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Effect of Different Dates of Pinching on Growth and Yield Attributes of Chilli Pepper (Variety- Marshal) in Chitwan, Nepal

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Abstract— *Low yield and increased use of chemical fertilizers are major problems for chilli growers in Chitwan, Nepal. An experiment to determine the effect of pinching on the vegetative and reproductive attributes of Chilli was conducted in the farmer's field to study its effect on height, branching system, and yield attributes of the plant. Seven treatments in total that were pinching at 15th, 30th, 45th, 15th & 30th,15th & 45th, 30th & 45th DAT and control with three replications were laid out in randomized complete block design in an area of 5.4 m^2. A significant reduction in height by 32.70% was observed in the double-pinched plot than in the un-pinched plot. Similarly, an increase in the number of primary, secondary, and tertiary flowering branches was recorded in pinched plants as compared to controlled conditions. Pinching after the 15th & 45th DAT recorded a greater number of days to 1st flowering and 50% flowering while double pinching takes a maximum of days to flower followed by single pinching. Notably, double pinching at 15th & 30th DAT resulted in a substantial increase in the number of fruits per plant by 77.56%, average fruit weight by 27.57%, fruit length by 18.04%, and overall fruit yield by 118.65% compared to the control. While single pinching at the 15th, 30th, and 45th DAT yielded comparable results, the control treatment displayed inferior outcomes. These findings underscore the efficacy of pinching at 15th & 30th DAT as a beneficial approach to enhance the growth and yield traits of Chilli plants in Chitwan, Nepal.*

Keywords*— *Branches, Height, Marshal, Pinching, Yield

I. INTRODUCTION

Chilli peppers, often known as chillies, are a type of fruit that grows on plants in the Capsicum genus, which belongs to the nightshade family Solanaceae (Basu & De, 2003). Chilli peppers were domesticated some 6,000 years ago in what is now Mexico and then spread throughout the Americas by indigenous peoples. Chilli peppers were introduced to Europe and subsequently to other areas of the globe, including Africa and Asia, when Europeans arrived in the Americas in the 15th century (Kraft et al., 2014). There are perhaps fifty thousand Capsicum cultivars grown worldwide. The five most commonly cultivated species of Chilli peppers are *Capsicum annum*, *Capsicum frutescens*, *Capsicum chinense*, *Capsicum baccatum*, and *Capsicum pubescens*. Each chilli pepper species has various characteristics such as flavor, heat intensity, and appearance (Bosland et al., 2012).

Capsicum species, widely known as chillies, are diploid Solanaceae plants with chromosome number 2n=2x=24. Several wild species contain 26 chromosomes (n=x=13) (Pickersgill, 1991; R. Singh, 2001). It can be herbaceous, semi-woody, annual, or perennial. The leaves vary in size and can be oval, tapering to a sharp point, and up to 15 cm long. The plant had multiple branches, powerful taproots, and numerous widely branching laterals that were one meter long (Muthukrishnan et al., 1986). The flower is terminal and usually borne singly. The blooms are tiny, and white, and appear alone or in clusters of two or three in the leaf axils. According to reports, the rate of natural crossover in chillies is approximately 16.5% (Dhaliwal et al., 2014). Flowers remain open for 2-3 days and the percentage of fruit set is 40-50%. The flowering begins 1-2 months after planting and it takes again one month for fruiting (Muthukrishnan et al., 1986; R. Singh, 2001). Chillies' blossoms bloom between 6 and 10 a.m., and the anthers dehisce an hour later. However, meteorological conditions have a significant impact on flower opening and anther dehiscence. Fruits typically develop in around 45 days (R. Singh, 2001). Depending on the type, the fruits vary in form and size. The fruits are many-seeded berries that bear individually or in clusters at nodes, with a pendulous or erect bearing habit.

The production area and output of chilli in Nepal have not expanded as projected, and they are inadequate to meet expanding demand. This has resulted in increased imports from India to meet current demand. To reduce imports, the greatest approach is to boost output. Pinching will be the most cost-effective and simple method of increasing production. Several studies have shown that pinching in chilli plants can promote the development of a strong root system, improve branching, and increase the number of flowers and fruits (Frimpong, 2011). However, depending on when the operation is performed, pinching has different effects on chilli development and production. For instance, pinching at the vegetative stage has been reported to boost the output of Chilli (Rathore et al., 2018), whereas pinching at the flowering stage can lead to a reduction in yield due to flower abortion (Sunitha et al., 2007). Moreover, environmental variables like temperature, light, and humidity might have an impact on how pinching affects chilli growth and production (Frimpong, 2011). Therefore, it is crucial to investigate the effect of different dates of pinching on chilli growth and yield in specific regions, considering the local environmental conditions.

