of pinching, maximum plant height (31.24, 32.73 cm) was recorded in P_3-(no pinching) and significantly minimum plant height (20.16, 23.84 cm) was noticed in P_2-(double pinching) at 45 DAT and at the end of flowering season respectively. The treatment P_1-(single pinching) showed intermediate results between no pinching and double pinching.

Among different concentrations of paclobutrazol spray, minimum plant height (24.25, 25.79 cm) was recorded in paclobutrazol 150 ppm (R_3) which is followed by 100 ppm paclobutrazol (R_3) (24.69, 27.52 cm), while maximum plant height (27.75, 30.65cm) was observed in no spray (R_4) at 45 DAT and at the end of flowering season respectively.

The interaction effect of pinching and paclobutrazol spray on plant height was statistically significant. The treatment combination P_2R_3 (double pinching with 150 ppm of paclobutrazol) recorded minimum plant height (18.93, 21.55 cm) which is followed by double pinching with 100 ppm of paclobutrazol (P_2R_2) (19.23, 23.69 cm) while the maximum plant height (33.24, 36.58 cm) was registered in P_3R_4 (control) at 45 DAT and at the end of flowering season respectively. Similar results were observed in Sharaf-Eldien *et al.* (2017) in zinnia.

Plants without pinching recorded significantly maximum plant height at 45 DAT and at the end of flowering season respectively. The reduction in plant height in pinched plants might be due to removal of apical meristematic tissue, inhibiting apical dominance (Mutlu and Agan, 2015). As a result, the plant metabolites are diverted from vertical growth to horizontal growth. Similar effects were reported by Khan *et al.* (2018) in marigold and Ullah *et al.* (2019) in zinnia and Habiba *et al.* (2012) in chrysanthemum.

The reduction in plant height with the paclobutrazol spray might be due to inhibition of gibberellin biosynthesis and restricted growth of the internodes. As a result, the cell elongation was restricted (Laermann *et al*., 1992). Similar results were also reported by Asgarian *et al.* (2013) and Pinto *et al.* (2003) in zinnia, Lee *et al*. (1990) in gerbera and Singh *et al*. (1999) on chrysanthemum.

Table 4.1. Effect of pinching levels and paclobutrazol on plant height (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	25.36	20.15	31.58	**25.69**	28.48	24.97	32.74	**28.73**
R_2	24.65	19.23	30.21	**24.69**	27.54	23.69	31.33	**27.52**
R_3	23.89	18.93	29.93	**24.25**	25.54	21.55	30.29	**25.79**
R_4	27.69	22.34	33.24	**27.75**	30.19	25.18	36.58	**30.65**
MEAN	**25.39**	**20.16**	**31.24**		**27.93**	**23.84**	**32.73**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.05		0.16		0.26		0.78	
R	0.06		0.18		0.31		0.90	
P*R	0.11		0.32		0.53		1.57	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

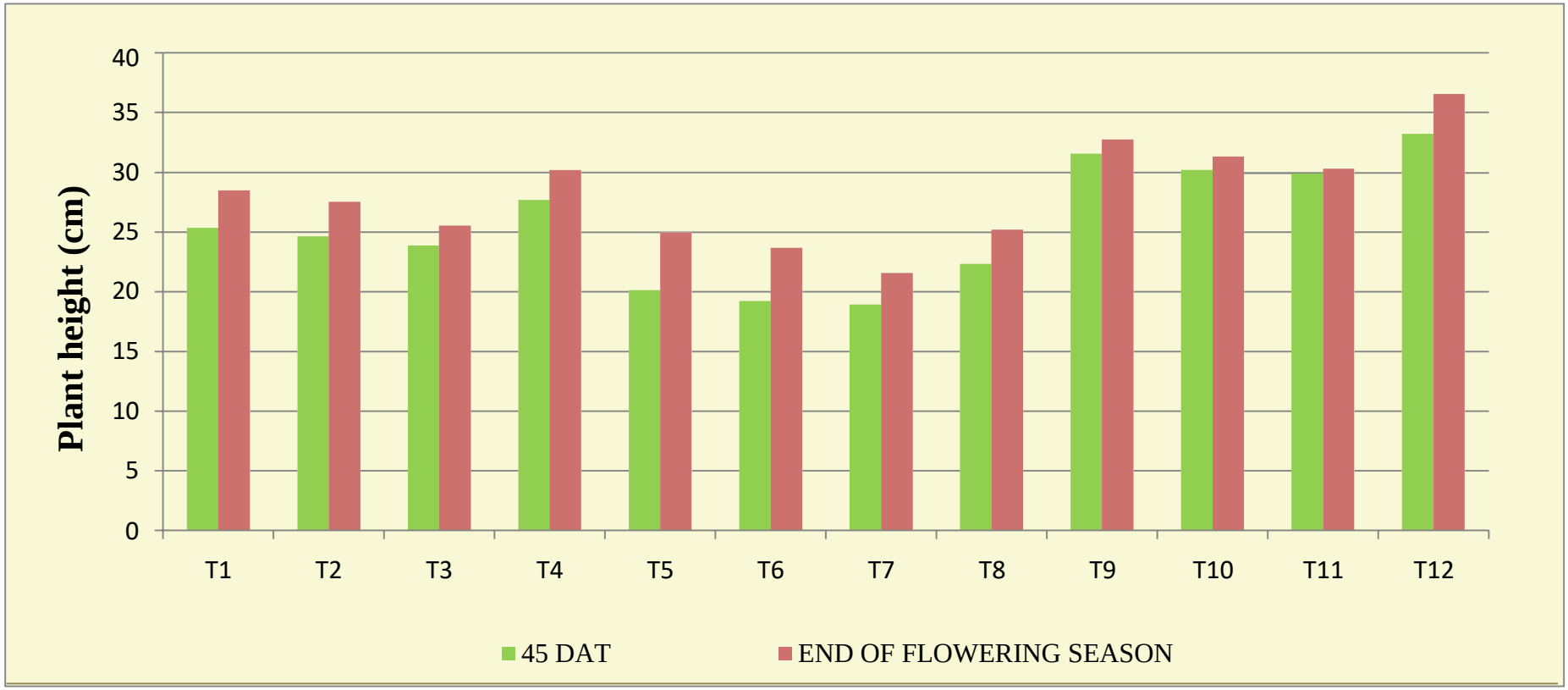

Fig 1. Effect of pinching levels and paclobutrazol on plant height (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

4.1.2 Stem diameter (cm)

Pinching and paclobutrazol application significantly influenced the stem diameter. The mean data pertaining to stem diameter as influenced by pinching and paclobutrazol concentrations at 45 DAT and at the end of flowering season is presented in Table 4.2 and Fig 2.

The data from table 4.2 and Fig 2 revealed significant difference thatmaximum stem diameter (0.59, 0.62 cm) was recorded in double pinching (P2) and minimum (0.43, 0.45 cm) was observed in no pinching (P3) at 45 DAT and at end of flowering seasons respectively.

Increase in stem diameter due to pinching might be due to the fact that at lower plant heights, better growth was observed due to less vegetative growth and sufficient space and less competition, which helped the individual plant to utilize more water, air, and light to put better growth. Similar results were also reported by Ullah *et al*. (2019) in Zinnia and Nathan *et al*. (2019) in gompherena.

Among different paclobutrazol concentrations, 150 ppm (R3) of recorded maximum stem diameter (0.57, 0.61 cm) which was on par with 100 ppm of paclobutrazol (R2) (0.56, 0.58 cm) and minimum (0.46, 0.47 cm) was recorded in no spray (R4) at 45 DAT and at the end of flowering season respectively.

Increase in stem diameter due to paclobutrazol spray is due to the fact that, paclobutrazol inhibits gibberelin bio-synthesis thus cell elongation was checked in middle of stem but not the cell division which results in stem thickness. This may be explained by the low levels of gibberellic acid after early application of paclobutrazol as high levels of gibberellic acid limitradial expansion of plant organs. Paclobutrazol treatment increases thethickness of cortex, vascular bundles, and pith diameter resulting in thickerstems according to Tsegaw (2005). Similar results were also reported by Karaguzel *et al*. (2004) in Lupinus.

The effect of interaction of pinching and paclobutrazol was statistically non-significant.

Table - 4.2. Effect of pinching levels and paclobutrazol on stem diameter (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	0.51	0.58	0.42	**0.50**	0.52	0.60	0.44	**0.52**
R_2	0.59	0.63	0.46	**0.56**	0.61	0.65	0.48	**0.58**
R_3	0.61	0.64	0.47	**0.57**	0.64	0.68	0.51	**0.61**
R_4	0.47	0.54	0.38	**0.46**	0.48	0.55	0.39	**0.47**
MEAN	**0.54**	**0.59**	**0.43**		**0.56**	**0.62**	**0.45**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.016		0.04		0.019		0.05	
R	0.019		0.05		0.022		0.06	
P*R	0.033		NS		0.039		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

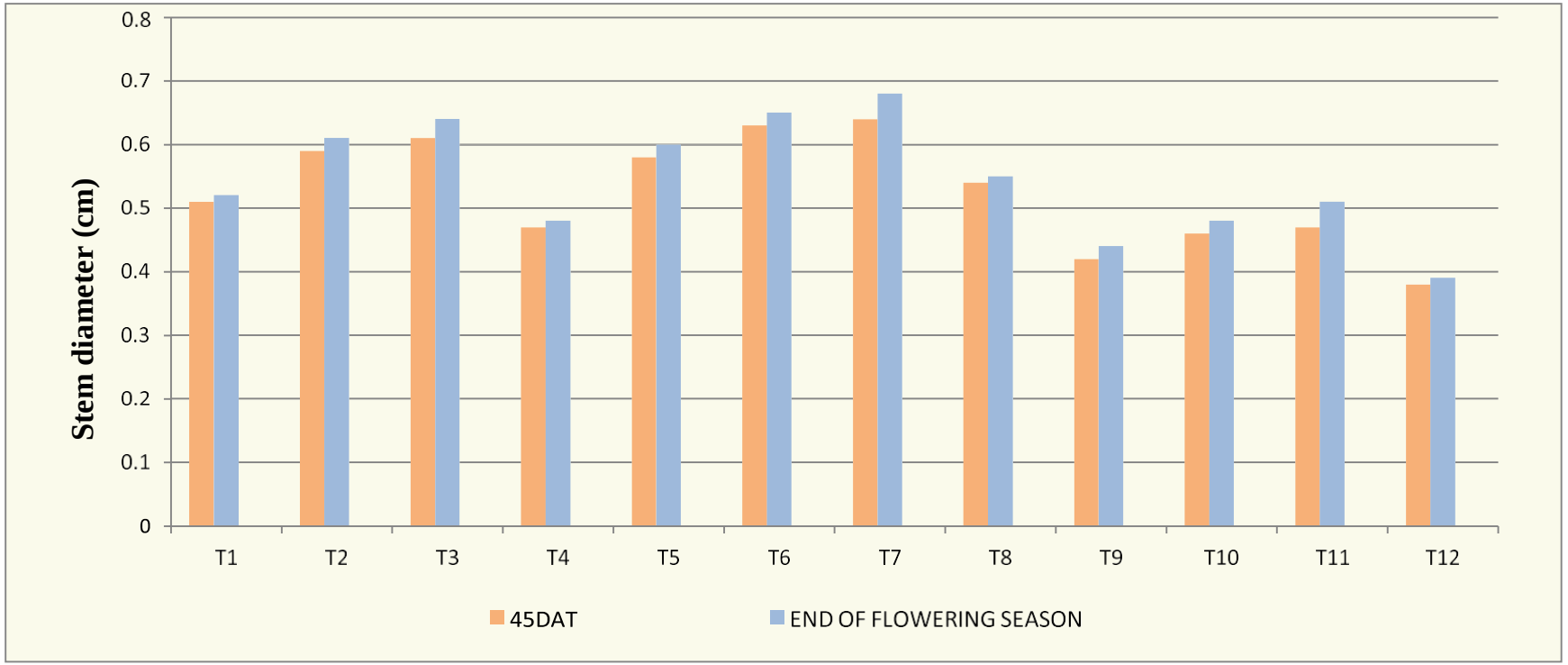

Fig 2. Effect of pinching levels and paclobutrazol on stem diameter (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

4.1.3 Number of nodes

Number of nodes significantly increased by pinching and paclobutrazol application. The mean data pertaining to number of nodes as influenced by pinching and paclobutrazol concentrations at 45 DAT and at the end of flowering season is presented in Table 4.3. and Fig 3.

There was a significant increase in number of nodes with pinching levels. Maximum number of nodes (27.22, 31.13) were observed in double pinching (P2) and minimum numbers of nodes (18.78, 20.61) were observed onno pinching (P3) at 45 DAT and at the end of flowering season respectively. The treatment single pinching (P1) showed intermediate results. Increase in number of nodes might be due to removal of apical dominance resulted in more number of branches which in turn increased numberof nodes.

The results were found significant with paclobutrazol application on number of nodes. Among paclobutrazol concentrations, 100 ppm paclobutrazol (R2) resulted in maximum number of nodes (24.57, 27.37) which was followedby 150 ppm paclobutrazol (R3) (23.52, 25.66) whereas minimum number of nodes (20.35, 23.11) were recorded in no spray (R4) (Control) at 45 DAT and at the end of flowering season respectively. The reduction in growth is due topaclobutrazol application leads to increase in number of nodes.

The interaction effect was also found to be significant. Among treatment combinations, double pinching with 100ppm of paclobutrazol (P2R2) spray recorded maximum number of nodes (29.66, 34.20) which was followed by double pinching with 50 ppm paclobutarzol (R_3P_2) (27.61, 31.25) and minimum (16.43, 18.23) in no pinch and no spray (P_3R_4) (Control) at 45 DAT and at theend of flowering season respectively.