Pinching is the process of removing the apical bud along with a few leaves, which favors the growth of the number of side branches (Rajput et al., 2020). The main goal of pinching is to promote branching, which results in bushy growth and increases flower and fruit production (Lalit et al., 2020). The effects of pinching have been recorded in many commercial crops as a significant decrease in plant height, a delayed flowering period, and an increase in the number of flowering stems (Dorajeerao & Mokashi, 2012; Ramesh Kumar & Singh, 2003b). The yield is mainly determined by the number of flowers, which is determined by the number and quality of blooming branches, which can be increased by pinching the apical growth (Acharya et al., 2022). The majority of farmers are unfamiliar with the pinching technique, and little research has been undertaken on it. Pinching may play a significant role in determining yield. According to Khan et al., 2018, pinching has a considerable impact on plant height, flower diameter, stem diameter, flower count, and days to 50% blooming.

The timing of pinching has a major effect on the growth and yield of Chilli plants as it affects the plant's overall growth and development. Several studies have been conducted to investigate the impact of various pinching dates on the growth and yield parameters of chilli. In one study conducted in Lamjung, Nepal, double pinching at the 25th and 40th DAT produced the greatest amount of primary and secondary branches, followed by pinching at the 25th and 35th DAT. Similarly, days to 50% flowering were found to be greatest when double pinching and lowest when controlled (Acharya et al., 2022). Similarly, a study conducted in Jodhpur, India, evaluated the effect of pinching at different dates (20, 30, 40, and 50 days after transplanting) on the growth and yield of chilli (Kumawat, 2018). The results revealed that pinching at 20 and 30 days after transplanting resulted in higher yield and quality metrics while pinching at 40 and 50 days after transplanting resulted in lower yield and quality (Kumawat, 2018). Chauhan et al., (2009) studied the impact of apical pinching on bell pepper seedling development and discovered that it had a significant effect on plant height, number of branches per plant, days to first picking of green fruits, days of harvest duration, and green fruit yield per hac.

These studies suggest that the optimal timing of pinching can vary depending on the variety, season, and location of chilli cultivation and that earlier pinching generally results in higher yields and improved quality parameters. However, more research is needed to determine the best pinching practices for different varieties of chilli under different growing conditions.

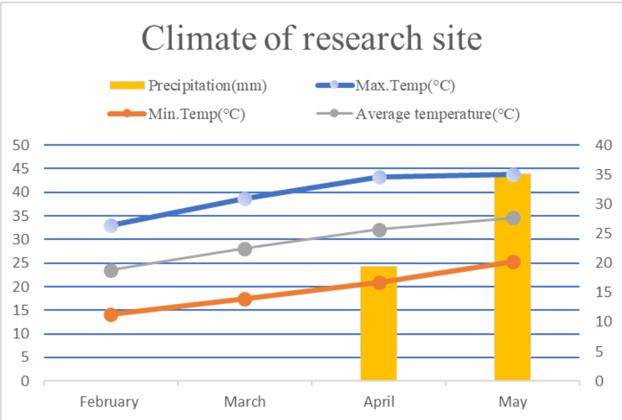
II. MATERIALS AND METHODS

An experiment “Effect of different dates of pinching on growth and yield attributes of chilli” was carried out in the year 2023 during the summer season at Chitwan, Nepal. The geographical location of the site was 27°38'57.2"N latitude and 84°20'44.8"E longitude and situated at an elevation of 208 meters above sea level. The results of some chemical and physical properties of the soil taken from different locations of the field at 0-30 cm depth are shown in Table 1**.** The meteorological data during the experimental period are also shown in the figure 1.

Table 1: Chemical & Physical Properties of Research Site

Soil Properties	Values
Textural class	Sandy Loam
pH	5.9 (Acidic)
Nitrogen (%)	0.19 (Medium)
Phosphorus, P_2O_5 (kg/ha)	110 (High)
Potash, K_2O (kg/ha)	402 (High)
Organic Matter (%)	3.72 (Medium)

Source: Soil Lab, Hetauda



Source: NMRP, Chitwan

Fig.1: The meteorological data during the experimental period

To treat soil-borne illnesses, the nursery bed was prepared 30 days before transplanting and saturated with Blitox 0.3% solution, as recommended by Gupta & Thind, 2018. Furadan (3% carbofuran @ 2.5 g/m2) was added to the soil during the final nursery bed preparation to control insect damage (Alexander et al., 2009). On February 10, 2023, 5gm of seeds were sowed in the nursery beds. Straw was used to mulch the beds, which were then covered with a white transparent plastic covering. The mulch was removed as soon as the seeds germinated.

A week before the transplant, the experimental land was prepared by heavy plowing and leveling. A fertilizer of 100:100:100 Kg/hac NPK along with 15 Mt/hac of freshly decomposed FYM was applied (Krishi Diary, 2020). Before transplantation, the layout was also planned. The first and light irrigation was given when transplanting, and successive irrigations were given at intervals of 4-5 days, once a week, or once every 10 days, depending on the weather and soil moisture conditions.

A uniform and strong 40-day-old seedling with 3-4 leaves was selected, and transplantation was performed on March 10th in the main field in the evening, with irrigation applied in a minor amount. Nitrogen was applied at a rate of 100 kg/ha, with 1/3 as a basal dosage, the second 1/3 in 25 days after transplanting, and the last 1/3 in 50 days after transplanting, while phosphorus was applied as a single superphosphate at a rate of 100 kg/ha. The weeding was done on the 14th DAT, and the second wedding was done on the 35th DAT.

1.1. Experimental Design

The experiment was conducted in a Randomized Complete Block Design (RCBD) design. There was a total of seven treatments and each treatment was replicated three times. So, the total number of plots was 21 and each plot contained 20 plants i.e. 5 rows in a plot accommodating 4 plants in each row. Each plot measured 3 m × 1.8 m, ensuring an adequate area for the growth and development of the chilli plants. The row-to-row distance was maintained at 60 cm, while the plant-to-plant distance was set at 45 cm (Krishi Diary, 2020). To minimize potential external influences, a distance of 1 m separated replications, and a 50 cm gap was maintained between individual plots. The experimental setup commenced with the sowing of Chilli seeds on March 10, 2023.

Five plants were picked using sampling procedures from a total of 20. The sample approach used was basic random sampling. This technique involved choosing chilli plants at random from the whole field population. It guaranteed that each plant had an equal chance of being chosen and helped to reduce bias. Initially, the hand was cleansed with sanitizer, and the equipment used for pinching (scissors) was sterilized.

Table 2: Details of Treatments

Treatment	Treatment details
T1	Control
T2	Pinching after 15th DAT
T3	Pinching after 30th DAT
T4	Pinching after 45th DAT
T5	Pinching after 15th & 30th DAT
T6	Pinching after 15th & 45th DAT
T7	Pinching after 30th & 45th DAT

1.2. Studied Parameters

The parameters which were studied to find out the effect of pinching on chilli growth and yield are as follows. All the vegetative parameters were measured at 55, 65, and 75, days after transplanting.

Plant height (cm): Plant height was measured from five randomly selected tagged plants within the net plot area. It was measured from ground level to the tip of the main shoot, and the average was calculated.

Number of primary branches per plant: The number of primary branches arising from the main shoot was counted in five sample plants and the average was calculated.

Number of secondary branches per plant: The number of secondary branches arising from primary branches was counted in five sample plants and the average was calculated.

Number of tertiary branches per plant: The number of tertiary branches arising from secondary branches was counted in five sample plants and the average was calculated.

Number of leaves per plant: The number of green, photosynthetically active leaves excluding senescent and emerging leaves per plant was counted in selected five plants in each plot.

Days to first plant flowering: The number of days to first flowering was recorded when the first flower was observed on any of the observational plants.

Days to 50% plant flowering: The number of days of fifty percent of flowering was recorded when fifty percent of the observational plants of each plot started flowering.

Fruit length (cm): Green matured fruits were randomly taken from five selected plants of each plot at the time. The length was measured from the base of the fruit to the tip excluding the fruit stalk with the help of scale. Then the average fruit length in each treatment was computed.

Fruit diameter (mm): The same fruit taken for measuring fruit length was used for recording the fruit diameter at the point of maximum thickness near the shoulder of the fruits with the help of vernier calipers and the average was calculated.

Total number of fruits per plant: Green matured fresh fruits were picked from all five experimental plants.

Average fruit weight: For calculating average fruit weight(gm), the total weight of all the fruits picked was divided by the total number of fruits picked from five experimental plants.

Fruit yield per hectare: The total fruit weight from all the pickings obtained from all five experimental plants of each treatment was summed up separately and treatment-wise yield per hectare will be calculated based on the area covered by 5 experimental plants.