Table 4.3. Effect of pinching levels and paclobutrazol on number of nodes of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	21.94	26.80	18.29	**22.34**	23.73	30.42	20.5	**24.88**
R_2	23.70	29.66	20.36	**24.57**	25.46	34.20	22.46	**27.37**
R_3	22.92	27.61	20.04	**23.52**	24.48	31.25	21.24	**25.66**
R_4	19.81	24.80	16.43	**20.35**	22.45	28.65	18.23	**23.11**
MEAN	**22.09**	**27.22**	**18.78**		**24.03**	**31.13**	**20.61**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.12		0.35		0.16		0.47	
R	0.14		0.41		0.18		0.54	
P*R	0.24		0.71		0.32		0.94	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

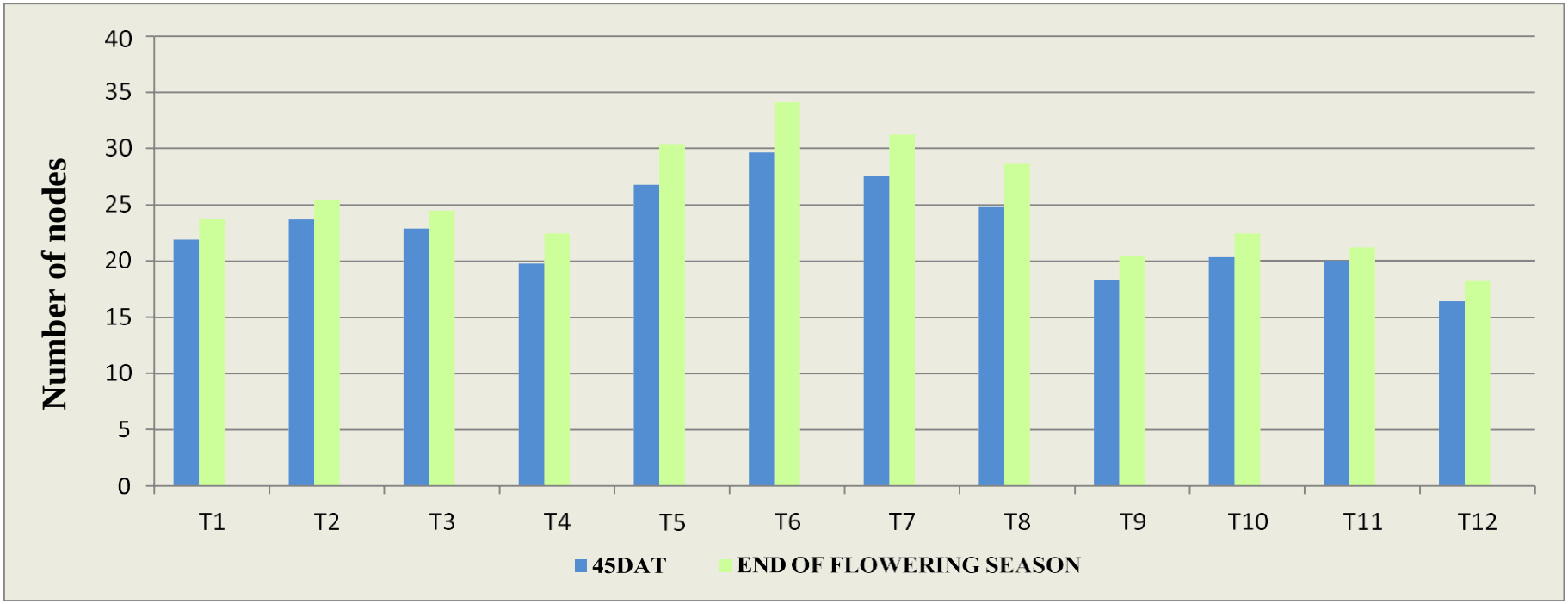

Fig 3. Effect of pinching levels and paclobutrazol on number of nodes of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

4.4.1 Internodal length (cm)

The observations on internodal length as influenced by different pinching levels and paclobutrazol concentrations were recorded periodically and the datais represented on Table 4.4. and illustrated in Fig. 4.

It is vivid from the data that there was a continuous decrease in internodal length with all pinching and paclobutrazol treatments. The internodal length at 45 DAT and at the end of flowering season was significantly influenced by pinching treatments. It was observed that by increasing the pinching levels, double pinching (P2) recorded significantly minimum internodal length (2.51, 2.61 cm) and maximum internodal length (4.32, 4.55 cm) was observed in no pinching (P_3) at 45 DAT and at the end of flowering season respectively. The treatment single pinching (P1) showed intermediate results. This decrease in internodal length due to pinching may be due to the restricted growth with increase in pinching levels.

The effect of paclobutrazol on internodal length is also observedsignificant. Minimum internodal length (3.05, 3.11 cm) was observed with R_3- paclobutrazol at 150 ppm which was followed by 100 ppm of paclobutrazol(3.32, 3.51 cm) while, maximum internodal length (3.85, 4.11 cm) was recordedin R_4- no spray at 45 DAT and at the end of flowering season respectively.

Paclobutrazol was found to restrict gibberellin biosynthesis in plant by inhibiting activity of ent-kaurene oxidase and cytochrome P450 oxidase, thus restricting the oxidation of ent-kaurene to ent-kaurenoic acid (Dalziel and Lawrence 1984). It has been shown to decrease plant growth by reducing plant height and internode elongation effectively. Paclobutrazol has been reported to reduce plant growth, height, internodal distance with thicker and darker leaves in pepper and tomato (Rahman *et al.* 1989a, b). Reduced height is a consequence of paclobutrazol induced gibberellin inhibition exemplified by reduced internodal elongation (Fletcher *et al*. 2000). Similar results were also reported by Sittinam (2004) in zinnia and Mansuroglu *et al.* (2009) in *Consolida orientalis*

Table - 4.4. Effect of pinching levels and paclobutrazol on internodal length (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	3.46	2.54	4.27	**3.42**	3.61	2.65	4.56	**3.60**
R_2	3.39	2.42	4.15	**3.32**	3.52	2.49	4.52	**3.51**
R_3	3.13	2.14	3.89	**3.05**	3.21	2.18	3.96	**3.11**
R_4	3.64	2.94	4.97	**3.85**	4.05	3.13	5.16	**4.11**
MEAN	**3.40**	**2.51**	**4.32**		**3.59**	**2.61**	**4.55**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.04		0.14		0.05		0.15	
R	0.05		0.16		0.06		0.17	
P*R	0.09		NS		0.10		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

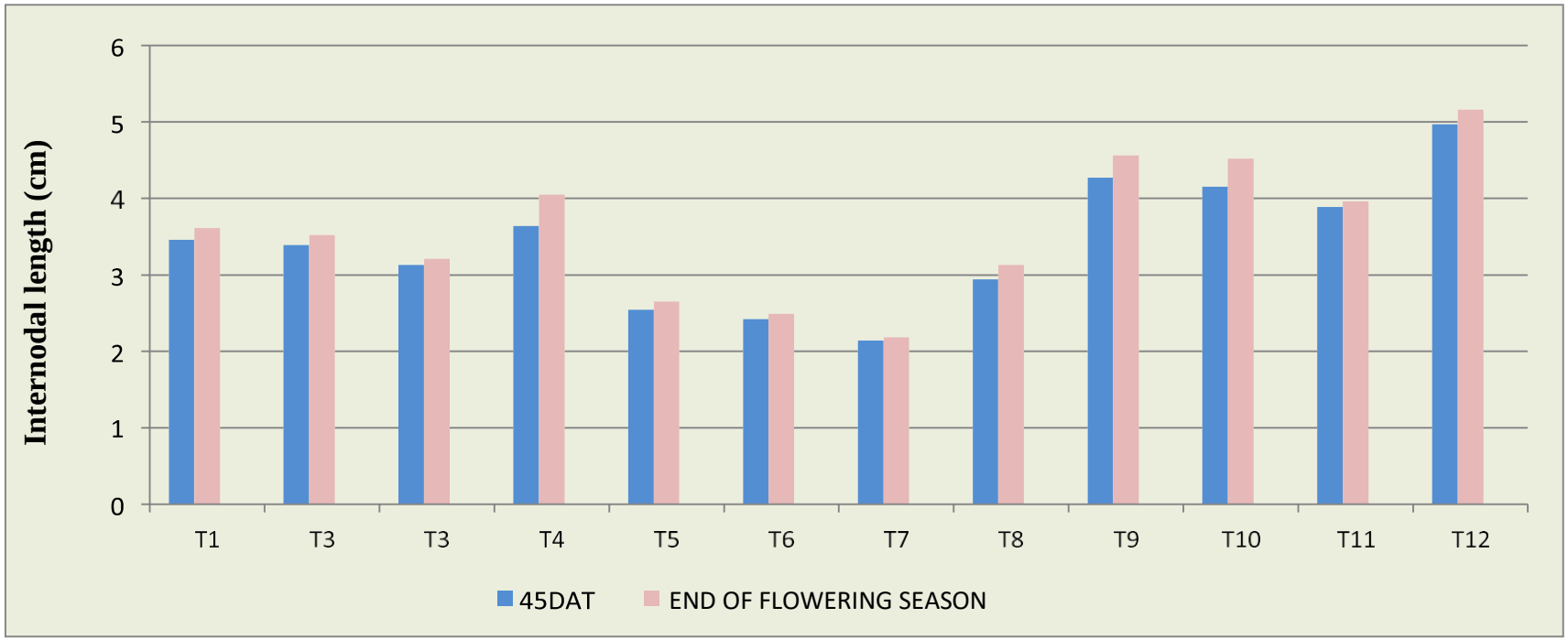

Fig 4. Effect of pinching levels and paclobutrazol on internodal length of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

The effect of interaction of pinching with paclobutrazol on internodal length was non-significant.

4.1.5 Number of branches per plant

The effect of pinching and paclobutrazol spray and their interaction on number of branches per plant was statistically significant.

It is evident from table 4.5. and Fig. 5 that maximum number of branches (20.35, 23.56) was observed in double pinching (P_2). While minimum number of branches (8.08, 8.78) was recorded in no pinching (P_3) at 45 DAT and at the end of flowering season respectively. The treatment single pinching (P_1) showed intermediate results between single and double pinching. Increased number of branches due to pinching might be attributed to the breaking of apical dominance and sprouting of auxiliary buds (Khan *et al. 2018*). Similar results were also reported by Khan *et al*. (2018) and Singh *et al*. (2019) on marigold.

Among paclobutrazol treatments, Paclobutrazol 100ppm (R_2) registered maximum number of branches (16.33, 18.30) which is followed by Paclobutrazol 150ppm (R_3) (15.31, 16.40) whereas minimum number of branches (12.13, 14.09) were recorded by no spray (R_4) at 45 DAT and at the end of flowering season respectively.

Increase in number of branches by paclobutrazol application is correlated with greater metabolic and divisional activity in the shoot apical meristem region. Increased branching indicates that paclobutrazol caused major changes in apical dominance and induced lateral bud initiation (Setia *et al.* 1995)**.** Similar results were also reported by Mohd *et al.* (1990) in cosmos, Asgarian *et al.* (2013) in zinnia.

The interaction effect was also shown to be significant. Among treatment combinations double pinching with 100 ppm paclobutrazol (P_2R_2) recorded maximum number of branches (22.65, 25.56) which was at par with double pinching with 150 ppm of paclobutrazol (P_2R_3) (21.81, 24.88) and minimum number of branches (6.45, 7.32) were recorded by no pinch and no paclobutrazol spray (P_3R_4) (control) at 45 DAT and at the end of flowering

Table no- 4.5. Effect of pinching levels and paclobutrazol on number of branches per plant of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	13.96	19.68	7.22	**13.62**	15.24	23.36	8.32	**15.64**
R_2	16.67	22.65	9.67	**16.33**	18.98	25.56	10.36	**18.30**
R_3	15.43	21.81	8.98	**15.31**	16.58	24.88	9.14	**16.86**
R_4	12.69	17.26	6.45	**12.13**	14.54	20.43	7.32	**14.09**
MEAN	**14.68**	**20.35**	**8.08**		**16.33**	**23.56**	**8.78**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.15		0.46		0.22		0.66	
R	0.18		0.53		0.26		0.76	
P*R	0.31		0.92		0.45		1.32	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

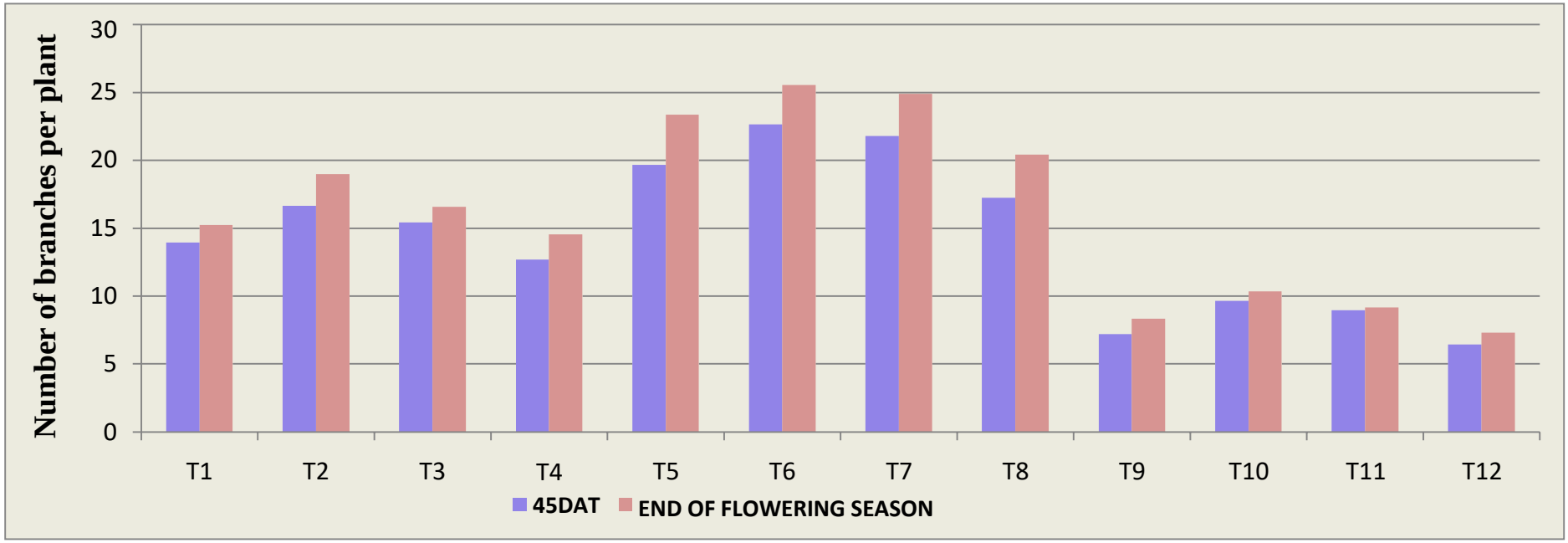

Fig 5. Effect of pinching levels and paclobutrazol on number of branches per plant of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

season respectively. This can also be supported by Sharaf-Eldien *et al.* (2017) and Ahmade *et al.* (2019) in zinnia.

4.1.6 Plant spread (E-W) (cm)

The effect of pinching, paclobutrazol spray and their interaction on plant spread (E-W) was statistically significant.

It is evident from table 4.6. and fig 6 that, plant spread was found significant due to pinching and maximum plant spread (E-W) (20.58, 24.18 cm) was recorded in double pinching (P_2) and minimum plant spread (E-W) (16.34, 16.93 cm) in no pinching (P_3) at 45 DAT and at the end of flowering season respectively. The treatment single pinching (P_1) showed intermediate results.

Among different concentrations of paclobutrazol, spray at 100 ppm (P_2) registered maximum plant spread (E-W) (19.48, 21.78 cm) which was followed by 150 ppm of paclobutrazol (R_3) (18.95, 20.78 cm) and minimum plant spread (E-W) (17.05, 18.09 cms) was recorded in no spray of paclobutrazol (R_4) at 45 DAT and at the end of flowering season respectively.

Among treatment combinations, double pinching with 100 ppm of paclobutrazol (P_2R_2) recorded maximum plant spread (E-W) (21.46, 25.78 cm) which was followed by double pinching with 150 ppm of paclobutrazol (P_2R_3) (20.97, 25.13 cm) and minimum plant spread (E-W) (14.56, 14.97 cm) was recorded in no pinch and no paclobutrazol spray (P_3R_4) (control) at 45 DAT andat the end of flowering season respectively.

4.1.7 Plant spread (N-S) (cm)

The effect of pinching, paclobutrazol spray and their interaction on plant spread (N-S) was statistically significant.