1.3. Statistical Analysis

The experiment was conducted three times, with no pinching serving as a control treatment at each stage of the analysis. The statistical tools utilized for variance analysis and tabulation were MS-EXCEL and R-STAT. To determine significant differences between mean values at the 5% level of significance, Duncan's Multiple Range Test (DMRT) was performed. For all statistical analyses, the Least Significant Difference test was used to examine the variation between treatment means.

III. RESULTS AND DISCUSSION

Plant height

Plant height was significantly influenced by different pinching dates at all observation periods (Table 3). At 55 DAT, the control group showed the maximum height (47.21 cm), and the minimum height (34.03 cm) was in pinching after the 15th and 30th DAT. At 65 and 75 DAT, the control group again had the maximum heights (58.77 cm and 70.05 cm, respectively), while the minimum heights were observed in pinching after the 15th & 30th DAT. These results indicate that pinching at different dates significantly impacts plant height, with the control group consistently showing the greatest height across all observation periods. Pinching appears to restrict height growth, with the combination of pinching after the 15th & 30th DAT showing the most pronounced reduction. A significant reduction in height by 32.70% was observed in the double-pinched plot than in the un-pinched plot.

Table 3: Effect of Different Dates of Pinching on Plant Height of Chilli in Rampur, Chitwan, 2023

Treatment	Plant height (cm)		
	55 DAT	65 DAT	75 DAT
Control	47.21^{a}	58.77^{a}	70.05^{a}
PA 15th DAT	40.12^{bc}	47.75^{b}	56.80^{b}
PA 30th DAT	39.40^{bc}	48.46^{b}	55.96^{b}
PA 45th DAT	41.57^{ab}	49.53^{b}	59.51^{b}
PA15th & 30th DAT	34.03^{c}	39.50^{c}	43.81^{d}
PA15th & 45th DAT	36.20b^{c}	42.38^{bc}	47.95^{cd}
PA30th & 45th DAT	36.53^{bc}	43.96^{bc}	49.98^{c}
LSD (0.05)	6.24	6.77	5.71
$SE_m(\pm)$	0.76	0.83	0.70
F probability	*	**	***
CV%	8.93	8.07	5.85
Grand mean	39.29	47.19	54.86

Pinching affects plant height because auxin (the hormone responsible for cell elongation) produced by plants in apical portions is withdrawn and diverted to buds, resulting in the production of lateral branches and a reduction in plant height (Jyothi et al., 2018). Similar results were previously reported in Field Bean (E. S. Kumar et al., 2018) and Stevia (Rakesh Kumar et al., 2014). Ramesh Kumar & Singh, (2003) reported that pinching practice in Carnation promoted lateral branches while reducing plant height. According to Menon & Khader, (1997), the removal of the apical bud restricts the vertical growth of the plant and redirects photosynthates towards the axils of leaves; as a result, a greater number of lateral branches occur. According to Joshi et al., (2022), the un-pinched plants were 25% taller than the pinched ones in height. (Acharya et al., 2022), also reported that the height of the chilli plants in the pinched plot was significantly lower than in the control plot. The highest height was found at the control, followed by single pinching at the 30th and 40th DAT, while the minimum height was found at the 25th and 40th DAT. According to (Rajyalakshmi & Rajasekhar, 2014), the non-pinched plant marigold grows to its greatest height at maturity than the pinched plant due to apical dominance.

Number of primary branches

The analysis of variance showed that the number of primary branches is significantly affected by different dates of pinching at all dates of observation (Table 4). At 55 DAT, the maximum number of primary branches (8.23) was observed in pinching after the 15th & 45th DAT which was statistically similar to the remaining treatments except for control and pinching after 45th DAT. The minimum number of primary branches (3.86) was observed in control.

Similarly, the maximum number of primary branches at 65th DAT (13.97) and 75th DAT (15.79) was observed in pinching after the 15th & 30th DAT which was statistically at par with double pinching after the 30th & 45th DAT and pinching after 15th & 45th DAT for 75 DAT observation. Whereas the minimum number of primary branches were observed in control i.e., 5.97 at 65th DAT and 8.70 at 75th DAT which was statistically at par with pinching after 45th DAT for both dates of observation.

These findings show that pinching greatly increases the number of primary branches, with the most successful treatments using pinching after the 15th & 30th DAT, or a combination of the two. The control group consistently had the fewest branches, demonstrating the relevance of pinching in promoting branching. The time and frequency of pinching are critical for optimizing plant architecture and increasing the number of major branches, which can boost total yield.