It is evident from table 4.7. and fig 7 that, plant spread was found significant due to pinching and maximum plant spread (N-S) (21.04, 23.10 cm) was recorded in double pinching (P_2) and minimum (14.46, 15.20 cm) in no pinching (P_3) at 45

Table no- 4.6. Effect of pinching levels and paclobutrazol on plant spread (E-W) (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	17.26	20.23	15.98	**17.82**	18.64	23.64	16.25	**19.51**
R_2	19.34	21.46	17.64	**19.48**	20.93	25.78	18.65	**21.78**
R_3	18.68	20.97	17.21	**18.95**	19.37	25.13	17.86	**20.78**
R_4	16.94	19.67	14.56	**17.05**	17.13	22.17	14.97	**18.09**
MEAN	**18.05**	**20.58**	**16.34**		**19.01**	**24.18**	**16.93**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.11		0.32		0.06		0.20	
R	0.12		0.37		0.08		0.23	
P*R	0.22		0.64		0.13		0.40	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

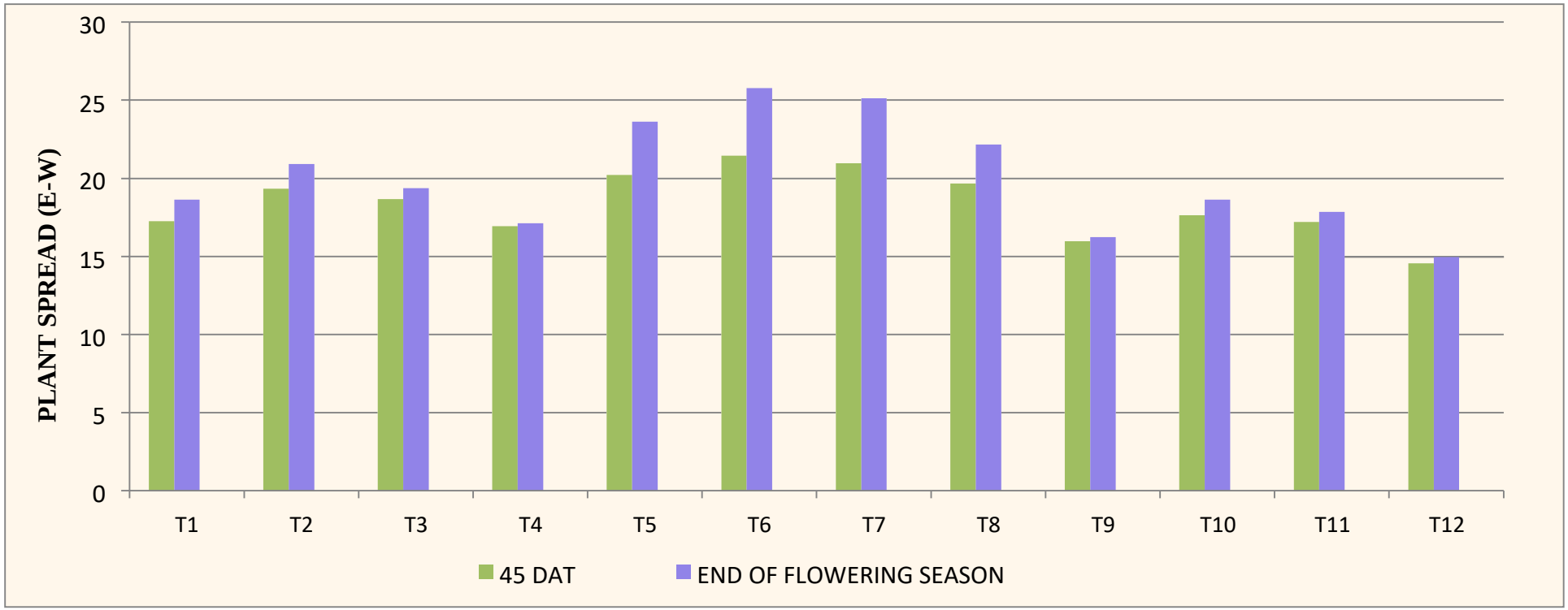

Fig 6. Effect of pinching levels and paclobutrazol on plant spread (E-W) (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

DAT and at the end of flowering season respectively. The treatment single pinching (P_1) showed intermediate results.

The increase in plant spread on both the directions due to pinching might be that the plant metabolites at meristematic tissues had diverted and the vertical growth was terminated to horizontal growth and thus, the plant spread increased. Due to repetitive removal of portion of main branch, axillary buds became free from correlative inhibition of apical dominance and started growing which resulted into more branching and spread of plants in E-W and N-S directions. Similar resultswere also reported by Kumar *et al*. (2013) in chrysanthemum and Singh *et al*. (2019) in marigold.

Among different concentrations of paclobutrazol, spray at 100 ppm paclobutrazol (R_2) registered maximum plant spread (N-S) (19.32, 20.35 cm) which was followed by 150 ppm of paclobutrazol (R_3) (18.59) at 45 DAT, and at par with same treatment (19.61 cm) at end of flowering season. Minimum plant spread (N- S) (15.59, 16.88 cm) was recorded in no spray (R_4) of paclobutrazol at 45 DAT and at the end of flowering season respectively.

The possible explanation might be that paclobutrazol caused suppressing effect on apical bud thereby enough auxin was made available to lateral buds which after sprouting produced more branches and increased spread. Similar results were also reported by Pinto *et al*. (2003) in zinnia and Latimer *et al*. (1991) in zinnia, Impatiens and marigold.

Interaction effect was also shown significant. Among treatmentcombinations, double pinching with 100 ppm of paclobutrazol (P_2R_2) recordedmaximum plant spread (N-S) (22.35, 24.52 cm) which was at par with double pinching with 150 ppm of paclobutrazol (P_2R_3) (21.94, 23.56 cm) and minimum plant spread (N-S) (11.46, 12.13 cm) was recorded by no pinch and no paclobutrazol spray (P_3R_4) control at 45 DAT and at the end of flowering season respectively.

Table no- 4.7. Effect of pinching levels and paclobutrazol on plant spread (N-S) (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	16.65	20.46	13.87	**16.99**	17.34	22.41	14.36	**18.03**
R_2	18.64	22.35	16.97	**19.32**	19.09	24.52	17.45	**20.35**
R_3	18.21	21.94	15.64	**18.59**	18.41	23.56	16.87	**19.61**
R_4	15.91	19.42	11.46	**15.59**	16.57	21.94	12.13	**16.88**
MEAN	**17.35**	**21.04**	**14.46**		**17.85**	**23.10**	**15.20**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.21		0.58		0.22		0.66	
R	0.25		0.67		0.26		0.76	
P*R	0.43		1.17		0.45		1.32	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

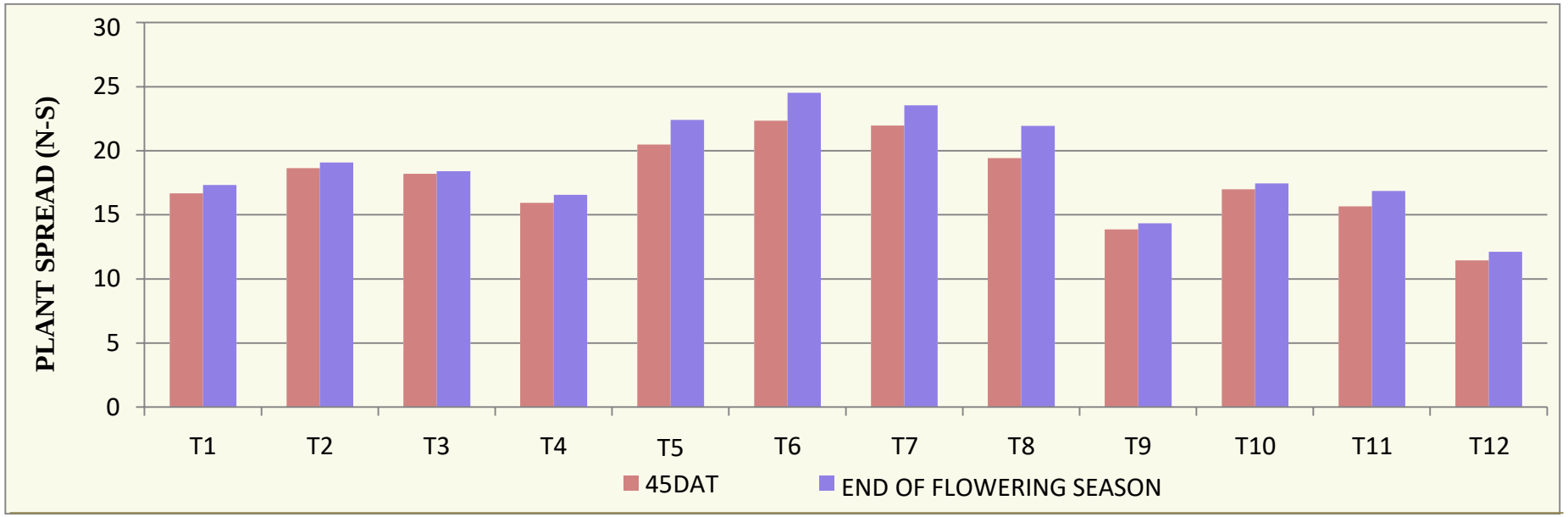

Fig 7. Effect of pinching levels and paclobutrazol on plant spread (N-S) (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

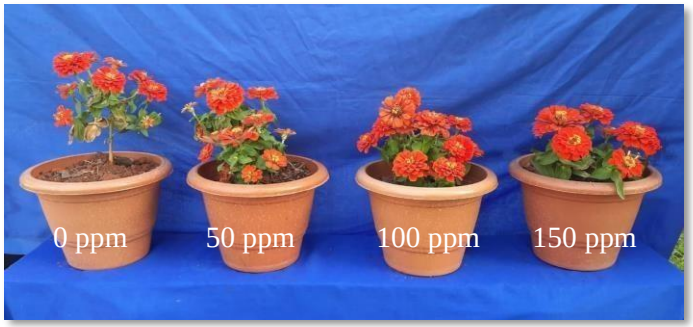

PLATE 4 - Effect of different paclobutrazol concentrations with double pinching on plant height

PLATE 5- Effect of different pinching levels at 100ppm paclobutrazol on plant spread

4.1.8 Leaf width (cm)

The mean data regarding leaf width as influenced by pinching andpaclobutrazol and their interaction effects is presented in table 4.8. and depicted in fig 8.

The significant variation on leaf width was observed among different pinching practices. The minimum leaf width (3.69, 3.72 cm) was recorded in the plants with double pinching (P_2) while maximum leaf width (4.54, 4.60 cm) was recorded in no pinching (P_3) at 45 DAT and at the end of flowering season respectively. The treatment single pinching (P_1) showed intermediate results between single and double pinching.

The leaf width was also significantly influenced by different paclobutrazol concentrations. The minimum leaf width (3.83, 3.85 cm) was recorded in R_3-150 ppm of paclobutrazol and maximum leaf width (4.40, 4.50 cm) was recorded in no spray (R_4) which was followed by 50 ppm of paclobutrazol (R_1) (4.23, 4.26 cm) at 45 DAT and at the end of flowering season respectively. Similar results were also reported by Sittinam (2004) in Zinnia, Lee *et al.* (1990)in gerbera.

The interaction effect of pinching and paclobutrazol concentrations on leaf width was found to be non-significant.

4.1.9 Leaf length (cm)

The mean data regarding leaf length as influenced by pinching and paclobutrazol and their interaction effects is presented in table 4.9. and depicted in fig 9.

The significant variation on leaf length was observed among different pinching practices. The minimum leaf length (5.84, 5.86 cm) was recorded in the plants with double pinching (P_2) while maximum leaf length (7.50, 7.52 cm) was

Table no- 4.8. Effect of pinching levels and paclobutrazol on leaf width (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	4.19	3.92	4.58	**4.23**	4.23	3.96	4.6	**4.26**
R_2	4.06	3.57	4.46	**4.03**	4.09	3.61	4.52	**4.07**
R_3	3.97	3.23	4.31	**3.83**	3.99	3.25	4.33	**3.85**
R_4	4.37	4.04	4.81	**4.40**	4.45	4.09	4.98	**4.50**
MEAN	**4.14**	**3.69**	**4.54**		**4.19**	**3.72**	**4.60**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.05		0.16		0.06		0.19	
R	0.06		0.19		0.07		0.22	
P*R	0.11		NS		0.13		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

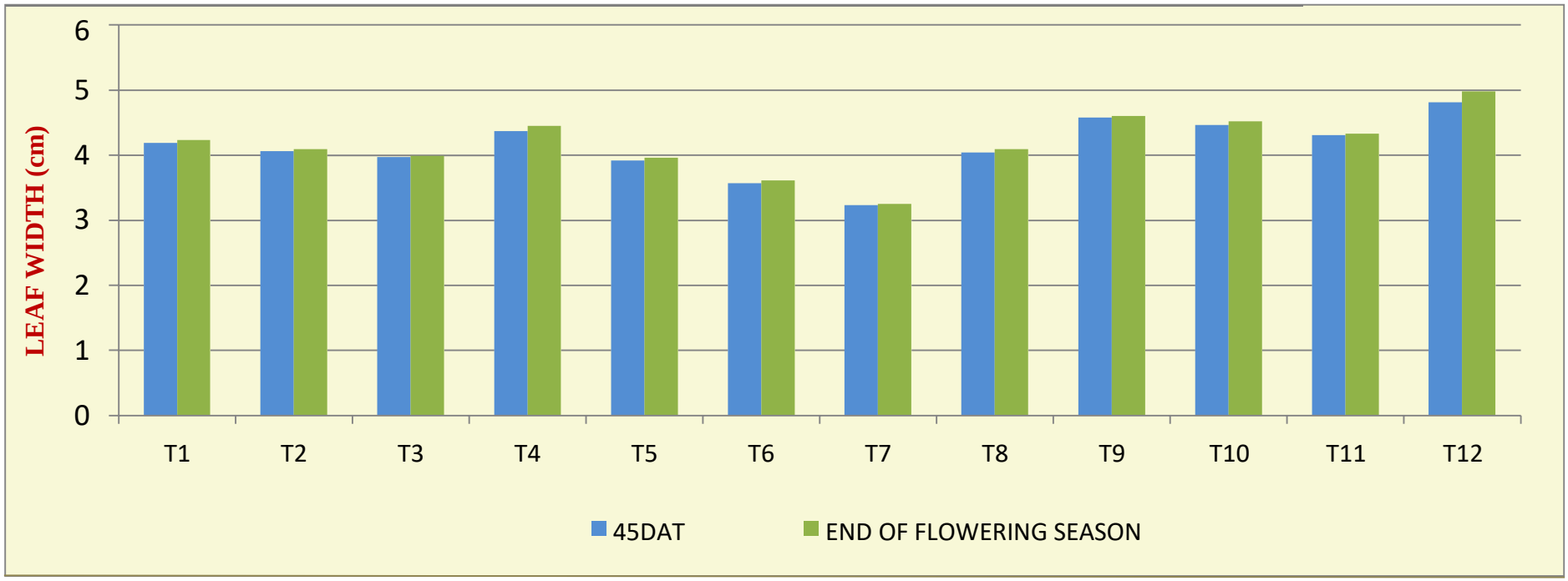

Fig 8. Effect of pinching levels and paclobutrazol on leaf width (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

recorded in P_3-no pinching at 45 DAT and at the end of flowering season respectively. The treatment P_1-(single pinching) showed intermediate results.