Table 4: Effect of Different Dates of Pinching on the Number of Primary Branches of Chilli in Rampur, Chitwan, 2023

Treatment	Number of primary branches		
	55 DAT	65 DAT	75 DAT
Control	3.86^{c}	5.97^{d}	8.70^{d}
PA 15th DAT	6.39^{ab}	9.03^{c}	11.55^{bc}
PA 30th DAT	6.74^{ab}	9.60^{c}	12.25^{bc}
PA 45th DAT	5.88^{b}	7.84^{cd}	10.12^{cd}
PA15th & 30th DAT	8.20^{a}	13.97^{a}	15.79^{a}
PA 15th &45th DAT	8.23^{a}	11.89^{b}	13.62^{ab}
PA 30th &45th DAT	7.93^{ab}	11.53^{b}	13.71^{ab}
LSD (0.05)	2.01	1.92	2.56
$SE_m(\pm)$	0.25	0.24	0.31
F probability	**	***	**
CV%	16.73	10.82	11.75
Grand mean	6.74	9.97	12.25

Number of secondary branches

Pinching had a statistically significant effect on the secondary branches at 55, 65, and 75 DAT (table 5). The maximum number of secondary branches at 55th DAT was observed in pinching after the 15th & 30th DAT (10.09) which was statistically similar to the remaining double-pinched plots. The minimum number of secondary branches was observed in control (5.51) which was statistically at par with pinching after 45th DAT (7.17).

At 65 DAT and 75 DAT of observation, the maximum number of secondary branches was observed in pinching after the 15th & 30th DAT (15.63 and 19.67 respectively) which was statistically at par with both double-pinched plots. The minimum number of secondary branches at 65 DAT was observed in control (8.80). Similarly, at 75 DAT the minimum number was also observed in control (10.77) which was statistically at par with single pinching after 15th DAT (14.20) and 45th DAT (14.72).

These results show that pinching, especially after the 15th & 30th DAT, dramatically increases the number of secondary branches. Double pinching consistently outperformed single pinching or no pinching, highlighting the relevance of pinching frequency and timing. The control group consistently had the fewest secondary branches, demonstrating the importance of pinching for proper branching and potentially higher plant yield.

Table 5: Effect of Different Dates of Pinching on the Number of Secondary Branches of Chilli in Rampur, Chitwan, 2023

Treatment	Number of secondary branches		
	55 DAT	65 DAT	75 DAT
Control	5.51[c]	8.80[c]	10.77[c]
PA 15th DAT	7.99[ab]	11.70[b]	14.20[bc]
PA 30th DAT	8.44[ab]	12.31[b]	15.00[b]
PA 45th DAT	7.17[bc]	11.97[b]	14.72[bc]
PA15th & 30th DAT	10.09[a]	15.63[a]	19.67[a]
PA 15th & 45th DAT	9.72[a]	14.33[ab]	17.72[ab]
PA 30th & 45th DAT	9.91[a]	13.92[ab]	17.17[ab]
LSD (0.05)	2.18	2.58	3.84
$SE_m(\pm)$	0.27	0.32	0.47
F probability	**	**	**
CV%	14.55	11.45	13.84
Grand mean	8.40	12.66	15.60

Number of tertiary branches

The maximum number of tertiary branches at 55 DAT was observed in pinching after the 15th & 30th DAT (8.13) which was statistically similar with remaining both double pinching. The minimum number of tertiary branches was observed in control (3.32). At 65 DAT, the maximum number of tertiary branches were observed in pinching after the 15th & 30th DAT (13.25) which was statistically similar with remaining double pinched treatments, and the minimum numbers are observed in control (6.99). At 75 DAT, the maximum number of tertiary branches were observed in pinching after the 15th & 30th DAT (31.75) which was statistically at par with pinching after the 15th & 45th DAT (30.47).

These findings indicate that pinching considerably increases the number of tertiary branches, with pinching being the most effective treatment after the 15th and 30th DAT. Double-pinched treatments consistently produce more tertiary branches, highlighting the importance of pinching frequency and timing in branch development.

By removing the apical part from the main branches, auxiliary buds become free of correlative suppression of apical dominance, thus redirecting plant metabolites from vertical growth to horizontal growth, thus the number of lateral branches increases due to the translocation of photosynthates and hormones to leaf axils (Sailaja & Panchbhai, 2014; Wilkins, 1984). The cytokinin is stimulated when the apical bud is removed, which encourages lateral branching (Naafe et al., 2022). Like our results, an increase in the number of lateral branches as a result of pinching treatment has been reported in various vegetable species including Chickpeas (Baloch & Zubair, 2010), Fenugreek (Vasudevan et al., 2010), Bottle gourd (Patel et al., 2017) and in Field bean (Patel et al., 2017).

A similar result was observed by (Acharya et al., 2022), which reported the highest number of primary branches in double pinching after the 25th & 40th DAT while the lowest number of branches was reported at control. Another experiment conducted by (Sunitha et al., 2007), also observed an increase in the number of branches due to the removal of the shoot tip. Plants pinched at 20 DAT were found to be the most effective for enhancing vegetative growth parameters (Bhusal et al., 2023). According to (Acharya et al., 2022) the highest number of secondary branches was reported at the 25th, and 40th DAT, and a minimum number of branches were reported at control. A similar observation was made by (Sunitha et al., 2007) on the number of lateral branches.

Table 6: Effect of Different Dates of Pinching on the Number of Tertiary Branches of Chilli in Rampur, Chitwan, 2023

Treatment	Number of tertiary branches		
	55DAT	65 DAT	75 DAT
Control	3.32[d]	6.99[c]	13.13[e]
PA 15th DAT	5.48[c]	9.24[b]	20.57[c]
PA 30th DAT	6.08[bc]	10.36[b]	21.27[c]
PA 45th DAT	4.82[c]	9.87[b]	17.13[d]
PA15th & 30th DAT	8.13[a]	13.25[a]	31.75[a]
PA 15th & 45th DAT	7.93[a]	12.87[a]	30.47[ab]
PA 30th & 45th DAT	7.39[ab]	12.42[a]	28.12[b]
LSD (0.05)	1.47	1.67	2.90
$SE_m(\pm)$	0.18	0.20	0.36
F probability	***	***	***
CV%	13.39	8.76	7.04
Grand mean	6.16	10.71	23.20

Number of leaves

Pinching had a statistically significant effect on the number of leaves at 55, 65, and 75 DAT (Table 7). At 55 DAT, the maximum number of leaves were observed in pinching after the 15th & 30th DAT (107.57) which was statistically similar with remaining both double pinching.

The minimum number of leaves was observed in control (57.93) which was statistically at par with pinching after 45th DAT (74.13). At 65 DAT, the maximum number of leaves were observed in pinching after the 15th & 30th DAT (195.97) which was statistically similar with remaining both pinching. The minimum number of leaves was observed in control (105.47) which was statistically at par with pinching after 45 DAT (116.43). An exactly similar pattern with maximum (356.63) and minimum (161.77) number of leaves was observed at 75 DAT.

These data show that pinching considerably increases the number of leaves, with the most effective benefits occurring after the 15th and 30th DAT. The control group constantly had the fewest leaves, demonstrating the effectiveness of pinching in promoting leaf development. Pinching has previously been shown to enhance the number of leaves per plant in China asters (Rakesh Kumar et al., 2014), in Field beans (E. S. Kumar et al., 2018), and in Bottle gourd (Patel et al., 2017). (Ramesh Kumar & Singh, 2003a), stated that pinching enhances branch production, which in turn increases young leaf production, therefore the number of leaves is proportional to the number of branches. In their study, they discovered a bigger number of leaves and an increasing number of branches in Carnation. Furthermore, the results of the current study are also in line with the findings of (Eve et al., 2016) who reported that pinching treatment resulted in more branches in Butternuts, which in turn increased young leaf production. Overall, strategic pinching procedures are critical for maximizing leaf production and plant growth.

Table 7: Effect of Different Dates of Pinching on the Number of Leaves of Chilli in Rampur, Chitwan, 2023

Treatment	Number of leaves		
	55 DAT	65 DAT	75 DAT
Control	57.93^{d}	105.47^{c}	161.77^{d}
PA 15th DAT	82.23^{bc}	140.33^{b}	228.53^{bc}
PA 30th DAT	80.87^{bc}	139.43^{b}	247.43^{b}
PA 45th DAT	74.13^{cd}	116.43^{bc}	199.57^{cd}
PA15th & 30th DAT	107.57^{a}	195.97^{a}	356.63^{a}
PA 15th & 45th DAT	104.60^{a}	182.97^{a}	368.33^{a}
PA 30th & 45th DAT	101.23^{ab}	175.50^{a}	340.23^{a}
LSD (0.05)	20.22	31.88	43.31
$SE_m(\pm)$	2.48	3.79	5.31
F probability	**	***	***
CV%	13.07	11.51	8.96
Grand mean	86.94	150.87	271.78

Phenological parameter

Table 8: Effect of Different Dates of Pinching on the Number of Days to First and 50% Flowering of Chilli in Rampur, Chitwan, 2023