The leaf length was also significantly influenced by different paclobutrazol concentrations. The minimum leaf length (6.12, 6.13 cm) was recorded in R_4 - 150 ppm paclobutrazol and maximum leaf length (7.19, 7.22 cm) was recorded in no spray treatment of paclobutrazol (R_4) which was followed by R_1-50 ppm of paclobutrazol (6.74, 6.76 cm) at 45 DAT and at the end of flowering season respectively. Similar results were also reported by Sittinam (2004) on Zinnia, Lee *etal.* (1990) in Gerbera.

The interaction effect of pinching and paclobutrazol concentrations on leaf length was found to be non-significant.

4.1.10 Leaf area (cm^2)

The mean data pertaining to leaf area as influenced by pinching and paclobutrazol concentrations at 45 DAT and at end of flowering season was presented in table 4.10 and depicted in the fig 10.

The significant variation on leaf area was observed among different pinching practices. The minimum leaf area (19.68, 19.84 cm^2) was recorded in the plants with double pinching (P_2) while maximum leaf area (29.24, 29.85 cm^2) was recorded in P_3 -no pinching at 45 DAT and at the end of flowering season respectively. The treatment P_1-(single pinching) showed intermediate results between.

The leaf area was also significantly influenced by different paclobutrazol concentrations. The maximum leaf area (26.96, 27.35 cm^2) was recorded in no spray (R_4) which was followed by R_1- 50 ppm of paclobutrazol (25.60, 25.81 cm^2) and minimum leaf area (20.86, 20.98 cm^2) was recorded in R_3-50 ppm of paclobutrazol and at 45 DAT and at the end of flowering season respectively. Similar results were also reported by Sittinam (2004) on zinnia, Lee *et al.* (1990) in gerbera.

Table 4.9. Effect of pinching levels and paclobutrazol on leaf length (cm) in potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P1	**P2**	**P3**	**MEAN**	**P1**	**P2**	**P3**	**MEAN**
R1	6.51	6.04	7.67	**6.74**	6.53	6.07	7.69	**6.76**
R2	6.39	5.86	7.43	**6.56**	6.42	5.88	7.45	**6.58**
R3	6.19	5.24	6.94	**6.12**	6.20	5.25	6.95	**6.13**
R4	7.39	6.23	7.96	**7.19**	7.42	6.26	7.99	**7.22**
MEAN	**6.62**	**5.84**	**7.50**		**6.64**	**5.86**	**7.52**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.08		0.24		0.11		0.32	
R	0.09		0.28		0.12		0.37	
P*R	0.16		NS		0.22		NS	

P_1: Single pinching

P2: Double pinching

P3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R2: Paclobutrazol @ 100 ppm

R3: Paclobutrazol @ 150 ppm

R4: No spray

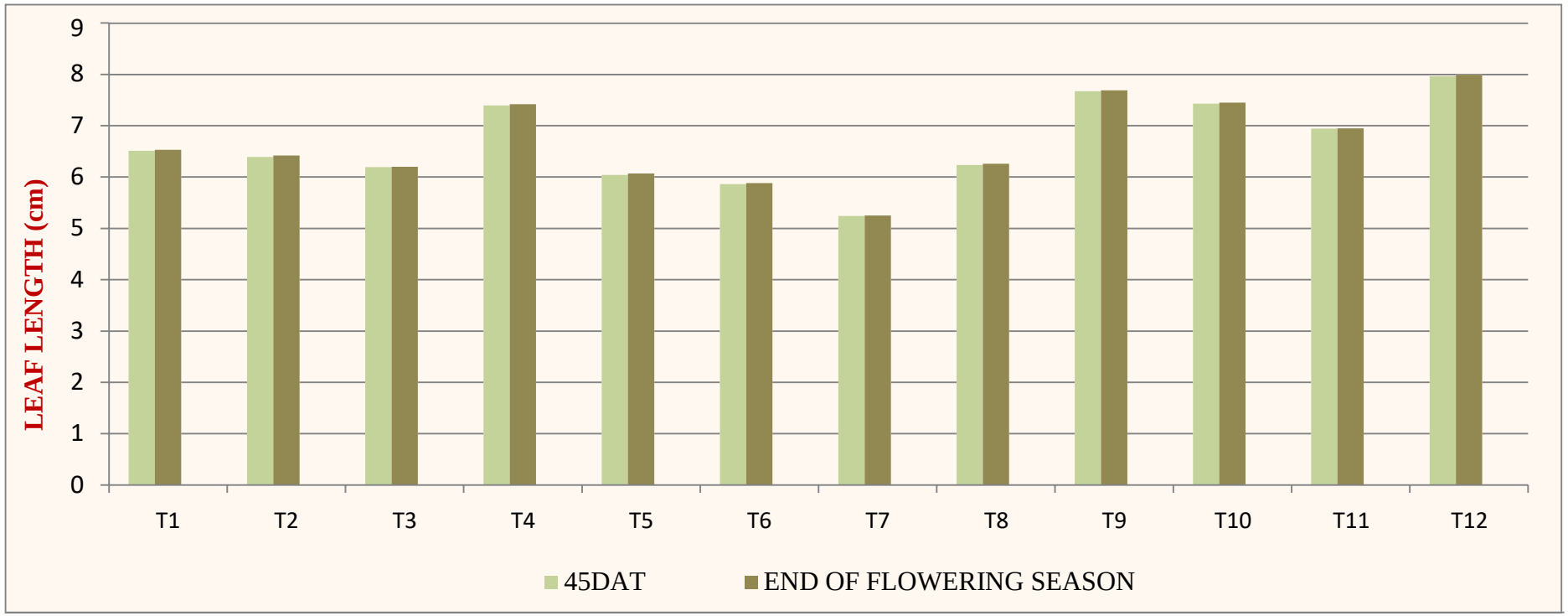

Fig 9. Effect of pinching levels and paclobutrazol on leaf length (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

Table no- 4.10. Effect of pinching levels and paclobutrazol on leaf area (cm^2) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)							
	45DAT				END OF FLOWERING SEASON			
	P_1	P_2	P_3	MEAN	P_1	P_2	P_3	MEAN
R_1	25.49	20.86	30.46	**25.60**	25.54	20.94	30.94	**25.81**
R_2	23.21	19.62	28.91	**23.91**	23.56	19.87	29.87	**24.43**
R_3	20.79	15.93	25.86	**20.86**	20.89	16.02	26.05	**20.98**
R_4	26.81	22.34	31.74	**26.96**	26.99	22.54	32.54	**27.35**
MEAN	**24.07**	**19.68**	**29.24**		**24.24**	**19.84**	**29.85**	
	S. Em±		**C. D at 5%**		**S. Em±**		**C. D at 5%**	
P	0.11		0.34		0.13		0.38	
R	0.13		0.39		0.15		0.44	
P*R	0.23		NS		0.26		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

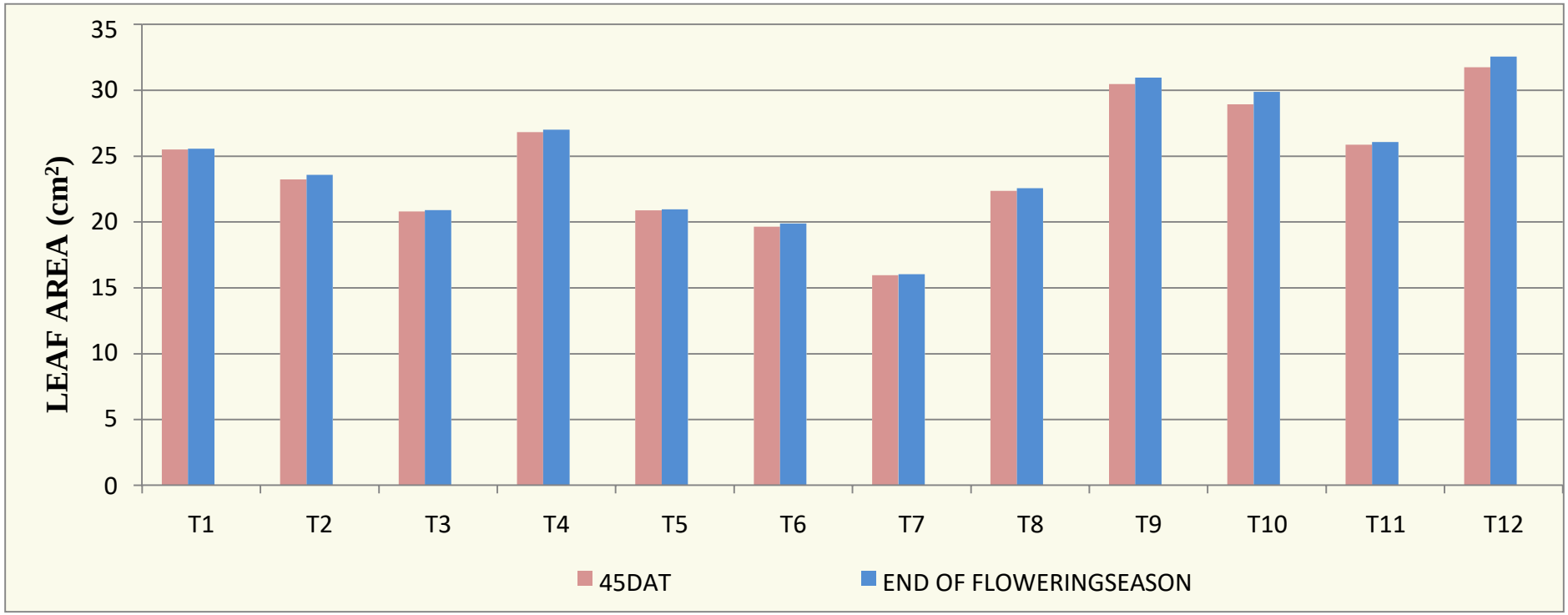

Fig 10. Effect of pinching levels and paclobutrazol on leaf area (cm^2) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

This reduction in leaf parameters due to pinching might be due to increase in number of branches, so that the photosynthates available might be limited for leaf growth and thereby reduced the width of leaf.

According to Gao *et al.* (1987) triazoles have several morphological effects on leaves, including reduced leaf area, and increased leaf thickness and epicuticular wax. So, the leaf width, length and area might be observed minimum with paclobutrazol application.

The interaction effect of pinching and paclobutrazol concentrations on leaf area was found to be non-significant.

4.1.11 Fresh weight of shoot (g)

The mean data pertaining to fresh weight of shoot as influenced by pinching and paclobutrazol concentrations is presented in Table 4.11. and Fig 11.

Significant variation was observed among different pinching levels on Zinnia. Among different levels of pinching, significantly maximum shoot fresh weight (84.12 g) was noticed in P_2-double pinching and minimum fresh weight of shoot (60.98 g) was recorded in P_3-no pinching. The treatment P_1- single pinching showed intermediate results. Similar results were also recorded by Rajesh *et al*. (2012) in china aster. The increase in fresh weight due to pinching wad due to increased branching and plant spread.

Among different concentrations of paclobutrazol spray, maximum fresh weight of shoot (81.65 g) was observed in R_4- No spray which is followed by R_1-50 ppm of paclobutrazol (75.97 g) while minimum fresh weight of shoot (64.10 g) was recorded with R_3- 150 ppm of paclobutrazol. Significant difference was observed on fresh weight of shoot due to paclobutrazol spray. Similar results were also reported by Lee (1990) in Gerbera and Latimer *et al*. (1991) in Zinnia, Impatiens and Marigold. The increase in fresh weight of shoot in no spray might be due to increased plant height, as concentration of paclobutrazol increased, fresh weight decreased due to stunted growth of plant.

Table no- 4.11. Effect of pinching levels and paclobutrazol on fresh weight of shoot (g) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	79.52	85.74	62.65	**75.9**
R_2	67.01	80.64	59.84	**69.16**
R_3	60.12	75.51	56.69	**64.10**
R_4	85.59	94.62	64.74	**81.65**
MEAN	**73.06**	**84.12**	**60.93**	
	S. Em±		**C. D at 5%**	
P	0.40		1.18	
R	0.46		1.36	
P*R	0.80		2.30	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

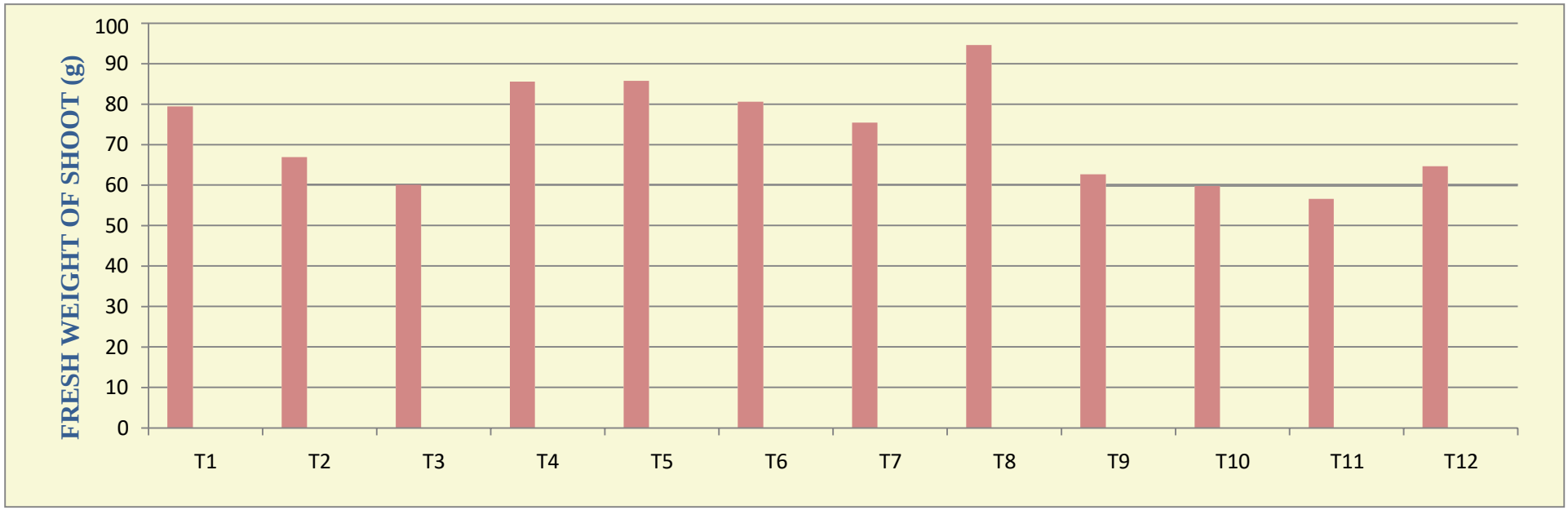

Fig 11. Effect of pinching levels and paclobutrazol on fresh weight of shoot (g) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

The effect of interaction of pinching and paclobutrazol spray on freshweight of shoot was statistically significant. The treatment combination P_3R_3 (no pinching with 150 ppm of paclobutrazol) recorded miminum fresh weight of shoot (56.69 g) while the maximum fresh weight of shoot (94.62 g) was registered in P_2R_4 which was followed by P_2R_1- double pinching with 50 ppm of paclobutrazol (85.74 g). Similar results were also reported by Sharaf-Eldien *et al.* (2017). The increase in fresh weight in no pinching and no spray treatment might bedue to increased plant height.