Treatment	Flowering	
	1st flowering	50% flowering
Control	50.33^{e}	53.67^{e}
PA 15th DAT	54.33^{d}	58.00^{d}
PA 30th DAT	55.67^{d}	59.67^{cd}
PA 45th DAT	59.33^{c}	61.67^{c}
PA15th & 30th DAT	64.00^{b}	67.00^{b}
PA 15th & 45th DAT	66.33^{ab}	69.33^{a}
PA 30th & 45th DAT	67.33^{a}	69.67^{a}
LSD (0.05)	2.98	2.15
$SE_m(\pm)$	0.32	0.26
F probability	***	***
CV%	2.81	1.93
Grand mean	59.61	62.71

The statistical analysis indicates pinching had a statistically significant effect on the number of first plant flowering and 50% flowering (Table 8). The highest number of days (67.33 days) to 1st flowering was observed in pinching after the 30th & 45th DAT which was statistically at par with pinching after the 15th and 45th DAT (66.33 days). The lowest number of days to 1st flowering was observed in control (50.33 days).

Pinching after the 30th & 45th DAT took the highest (69.67 days) number of days for 50% flowering which was statistically similar to pinching after the 15th and 45th DAT (69.33 days). The minimum number of days to 50% flowering was observed in the control (53.67 days).

In the current study, delayed flowering was seen in pinched plants; this could be attributed to the removal of the apical region. By eliminating the apical bud, the source of IAA is eliminated. Since the concentration of indole acetic acid is significantly lower, lateral branch initiation occurs, and they require a longer time to mature enough to commence blooming (S. Ali et al., 2021). Delayed flowering as a result of pinching practice has been reported previously in many crop species including Fenugreek (Vasudevan et al., 2010) and Bottle gourd (Patel et al., 2017). Pinching caused a delay in flowering because it removed the physiologically mature section, and the new shoots that sprouted from the pinched plants needed longer to become physiologically inductive to produce flowers than non-pinched plants. (Rajan et al., 2019) found similar results in Chrysanthemum.

The increase in the quantity of fruits vine-1 may have in pinched plants is related to the activation of endogenous hormones, which accelerates the growth stages and balances the carbon-nitrogen ratio, enhancing female flower production (Higashide et al., 2012). Pimpini & Gianquinto, (1992), demonstrated that pinching is beneficial for a healthy source-sink relationship, which promotes the number of female flower production and fruit set and increases the number of fruits due to the diversion of photo assimilates to lateral branches.

Fruit length & diameter

Fruit length was significantly affected by different dates of pinching (Table 9). The maximum fruit length (9.42 cm) was recorded in double pinching after the 15th & 30th DAT which is statistically similar to remaining both double pinching. The minimum fruit length (7.98 cm) was recorded in control which was statistically at par with all single pinching and There was no significant effect of pinching on fruit diameter.

Pinching reduces the concentration of auxin while increasing the concentration of cytokinin, which helps to balance the plant's carbon-nitrogen ratio, resulting in the accumulation of additional photosynthate, hence pinching may increase fruit length (Anand et al., 2014). Similar to our findings in this study lengthy fruits were noted in Bottle gourd (Patel et al., 2017), Cucumber (Nayak et al., 2018), and fenugreek (Vasudevan et al., 2010) after pinching treatment.

Table 9: Effect of Different Dates of Pinching on the Fruit Characters of Chilli in Rampur, Chitwan, 2023

Treatment	Fruit Characters	
	Length (cm)	Diameter (mm)
Control	7.98^{c}	9.13
PA 15th DAT	8.39^{bc}	9.22
PA 30th DAT	8.42^{bc}	10.14
PA 45th DAT	8.32^{bc}	9.06
PA15th & 30th DAT	9.42^{a}	10.06
PA 15th & 45th DAT	9.30^{a}	9.15
PA 30th & 45th DAT	9.14^{ab}	9.59
LSD (0.05)	0.81	
$SE_m(\pm)$	0.10	0.13
F probability	*	NS
CV%	5.21	6.13
Grand mean	8.71	9.48

Number of fruits

The statistical analysis indicates pinching had a statistically significant effect on the number of fruits per plant (Table 9). The highest number of fruits per plant (111.80) was observed in double pinching after the 15th & 30th DAT while the lowest number of fruits per plant (71.90) was observed in control (without pinching).

In this study, pinched plants produced more fruits than un-pinched plants. Plants with more lateral branches have robust vegetative development, which results in good photosynthetic efficiency (Aikins et al., 2017) and have greater translocation of photosynthates from source to sink which in turn have beneficial effects on reproductive growth (Dhedhi et al., 2017). Similar to the findings of this study beneficial effect of pinching on reproductive growth has been observed in Butternuts (Aikins et al., 2017), Sun hemp (Dhedhi et al., 2017), Fenugreek (Vasudevan et al., 2010) and in Pigeon pea (Sharma et al., 2010). Our results are also in line with the findings of (Sowmya et al., 2017), who reported more number of pods in Fenugreek plants pinched at a later stage as compared to an earlier stage.