4.1.12 Dry weight of shoot (g)

The mean data pertaining on dry weight of shoot as influenced by pinching and paclobutrazol concentrations is presented in Table 4.12. and Fig 12.

Significant variation was observed among different pinching levels on Zinnia. Among different levels of pinching, minimum dry weight of shoot (19.44 g) was recorded in P_3-no pinching and significantly maximum shoot dry weight (32.47 g) was noticed in P_2-double pinching. The treatment P_1-single pinching showed intermediate results. As fresh weight was more in this treatment, corresponding results were obtained. Similar results were also reported by Nathan *et al.* (2019) in gompherena.

Among different concentrations of paclobutrazol spray, minimum dry weight of shoot (22.93 g) was recorded by R_3- 150 ppm of paclobutrazol, while maximum dry weight of shoot (31.45 g) was observed in R_4- No spray which is followed by R_1- 50 ppm of paclobutrazol (28.43 g) corresponding to the more fresh weight in this treatment, dry weight was also more. Similar results were also reported by Lee *et al.* (1990) in gerbera.

The effect of interaction of pinching and paclobutrazol spray on dry weight of shoot was statistically significant. The treatment combination P_3R_3 (no pinching with 150 ppm of paclobutrazol) recorded minimum dry weight of shoot (15.89 g) while the maximum dry weight of shoot (37.33 g) was registered in P_2R_4 which is

Table 4.12. Effect of pinching levels and paclobutrazol on dry weight of shoot (g) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	30.12	34.94	20.23	**28.43**
R_2	26.75	27.95	18.74	**24.48**
R_3	23.23	29.68	15.89	**22.93**
R_4	34.12	37.33	22.91	**31.45**
MEAN	**28.55**	**32.47**	**19.44**	
	S. Em±		**C. D at 5%**	
P	0.23		0.68	
R	0.27		0.79	
P*R	0.47		1.37	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

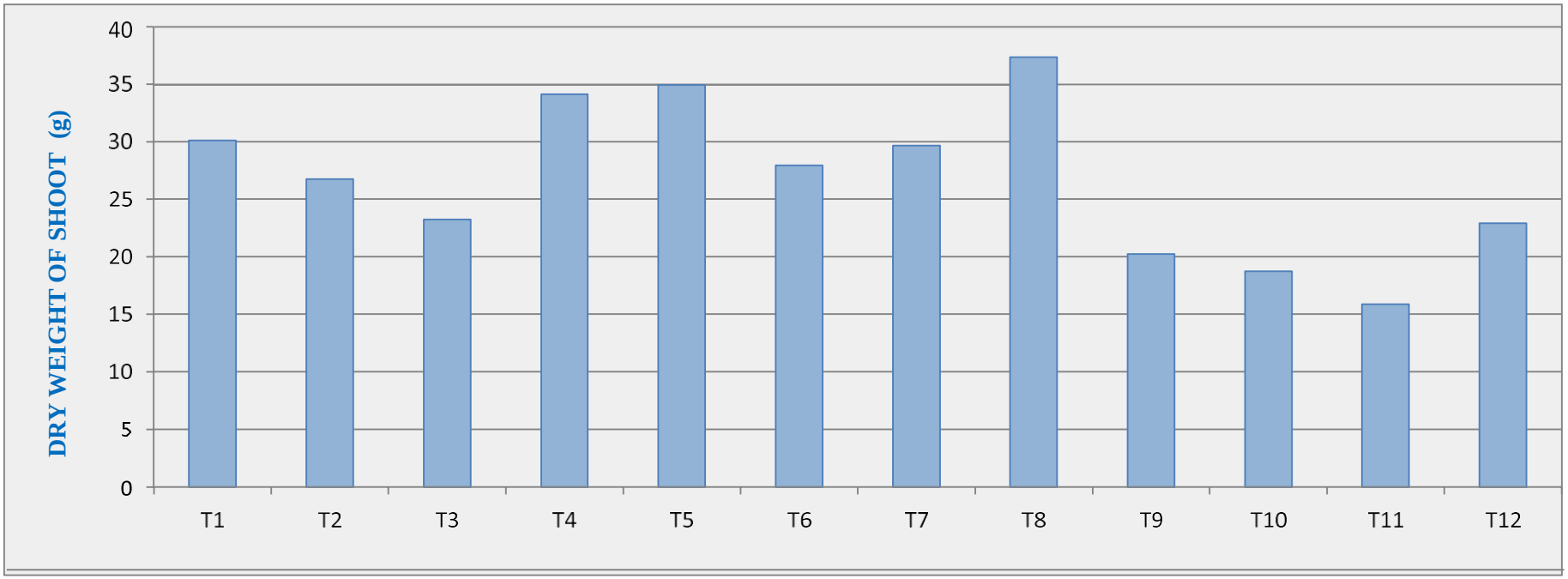

Fig 12. Effect of pinching levels and paclobutrazol on dry weight of shoot (g) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

followed by P_2R_1- double pinching with 50 ppm of paclobutrazol (34.94g). Similar results were also reported by Sharaf-Eldien *et al.* (2017) in zinnia.

4.2 FLOWERING AND YIELD PARAMETERS

4.2.1 Days to flower bud initiation

The mean data regarding days to flower bud initiation after transplanting as influenced by pinching, paclobutrazol concentrations and their interaction effects is presented in table 4.13. and depicted in the fig 13.

The significant variation on days to flower bud initiation was observed among the different pinching levels. The minimum number of days taken to flower bud initiation (13.69 days) was recorded in the plants with no pinch (P_3) while maximum number of days taken to flower bud initiation (47.48 days) was recorded in double pinching (P_2). The treatment P_1-(single pinching) showed intermediate results. Similar results were also reported by Sehrawat *et al*. (2003) in african marigold and Kumar *et al*. (2002) in carnation.

Number of days taken to flower bud initiation was significantly influenced by different paclobutrazol concentrations. It was observed that paclobutrazol at 150 ppm (R_2) took maximum number of days to flower bud initiation (30.19 days) which was at par with R_3- 100 ppm of paclobutrazol (29.90 days) and minimum days to flower bud initiation (28.10 days) was recorded in no spray (R_4). Similar results were also reported by Currey *et al.* (2010) in ester lilies.

The interaction effects of pinching levels and paclobutrazol concentrations on number of days to flower bud initiation was shown non significant.

4.2.2. Days to 50 % flowering

The mean data regarding days to 50 percent flowering as influenced by pinching, paclobutrazol concentrations and their interaction effects is presented in table 4.14. and depicted in the fig 14.

The significant variation on days to 50 percent flowering was observed among the different pinching levels. The minimum number of days to 50 percent

Table no- 4.13. Effect of pinching levels and paclobutrazol on days to flower bud initiation (after transplanting) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	26.57	47.24	13.67	**29.16**
R_2	27.86	47.67	14.19	**29.90**
R_3	27.64	48.36	14.59	**30.19**
R_4	25.34	46.65	12.31	**28.10**
MEAN	**26.85**	**47.48**	**13.69**	
	S. Em±		**C. D at 5%**	
P	0.28		0.82	
R	0.32		0.95	
P*R	0.56		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

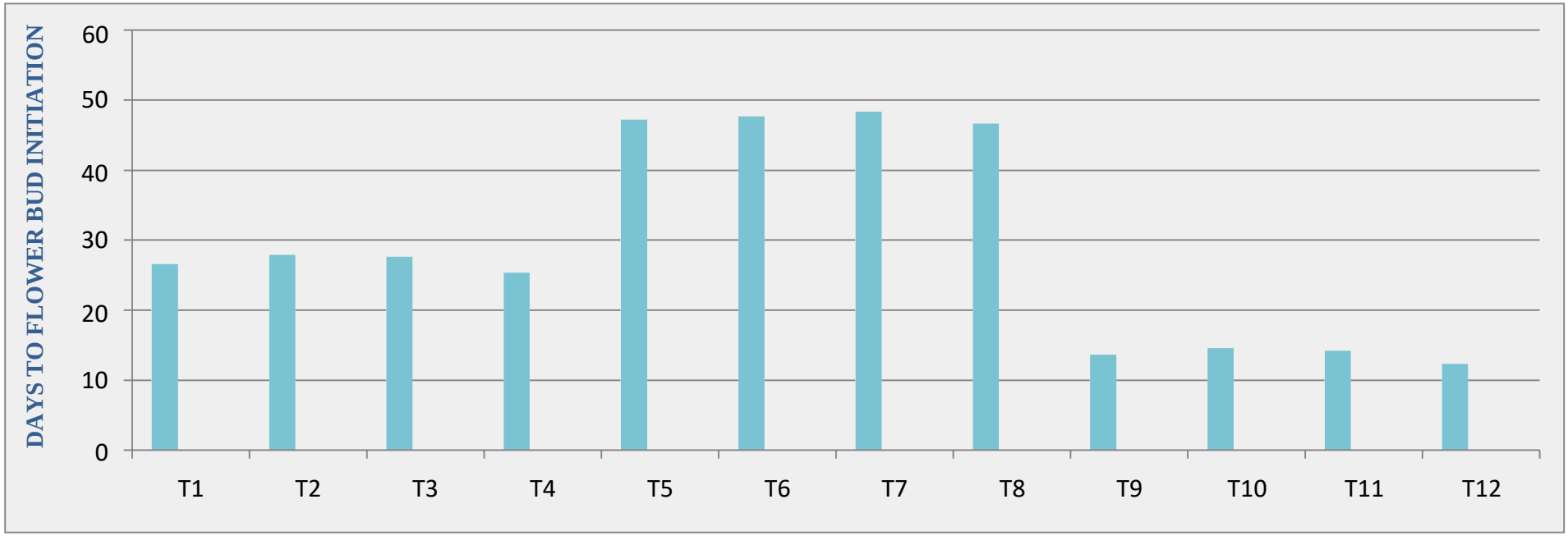

Fig 13. Effect of pinching levels and paclobutrazol on days to flower bud initiation (after transplanting) of potted annual – Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

flowering (21.49 days) was recorded in the plants with no pinch (P_3) while maximum days to 50 percent flowering (49.39 days) were recorded in double pinching. The treatment P_1-(single pinching) showed intermediate results between single and double pinching. Similar results were also reported by Khan *et al*. (2018) in Marigold.

Number of days to 50 percent flowering was significantly influenced by different paclobutrazol concentrations. It was observed that paclobutrazol at 150 ppm (R_3) took maximum number of days to 50 percent flowering (36.09 days) which was at par with R_2- 100 ppm of paclobutrazol (35.64 days) and minimum days to 50 percent flowering (33.74 days) was recorded in no spray (R_4).

The interaction effects of pinching levels and paclobutrazol concentrations on number of days to 50 percent flowering was shown non- significant.

4.2.3 Number of days taken to full bloom

The mean data regarding number of days to full bloom as influenced by pinching, paclobutrazol concentrations and their interaction effects is presented in table 4.15. and depicted in the fig 15.

The significant variation on number of days to full bloom was observed among the different pinching levels. The minimum number of days to full bloom (23.82 days) was recorded in the plants with no pinch (P_3) while maximum number of days to full bloom (58.89 days) was recorded in double pinching (P_2). The treatment P_1-single pinching showed intermediate results.

Delay in number of days to, bud initiation, 50 percent flowering and full bloom due to pinching might be attributed to the fact that, during the process of pinching mature portion of the shoot was removed and new shoots which emerged out from pinched plants took more time to become physiologically mature and produce flowering buds as explained by Wainwright and Irwin

Table no- 4.14. Effect of pinching levels and paclobutrazol on days to 50% flowering (after transplanting) potted annual – Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	34.23	49.16	21.65	**35.01**
R_2	34.93	49.86	22.13	**35.64**
R_3	35.17	50.24	22.87	**36.09**
R_4	33.56	48.33	19.34	**33.74**
MEAN	**34.47**	**49.39**	**21.49**	
	S. Em±		**CD at 5%**	
P	0.21		0.61	
R	0.24		0.71	
P*R	0.42		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

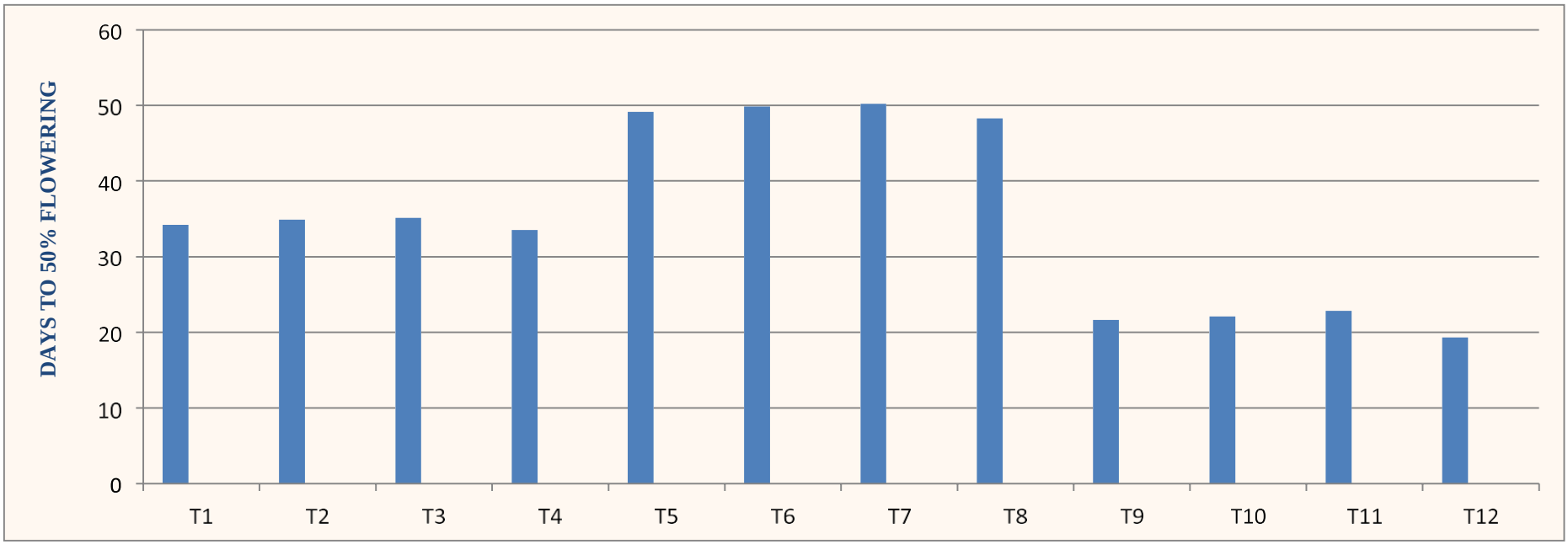

Fig 14. Effect of pinching levels and paclobutrazol on days to 50% flowering (after transplanting) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

(1987). Similar results were obtained by Jindal *et al*. (2018) in Chrysanthemum, Sehrawat *et al*. (2003) in african marigold and Kumar *et al*. (2002) in carnation.

Number of days to full bloom was significantly influenced by different paclobutrazol concentrations. It was observed that paclobutrazol at 150 ppm (R_3) took maximum number of days to full bloom (41.53 days) which was at par with R_2-100 ppm of paclobutrazol (40.99 days) and minimum number of days to full bloom (38.23 days) was recorded in no spray (R_4).

Application of paclobutrazol significantly delayed bud appearance, first flower opening and 50% flowering might be due to the reduced GA synthesis and prolonged vegetative phase by paclobutrazol application. This delay in flowering may be attributed to the reduced GA synthesis and prolonged vegetative phase by paclobutrazol application according to Chauhan *et al.* (2021). Similar results were also reported by Singh *et al*. (1999) in chrysanthemum and Currey *et al.* (2010) in easter lilies.

The interaction effect of pinching levels and paclobutrazol concentrations on number of days to full bloom was shown non-significant.

4.2.4 Number of flowers per plant

The mean data regarding number of flowers as influenced by pinching, paclobutrazol concentrations and their interaction effects is presented and depicted in the fig. 4.16. and table 16.

The significant variation on number of flowers was observed among the different pinching levels. The maximum number of flowers (18.91) was recorded in double pinching *i.e*, P_2 while minimum number of flowers (7.63) was recorded in the plants with no pinch *i.e*, P_3. The treatment P_1-single pinching showed intermediate results.

Increase in number of flowers may be due to the fact that pinched plant induced production of large number of axillary shoots (branches) resulting in

Table no- 4.15. Effect of pinching levels and paclobutrazol on days to full bloom (after transplanting) of potted annual – Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	37.25	58.84	23.31	**39.80**
R_2	38.85	59.21	24.91	**40.99**
R_3	39.01	59.89	25.71	**41.53**
R_4	35.68	57.65	21.36	**38.23**
MEAN	**37.69**	**58.89**	**23.82**	
	S. Em±		**C. D at 5%**	
P	0.19		0.57	
R	0.22		0.66	
P*R	0.39		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

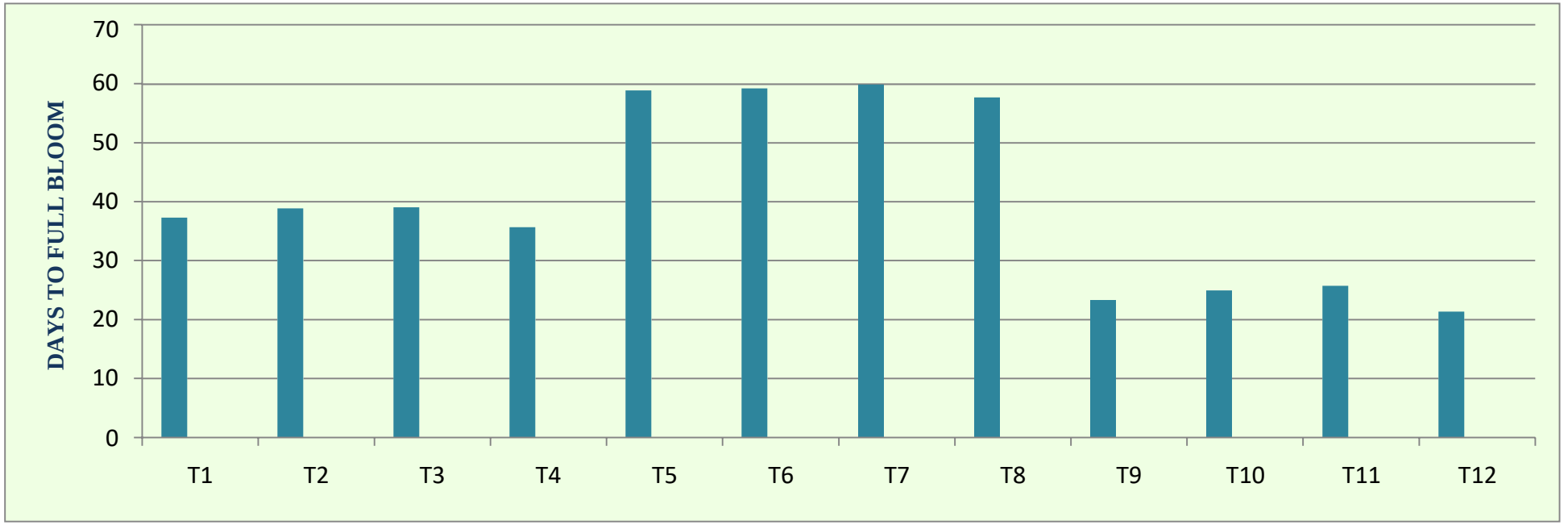

Fig 15. Effect of pinching levels and paclobutrazol on days to full bloom (after transplanting) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

well-shaped bushy plants bearing more number of uniform flowers. Similar results were also observed by Tomar *et al*. (2004) and Khan *et al*. (2018) on marigold and Ona *et al*. (2015) on chrysanthemum.

Number of flowers were significantly influenced by differentpaclobutrazol concentrations. It was observed that paclobutrazol at 100 ppm (R_2) produced maximum number of flowers (14.66) which was followed by R_3-
150 ppm of paclobutrazol (13.85) and minimum number of flowers (11.81) were recorded in no spray (R_4).

The increase in number of flowers may due to the reason that paclobutrazol alters the source-sink relation in the plant and directly or indirectly relocate carbohydrate resource, further, suppressed the vegetative growth (plant height, internodal length) and increased branching thereby yield. The results are in conformity with the findings of Asgarian *et al*. 2013 in zinnia.

The interaction effects of pinching levels and paclobutrazol concentrations on number of flowers was shown significant. The maximum number of flowers (20.61) was observed in P_2R_2 which is double pinching with 100 ppm of paclobutrazol which was at par with P_2R_3-double pinching with 150 ppm of paclobutrazol (19.82) whereas minimum number of flowers (6.71) was recorded in control (P_3R_4). The synergetic effect of double pinching and paclobutrazol spray resulted in reduced growth and increased branching and thereby more number of flowers per plant. Similar results were also reported by Sharaf-Eldien *et al.* (2017) in zinnia.

4.2.5 Flower diameter (cm)

Effect of paclobutrazol and pinching practices were found significant on flower diameter.

A cursory glance of data presented in table 4.17. and fig 17 revealed that minimum flower diameter (5.17 cm) was recorded in double pinch (P_2) while maximum flower diameter (7.21 cm) was found in no pinch (P_3). The treatment P_1-(single pinching) showed intermediate results.

Table no- 4.16. Effect of pinching levels and paclobutrazol on number of flowers per plant of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	12.61	18.91	7.41	**12.98**
R_2	14.80	20.61	8.56	**14.66**
R_3	13.92	19.82	7.82	**13.85**
R_4	10.50	16.32	6.71	**11.18**
MEAN	**12.96**	**18.91**	**7.63**	
	S. Em±		**CD at 5%**	
P	0.19		0.57	
R	0.22		0.66	
P*R	0.39		1.15	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

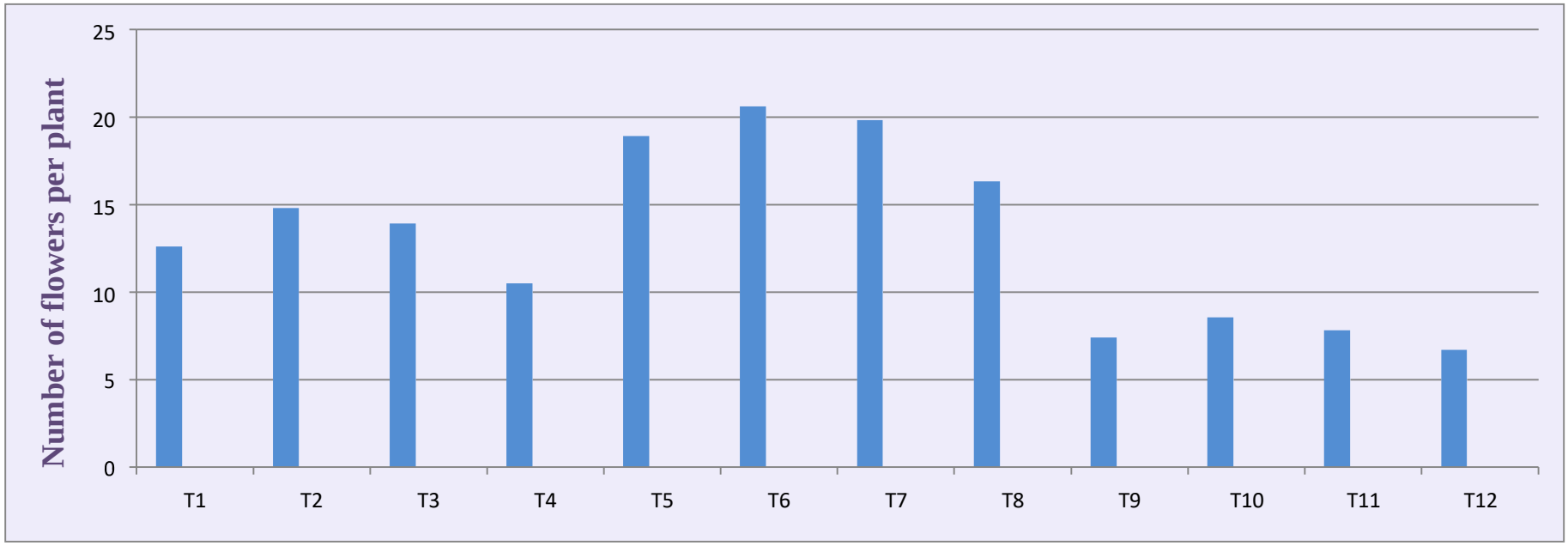

Fig 16. Effect of pinching levels and paclobutrazol on number of flowers per plant of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

The decrease in flower diameter might be attributed to the fact that in pinched plant energy is shared by the developing side branches, while in case of unpinched plants the energy sharing is limited to the flower developing on main branch only. Further, as number of flowers were less in no pinched plants dueto less competition, flower size increased. Similar results were also reported by Sailaja *et al*. (2014) in china aster.

Effect of paclobutrazol on flower diameter was found significant. Data on flower diameter revealed that, minimum flower diameter (5.56 cm) was recorded in R_3-150 ppm of paclobutrazol which is followed by 100 ppm paclobutraazol (R_2) while maximum flower diameter (6.87 cm) was recorded in R_4 (no spray). The increase in concentration of paclobutrazol decreased flower diameter.

The decrease in flower diameter by the application of paclobutrazol was due to its dwarfing effect which reduces the plant height, increases the main and secondary branching there by it increase the flower number with reduction in flower diameter as reported by Chauhan *et al.* (2021). Similar results were also reported by Mishra *et al*. (2011) in China aster.

The interaction effect of pinching and paclobutrazol on flower diameter was found non-significant.

4.2.6 Fresh weight of flowers per plant (g)

The mean data pertaining to dry weight of flowers per plant as influenced by pinching and paclobutrazol concentrations is presented in Table 4.18. and Fig 18.

Significant variation was observed among different pinching levels on Zinnia. Among different levels of pinching, maximum fresh weight of flowers per plant (44.68 g) was recorded in P_3-no pinching and significantly minimum (36.58 g) was noticed in P_2- double pinching. The treatment P_1- single pinching

Table no- 4.17. Effect of pinching levels and paclobutrazol on flower diameter (cm) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	SINGLE PINCH	**DOUBLE PINCH**	**NO PINCH**	**MEAN**
R_1	6.46	5.39	7.46	**6.43**
R_2	5.82	4.87	6.86	**5.85**
R_3	5.54	4.49	6.65	**5.56**
R_4	6.79	5.94	7.88	**6.87**
MEAN	**6.15**	**5.17**	**7.21**	
	S. Em±		**C. D at 5%**	
P	0.02		0.08	
R	0.03		0.09	
P*R	0.05		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 5ppm

R_2: Paclobutrazol @ 10ppm

R_3: Paclobutrazol @ 15ppm

R_4: No spray

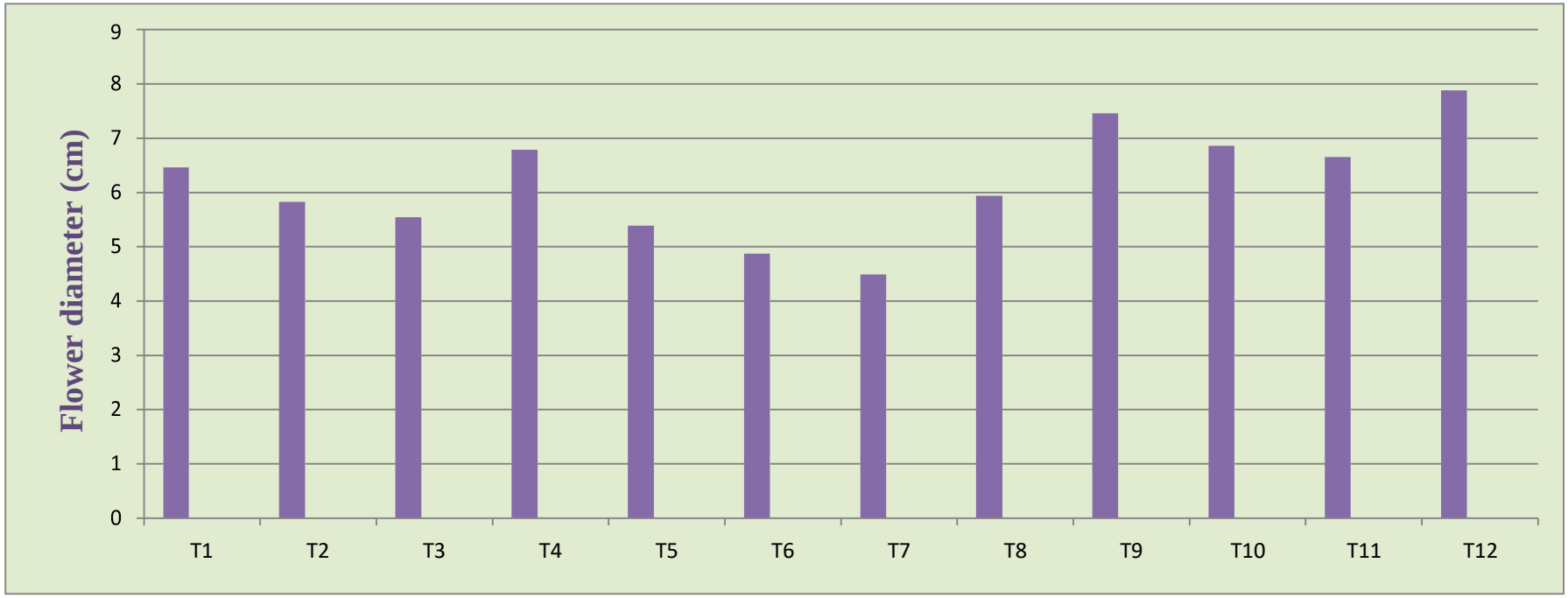

Fig 17. Effect of pinching levels and paclobutrazol on flower diameter (cm) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

PLATE- 7 Effect of pinching and paclobutrazol application on flower diameter.

showed intermediate results. Similar results were observed by Ullah *et al*. (2019) in zinnia.

Among different concentrations of paclobutrazol spray, maximum fresh weight of shoot (43.76 cm) was observed in R_2 – 100 ppm paclobutrazol which was at par with R_3-150 ppm of paclobutrazol (42.82g) while minimum fresh weight of flowers per plant (37.35g) was recorded by R_4- no spray. Significant difference was observed on fresh weight of flowers per plant due to paclobutrazol spray. Similar results were also reported by Sahu *et al.* (2021) in marigold.