Average fruit weight

Pinching had a significant effect on the average fruit weight of the plant (Table 9). The maximum average fruit weight (4.21 gm) was observed in pinching after the 15th & 30th DAT which was statistically similar with remaining both double pinching. The minimum average weight (3.30 gm) was observed in control which was statistically at par with pinching after 45th DAT (3.53 gm).

Weight variations may be caused by pinching and nutrition availability. Because of increased vegetative development (branches and leaves), food availability to the sink rises, increasing both the size and weight of reproductive growth. Our results are also in agreement with the results of Vasudevan et al., (2010), who reported higher pod weight in pinched fenugreek plants. Similar to our results beneficial effect of pinching on individual fruit weight has been reported in various plant species including Fenugreek (Sowmya et al., 2017) as well as in okra (Sajjan et al., 2002).

Ahmad et al., (2016), reported that pinched plants have more lateral branches, which have more leaves and produce more photosynthate. Thus, the source and sink theory could explain weighted pods in pinched plants. Similar results were observed by Singh & Devi, (2006) who stated that due to pinching practice, more photosynthates accumulate to sink which is beneficial for the production of weighted pea pods. Similarly pinching has been documented as a beneficial practice to improve yield parameters in Chickpeas (H. Khan et al., 2006; Ramesh Kumar & Singh, 2003a), Cowpeas (Prashant et al., 2012), and Pigeon pea (Srinivasan et al., 2019).

Yield

The statistical analysis indicates that the fruit yield of the Chilli plant is significantly affected by pinching (Table 9). The maximum fruit yield (19.70 mt/ha) was recorded in double pinching after the 15th & 30th DAT. Single pinching at the 15th DAT, 30th DAT, and 45th DAT were statistically at par with each other. The minimum fruit yield (9.01 mt/ha) was recorded in control.

One of the causes could be the robust vegetative growth (branches and leaves) and increased photosynthesizing in constricted plants. Naheed et al., (2013), demonstrated that pinching breaks apical dominance and directs energy toward the formation of additional branches, resulting in increased yield. Previously, pinching practice was reported effective for improving yield traits in many crop species, including Fenugreek (Sowmya et al., 2017), Bottle guard (Anand et al., 2014), Field Beans (E. S. Kumar et al., 2018) and okra (A. Ali et al., 2021). According to Acharya et al., (2022), there was a large difference in Chilli yield due to pinching. The maximum yield was obtained at the 25th and 40th DAT, while the minimal yield was produced under the control condition.

Table 10: Effect of Different Dates of Pinching on Yield Parameters of Chilli in Rampur, Chitwan, 2023

Treatment	Yield Parameter		
	Number of fruits per plant	Avg fruit Weight (gm)	Fruit yield (Mt/hac)
Control	71.90^{d}	3.30^{d}	9.01^{e}
PA 15th DAT	87.03^{c}	3.72^{bc}	11.96^{d}
PA 30th DAT	97.97^{bc}	3.80^{b}	13.77^{cd}
PA 45th DAT	85.77^{c}	3.53^{cd}	11.64^{d}
PA15th & 30th DAT	126.07^{a}	4.21^{a}	19.70^{a}
PA 15th & 45th DAT	111.80^{b}	4.13^{a}	16.18^{b}
PA 30th & 45th DAT	109.93^{b}	4.04^{a}	15.87^{bc}
LSD (0.05)	13.57	0.24	2.11
$SE_m(\pm)$	1.66	0.03	0.26
F probability	***	***	***
CV%	7.73	3.50	8.46
Grand mean	98.64	3.82	14.02

IV. CONCLUSIONS

The findings indicate that double pinching, particularly when applied after the 15th and 30th days after transplantation (DAT), is a superior technique. This approach outperforms in a variety of ways, including increased plant stature, increased leaf count, improved development of primary, secondary, and tertiary branches, and significant improvements in yield-related attributes such as fruit quantity, average fruit weight, and overall Chilli yield. The superiority of double pinching over its single equivalent is clear, confirming its effectiveness as a cultivation technique. These findings not only help to optimize Chilli production but also serve as a valuable reference for agricultural strategies that aim to maximize both morphological parameters and yield results. As we manage the challenges of modern agriculture, the strategic use of double pinching emerges as a promising route for increasing the overall productivity and sustainability of chilli growing.

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