The effect of interaction of pinching and paclobutrazol spray on fresh weight of flowers per plant was statistically non-significant.

4.2.7 Dry weight of flowers per plant (g)

The mean data pertaining on dry weight of flowers per plant as influenced by pinching and paclobutrazol concentrations at 45 DAT and at end of flowering season is presented in Table 4.19 and Fig 19.

Significant variation was observed among different pinching levels on Zinnia. Among different levels of pinching, maximum dry weight of flowers per plant (9.41g) was recorded in P_2-(double pinching) and significantly minimum (8.49g) was noticed in P_3-(no pinching). The treatment P_1-(single pinching) showed intermediate results between single and double pinching. As fresh weight was more in this treatment, corresponding results were obtained. Similar results were also reported by Atrachi *et al*. (2010) in zinnia.

Among different concentrations of paclobutrazol spray, maximum dry weight of flowers per plant (9.78g) was observed in R_2- 100 ppm paclobutrazol, which is followed by R_4- 150ppm of paclobutrazol (9.20g) while minimum dry weight of flowers per plant (7.93g) was recorded by R_4- no spray. Significant difference was observed on dry weight of flowers per plant due to paclobutrazol spray. Corresponding to the more fresh weight in this treatment, dry weight was

Table no- 4.18. Effect of pinching levels and paclobutrazol on fresh weight of flowers per plant (g) of potted annual – Zinnia.

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P1	**P2**	**P3**	**MEAN**
R1	41.88	43.05	36.54	**40.49**
R2	44.83	48.08	38.39	**43.76**
R3	43.59	47.43	37.46	**42.86**
R4	37.94	40.19	33.93	**37.35**
MEAN	**42.06**	**44.68**	**36.58**	
	S. Em±		**C. D at 5%**	
P	**0.33**		**0.96**	
R	**0.38**		**1.11**	
P*R	**0.66**		**NS**	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

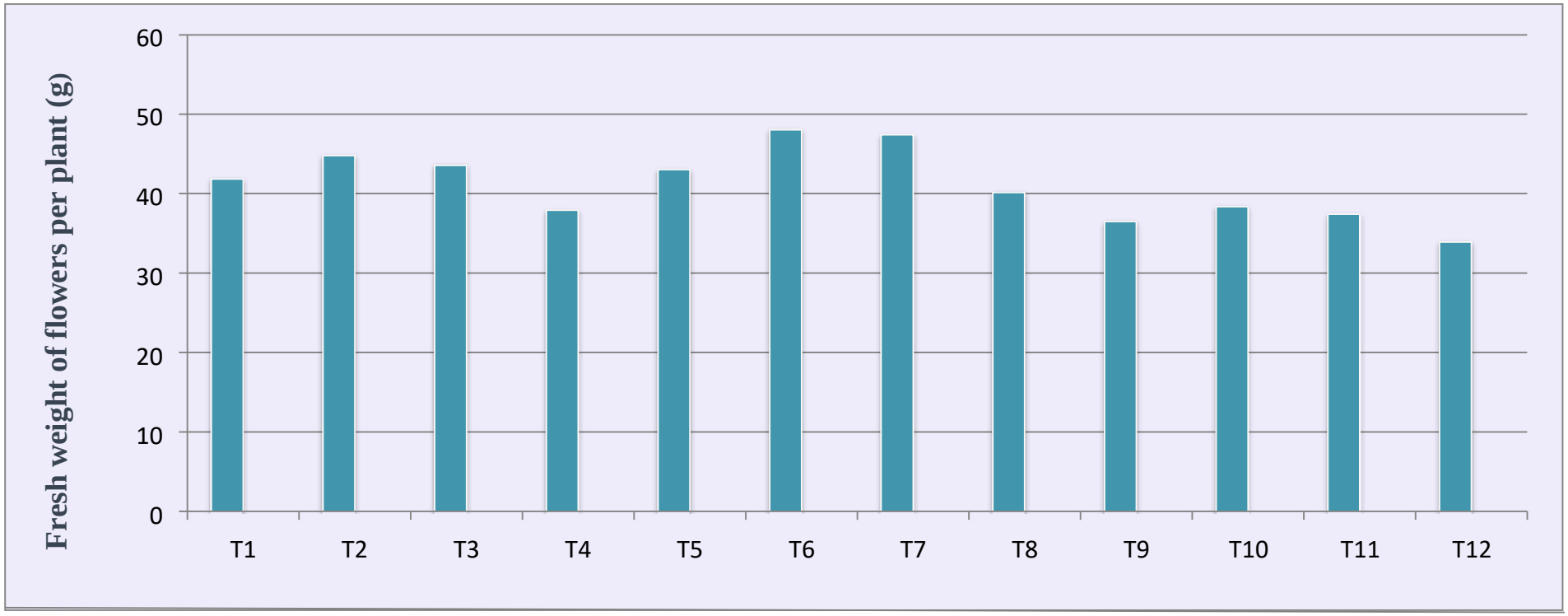

Fig 18. Effect of pinching levels and paclobutrazol on fresh weight of flowers per plant (g) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

Table - 4.19. Effect of pinching levels and paclobutrazol on dry weight of flowers per plant (g) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	8.73	9.03	8.51	**8.75**
R_2	9.94	10.25	9.61	**9.78**
R_3	9.07	9.69	8.84	**9.20**
R_4	7.64	8.67	7.48	**7.93**
MEAN	**8.84**	**9.41**	**8.49**	
	S. Em±		**C. D at 5%**	
P	0.10		0.29	
R	0.11		0.33	
P*R	0.20		NS	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

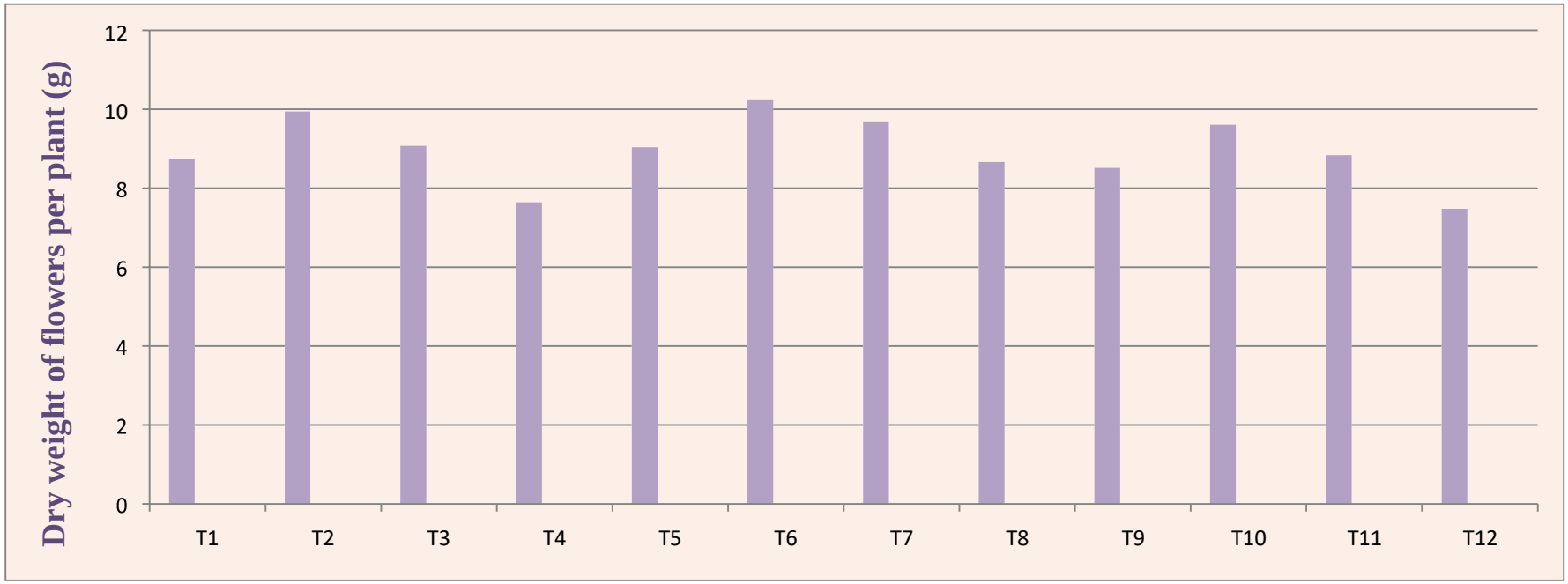

Fig 19. Effect of pinching levels and paclobutrazol on dry weight of flowers per plant (g) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

also more.

The effect of interaction of pinching and paclobutrazol spray on dry weight of flowers per plant was statistically significant.

4.2.8 Flower longitivity (days)

The mean data pertaining to flower longetivity as influenced by pinching and paclobutrazol is presented in table 4.20. and fig 20.

Significant variation was observed among different pinching levels on zinnia. Among different levels of pinching, maximum flower longetivity (21.34 days) was recorded in P_3-(no pinching) which was at par with P_1-single pinching (20.88 days) and significantly minimum (20.16 days) was noticed in P_2-(double pinching).

This might be due to the accumulation of more assimilates in non pinching treatment with less number of flowers. Similar results were also reported by Moon *et al*. (2017) in Gaillardia and Sailaja and panchbhai (2014) in china aster.

Among different concentrations of paclobutrazol spray, maximum flower longetivity (22.25 days) was recorded in R_2- 100 ppm of paclobutrazol which was at par with R_1-50 ppm of paclobutrazol (20.60 days), while minimum flower longetivity (18.66 days) was observed in R_4- No spray.

Paclobutrazol influences the isoprenoid pathway and changes the status of phytohormones by inhibiting gibberellin synthesis, decreasing ethylene production, and enhancing cytokinin and ABA contents (Kamountsis and Sereli, 1999). Similar results were Singh *et al.* (1999) on chrysanthemum.

The effect of interaction of pinching and paclobutrazol spray on flower longetivity was statistically non-significant.

Table 4.20. Effect of pinching levels and paclobutrazol on flower longitivity (days) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	20.68	20.04	21.08	**20.60**
R_2	22.31	21.49	22.96	**22.25**
R_3	21.64	21.17	22.23	**21.68**
R_4	18.89	17.97	19.12	**18.66**
MEAN	**20.88**	**20.16**	**21.34**	
	S. Em±		**C. D at 5%**	
P	**0.22**		**0.66**	
R	**0.26**		**0.77**	
P*R	**0.45**		**NS**	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

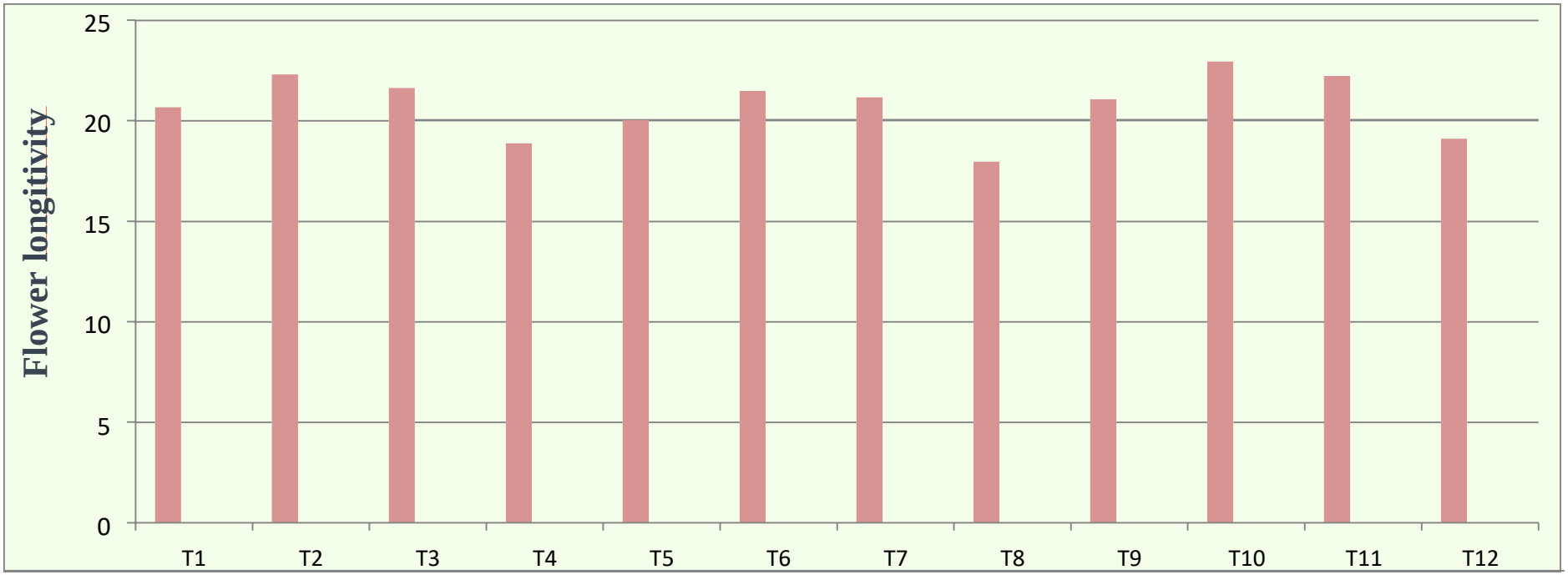

Fig 20. Effect of pinching levels and paclobutrazol on flower longitivity (days) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

4.3 Pot presentability (score)

The mean data pertaining on pot presentability as influenced by pinching and paclobutrazol concentrations is presented in Table 4.21. and Fig 21.

Significant variation was observed among different pinching levels on Zinnia. Among different levels of pinching, maximum pot presentability (80.34) was recorded in P_2-(double pinching) and significantly minimum (71.04) was noticed in P_3-(no pinching). The treatment P_1-(single pinching) showed intermediate results.

Among different concentrations of paclobutrazol spray, maximum pot presentability (82.90) was recorded by R_2- 100 ppm of paclobutrazol, which was followed by R_1-50 ppm of paclobutrazol (81.12) while minimum pot presentability score (67.29) was observed in R_4- No spray .Significant difference was observed on pot presentability due to paclobutrazol spray.

The effect of interaction of pinching and paclobutrazol spray on pot presentability was statistically significant. The treatment combination P_2R_2 (double pinching with 100 ppm of paclobutrazol) recorded maximum pot presentability score (87.41) which was followed by P_2R_3- double pinching with 50 ppm of paclobutrazol (85.31) while minimum score was recorded in P_3R_4- control (60.33).

Plants with double pinching with 100 ppm paclobutrazol spray showed best pot presentability score, because it had maximum number of flowers per plot, optimum flower size and good colour with self supporting strong stems and foliage without any infestation. It was also observed to have good plant height and plant spread. Overall appearance as a whole plant was also observed best in this treatment because, it had fresh appearance with no indication of senescence.

Table no- 4.21. Effect of pinching levels and paclobutrazol on pot presentability (score) of potted annual - Zinnia

PACLOBUTRAZOL CONCENTRATIONS (R)	PINCHING LEVELS (P)			
	P_1	**P_2**	**P_3**	**MEAN**
R_1	80.78	85.31	77.26	**81.12**
R_2	82.16	87.41	79.13	**82.90**
R_3	70.36	75.37	67.42	**71.05**
R_4	68.26	73.28	60.33	**67.29**
MEAN	**75.39**	**80.34**	**71.04**	
	S. Em±		**C. D at 5%**	
P	**0.27**		**0.80**	
R	**0.31**		**0.92**	
P*R	**0.54**		**1.60**	

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

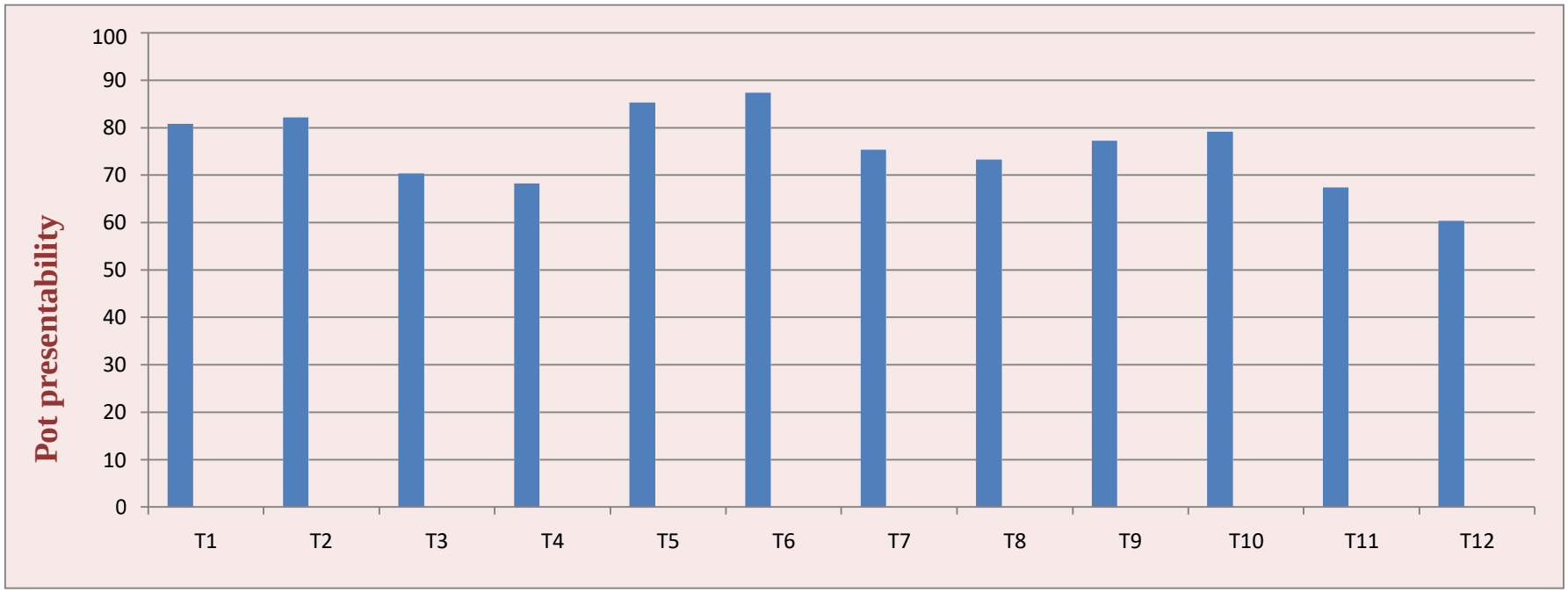

Fig 21. Effect of pinching levels and paclobutrazol on pot presentability (score) of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

4.4 Benefit cost ratio

The mean data pertaining on B:C ratio as influenced by pinching and paclobutrazol concentrations is presented in Table 4.22.

Highest B:C ratio (1.40) was observed in T_6 - Double pinching with 100 ppm of paclobutrazol which was followed by T_5 -Double pinching with 150 ppm of paclobutrazol (1.34) while minimum B:C ratio (0.66) was observed in T_{12} -No pinch with No spray *i.e,* control.

The maximum B:C ratio in T_6 was due to best pot presentability, which fetch good price.

Table no- 4.22. Effect of pinching levels and paclobutrazol on B:C ratioplant of potted annual - Zinnia

TREATMENTS	POT PRESENTABILITY SCORE	COST OF PRODUCTION PER TRETMENT	PRICE PER POT	GROSS RETURNS PER TREATMENT	NET RETURNS	BC RATIO
T1 (Single pinch+ 50ppm)	80.78	902.64	66.94	2008.2	1105.56	1.22
T2 (Single pinch+ 100ppm)	82.16	905.28	68.09	2042.7	1137.42	1.25
T3 (Single pinch+ 150ppm)	70.36	907.92	58.31	1749.3	841.38	0.92
T4 (Single pinch)	68.26	900	56.57	1697.1	797.1	0.88
T5 (Double pinch +50ppm)	85.31	902.64	70.70	2121	1218.36	1.34
T6 (Double pinch +100ppm)	87.41	905.28	72.44	2173.2	1267.92	1.40
T7 (Double pinch +150ppm)	75.37	907.92	62.46	1873.8	965.88	1.06
T8 (Double pinch)	73.28	900	60.73	1821.9	921.9	1.02
T9 (50ppm)	77.26	902.64	64.03	1920.9	1018.26	1.12
T10 (100ppm)	79.13	905.28	65.58	1967.4	1062.12	1.17
T11 (150ppm)	67.42	907.92	55.87	1676.1	768.18	0.84
T12 (Control)	60.33	900	50	1500	600	0.66

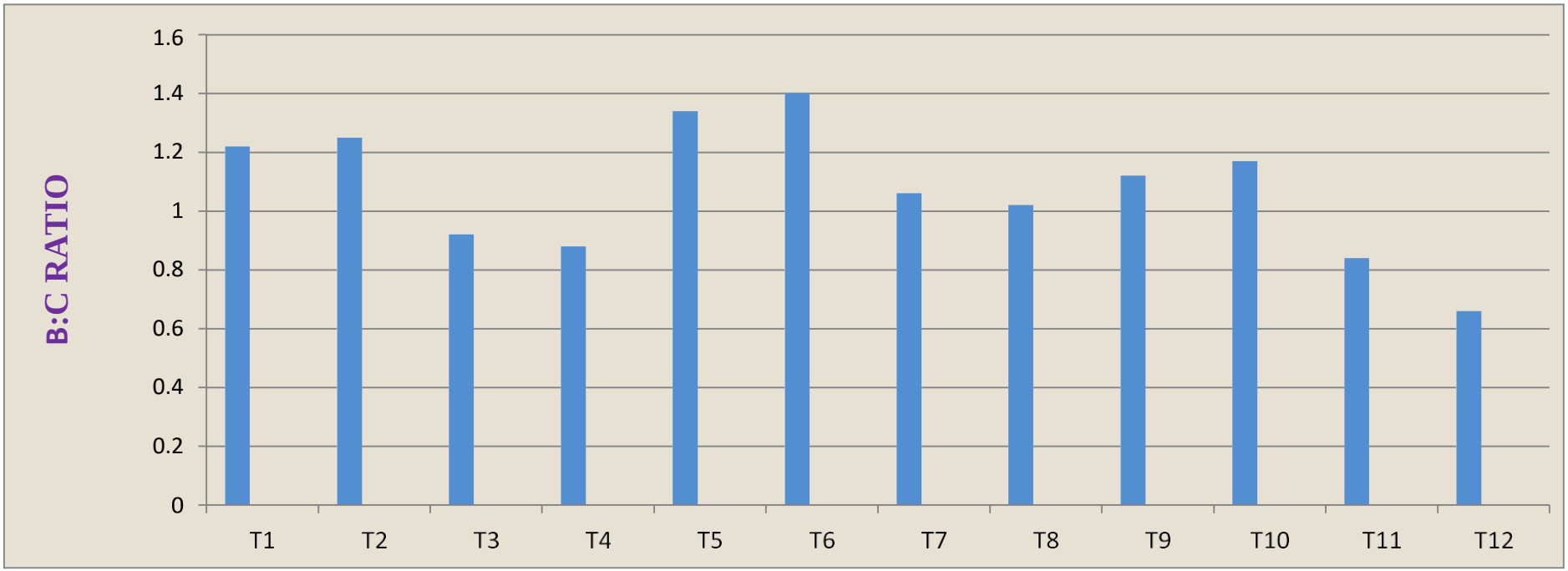

Fig 22. Effect of pinching levels and paclobutrazol on B:C ratio of potted annual - Zinnia

P_1: Single pinching

P_2: Double pinching

P_3: No Pinching

R_1: Paclobutrazol @ 50 ppm

R_2: Paclobutrazol @ 100 ppm

R_3: Paclobutrazol @ 150 ppm

R_4: No spray

Chapter - V

Summary and Conclusions

Chapter-V

SUMMARY AND CONCLUSIONS

The present investigation **"EFFECT OF PINCHING PRACTICES AND PACLOBUTRAZOL ON GROWTH, FLOWER YIELD AND POT PRESENTABILITY OF POTTED ANNUAL – *Zinnia elegans"*** was carried out at college of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Hyderabad during November 2020 to February 2021.

The treatments consisted of three levels of pinching *viz.,* P_1: Single pinching, P_2: double pinching and P_3: no pinching with four concentrations of paclobutrazol *viz.,* R_1: 50 ppm paclobutrazol, R_2: 100 ppm paclobutrazol, R_3: 150 ppm paclobutrazol and R_4 : No spray. The salient findings of the investigations are summarized below.

5.1 Growth parameters:

The data on growth characters such as plant height, stem diameter, number of nodes, internodal length, number of branches per plant, plant spread, leaf width, leaf length and leaf area were recorded at 45 DAT and at the end of flowering season. The data on fresh and dry weight of shoot were recorded at the end of flowering season only.

- Among pinching levels, no pinching (P_3) recorded the maximum values for leaf width (4.54, 4.60 cm), leaf length (7.50, 7.52 cm), leaf area (29.24, 29.85 cm^2) and double pinching (P_2) recoded maximum values of stem diameter (0.59, 0.62 cm), number of nodes (27.22, 31.13), number of branches per plant (20.35, 23.56), plant spread (E-W) (20.58, 24.18 cm), plant spread (N-S) (21.04, 23.10 cm) and minimum values for plant height (20.16, 23.84 cm) and internodal length (2.51, 2.61 cm) at 45 DAT and at the end of flowering season respectively and also for fresh weight of shoot (84.12 g), dry weight of shoot (32.47 g).
- Among paclobutrazol concentrations, no spray (R_4) recorded maximum leaf width (4.40, 4.50 cm), leaf length (7.19, 7.22 cm), leaf area (26.96, 27.35 cm^2) at 45 DAT and at the end of flowering season respectively also, for

fresh weight of shoot (81.65g) and dry weight of shoot (31.45 g). paclobutrazol (150 ppm) (R_3) recorded maximum stem diameter (0.57, 0.61 cm) and minimum plant height (24.25, 25.79 cm) and internodal length (3.05, 3.11 cm). Paclobutrazol (100ppm) (R_3) recorded maximum number ofnodes (24.57, 27.37), number of branches per plant (16.33, 18.30), plant spread (E-W) (18.95, 20.78 cm), plant spread (N-S) (19.32, 20.35 cm) at 45 DAT and at the end of flowering season respectively.

- Among treatment combinations, double pinching with 150 ppm of paclobutrazol (P_2R_3) recorded minimum plant height (18.93, 21.55 cm) at 45 DAT and at the end of flowering season respectively. Double pinching with 100 ppm of paclobutrazol (P_2R_2) recorded maximum number of nodes (29.66, 34.20), number of branches per plant (22.65, 25.56), plant spread (E-W) (21.46, 25.78 cm), plant spread (N-S) (22.35, 24.52 cm) at 45 DAT and at the end of flowering season respectively and double pinching with no spray (P_2R_4) for fresh weight of shoot (94.62 g) and dry weight of shoot (37.33 g).
- Interaction effect for some parameters like stem diameter, internodal length, leaf length, leaf width and leaf area was found non-significant.

5.2 Flowering and yield parameters:

Days to flower bud initiation, days to 50% flowering, number of days taken to full bloom, number of flowers per plant, flower diameter, fresh weight of flowers per plant, dry weight of flowers per plant, flower longitivity on plant were recorded.

- Among pinching levels, no pinching (P_3) recorded minimum number of days for flower bud initiation (13.69), days to 50 percent flowering (21.49), number of days taken to full bloom (23.82) and maximum flower longitivity (21.34). Double pinching (P_2) recorded minimum flower diameter (5.17 cm) and maximum number of flowers per plant (18.91), fresh weight of flowers (44.68) and dry weight of flowers per plant (9.41g).
- Among paclobutrazol concentrations, no spray (R_4) recorded minimum values for days to flower bud initiation (28.10), days to 50 percent flowering (33.74), and number of days taken to full bloom (38.23). 150 ppm

Paclobutrazol (R_3) recorded minimum flower diameter (5.56 cm). 100 ppm Paclobutrazol (R_2) recorded maximum number of flowers per plant (14.66).

- The interaction effect of pinching and paclobutrazol was found non significant for days to flower bud initiation, days to 50 percent flowering, number of days taken to full bloom, flower diameter, longitivity, fresh and dry weight of flower per plant. Number of flowers per plant (20.61) recorded maximum values in double pinching with 100 ppm paclobutrazol (P_2R_2).

5.3 Pot presentability:

- Pot presentability score was recorded maximum (80.34) in double pinching (P_2) among pinching levels and 100 ppm paclobutrazol (R_2) scored maximum (82.90) among paclobutrazol levels. Among the interactions, double pinching with 100 ppm paclobutrazol scored maximum (87.41) pot presentability.

5.4 Economics:

- Among pinching treatments, double pinching (P_2) registered maximum B:C ratio (1.34) and paclobutrazol at 100 ppm recorded maximum B:C ratio (1.17). Among the interactions, double pinching with 100 ppm paclobutrazol registered maximum B:C ratio of 1.40.

Conclusion:

Maximum positive effect on growth, yield, pot presentability and higher net realization parameters were registered by double pinching among pinching levels and 100 ppm paclobutrazol (R_3) among paclobutrazol concentrations. While, the interaction, double pinching with 100 ppm paclobutrazol (P_2R_3) was found preferrable for growth, yield, pot presentability and higher net realization which is followed by double pinching with 50 ppm paclobutrazol (P_2R_1).

Future line of work:

1. Flowering pot plants sale has huge potential in floriculture industry, hence, studies on density of plants per pot, at different pinching practices has to be standardized.
2. Combination of various herbaceous and flowering annuals in single pot may

be studied for creating interest in consumer acceptability

3. Studies on suitability of herbaceous flowering annuals/perennials are to be studied for Vertical garden arrangements

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APPENDIX-I

Monthly mean meteorological data recorded at ARI, Rajendranagar during Nov 2020 to February 2021.

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	No. of rainy days	Sunshine hours	Wind speed (Km/hr)	Evaporation (mm)
	Max.	Min.	I	II					
NOV	29.4	16.7	88	47	15.2	3	7.3	3.6	3.1
DEC	28.5	12.5	94	42	0.0	0	8.6	2.7	2.8
JAN	29.5	15.3	95	45	4.2	1	7.0	3.0	3.1
FEB	30.7	13.8	88	41	0.0	0	8.5	3.5	4.3