Turkish Journal of Agriculture - Food Science and Technology, 13(2): 346-352, 2025
DOI: https://doi.org/10.24925/turjaf.v13i2.346-352.7179

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Effects of Ethephon and Pruning Practices on Sex Expression and Yield of Cucumber (*Cucumis sativus* L.) in Rupandehi, Nepal

Kiran Gyawali [1,a,*], Dr. Pankaj Raj Dhital[1,b], Kapil Bhattarai[1,c], Sudikshya Baral R.[1,d]

[1]*Agriculture and Forestry University, Faculty of Agriculture, Department of Agricultural Extension and Rural Sociology, Chitwan, Nepal*
[*]*Corresponding author*

ARTICLE INFO

Research Article

Received : 06.10.2024
Accepted : 28.11.2024

Keywords:
Cucurbits
Cutting
Femaleness
Flower
Fruit

ABSTRACT

Enhancing crop productivity is essential for increasing farmer incomes, and application of ethephon along with proper pruning practices could provide effective approaches for improving yield of cucurbit crops. A field experiment was conducted to study the effect of ethephon and pruning practices on sex expression and yield of cucumber cv long green at Rupandehi, Nepal from April to July 2022. The experiment used a two-factor factorial RCBD, with 2 doses of ethephon (300 ppm & control spray) as one factor and pruning practices (3G, 2G & no pruning) as the other, resulting six treatments which were replicated four times. Morphological and phenological parameters such as plant height, days to flowering, number of male and female flowers per plant, M: F ratio, fruit length, fruit weight, fruit number per plant, and yield were recorded. It was observed that ethephon @ 300 ppm produced the highest yield (65.59 t/ha) with increased fruits per plant (13.19) and individual fruit weight (497.31 g). Highest fruit yield (66.97 t/ha), fruit number (13.47 per plant), and individual fruit weight (497.20 g) was observed with 3G pruning. Ethephon @ 300 ppm delayed male flowers, but female flowers were observed significantly earlier (34.21 DAT), with a similar effect observed in 3G pruning. Both ethephon @ 300 ppm (39.89) and 3G pruning (41.99) significantly increased the total number of female flowers in comparison with other treatments. Control spray of ethephon resulted in highest fruit length and application of ethephon @ 300 ppm resulted to highest fruit width. Pruning did not significantly influence fruit length but increased fruit width. The study revealed that a spray of 300 ppm ethephon and 3G pruning can enhance femaleness and productivity of cucumber.

[a] smartkiran10@gmail.com https://orcid.org/0009-0005-6590-2245
[b] prdhital@afu.edu.np https://orcid.org/0009-0008-9165-980X
[c] kapil.bhattarai.161@gmail.com https://orcid.org/0000-0001-5067-1679
[d] baralsudi@gmail.com https://orcid.org/0009-0007-3238-4511

Introduction

Cucumber, a widely cultivated vine crop belonging to the family Cucurbitaceae, originated from southern Asia (Adams et al., 1992). It is typically monoecious, where female flowers appear around a week after the appearance of the male flower. Early male flowers appear on lower nodes and female flowers on upper having small fruit at the base (Bantoc, 1964). Sex expression is a crucial factor affecting the yield of cucumber by influencing number of fruits in a plant. Genetics, chemical and environmental conditions influence the sex of a flower (Arpan, 1974). Seshadri (1990) reported that long days and higher temperature promote male flower production in cucumber. Heavy male flowering and reduced number of female flowers ultimately decrease the economic yield of crop (Chaurasiya et al., 2020).

Plant growth regulators(PGRs) are chemical compounds that influence the morphological and physiological attributes including yield attributing characters. They significantly affect sex expression and flowering in many cucurbits and reduces the number of male flowers or increases the number of female flowers (Al-Masoum & Al-Masri, 1999). Exogenous PGR application promotes femaleness in cucurbits, increasing pistillate flowers, fruit number, and yield (Mia et al., 2014). Application of PGR at two and four true leaf stage is critical for manipulating the sex ratio (Hossain et al., 2006). Chemically ethephon is 2-chloroethylphosphonic acid which releases ethylene when metabolized by plants (Arpan, 1974; Szyjewicz et al., 1984).

Exogenous application of PGRs like ethylene has demonstrated effective alteration of sex expression in cucumber through increment in the number of female flowers and suppression on the production of male flowers. Ethephon was useful in increasing the no. of female flowers, reducing male: female ratio and increasing the yield of cucumber (Dhakal et al., 2019).

Pruning cuts off unnecessary growth, conserving the plant's energy for fruit development, and improving harvest quality and quantity (Kumar et al., 2019), increases air circulation and CO_2 level thereby which increases the photosynthesis rate and increased accumulation of nutrients to economic parts (Mardhiana et al., 2017). Pruning has a positive correlation with vegetative growth and quality of fruit without any adverse effects (Usenik et al., 2008). Performing 2G and 3G pruning helps in growth of secondary and tertiary branches leading to better vegetative growth, higher fruit weight, a greater number of fruits per plant and a greater overall yield (Baral et al., 2022).

Although the previous studies have focused on effect of ethephon application and pruning practices on cucurbit crops, the combined effect of the interaction between level of pruning and application of ethephon are yet to be studied. Thus, this research aims to study the effect of ethephon, level of pruning and their interaction on sex expression and yield in cucumbers, with a goal to provide evidence-based recommendations for enhancing productivity and net returns for the farmers.

Materials and Methods

Site Details

The experiment was conducted during the spring-summer season of 2022 at a farmer's field in Siddharthanagar-9, Rupandehi, Nepal. It is located 25 km south of Butwal city and 25 km east of Lumbini. The coordinates of this area are $27^0$30' N Latitude and $83^0$27' E Longitude. The topography of the area is plain terai and there was proper provision of irrigation facility. The Siddharthanagar municipality is located at an altitude of 110 meters above sea level and has a tropical climate. The average spring summer temperature is above 30^0C and maximum temperature sometimes exceeds 40^0 C.

The Meteorological data during the research is depicted as follows

Land Preparation and Seedling Transplanting

This research was conducted on a long green variety of cucumber. One deep ploughing and 2 light harrowing was done after broadcasting the FYM. The field was levelled, and clods were broken to prevent the interference to root development. Full dose of FYM was applied at the time of land preparation. Recommended dose of chemical fertilizers was applied (i.e. Urea: 100 kg/ha; Di ammonium phosphate (DAP): 40 kg/ha; Muriate of potash (MOP): 100 kg/ha) before transplanting (Krishi diary, 2021). The remaining dose of urea (i.e. 40 kg/ha) was side dressed during flowering stage. The plots of the required size were made, and plastic mulching was carried out. Holes were made on plastic mulch at a distance of 1m and seedlings from the nursery polybags were transplanted in the main field at two true leaf's stages after 15 days of sowing. As frequent irrigation is important in summer season it was carried out at the interval of 2-3 days in early stage and 5-6 days interval in the later stage of plant growth.

Design of Experiment

The research was conducted in two factor factorial randomized complete block design including a total of six treatments replicated 4 times each. There was a total of 24 treatment plots with 16 plants on each plot. There was 1m plant to plant spacing and 1m row to row spacing. The gross plot size was $25m^2$ (5m×5m) and net plot size was 16 m^2 (4m×4m).

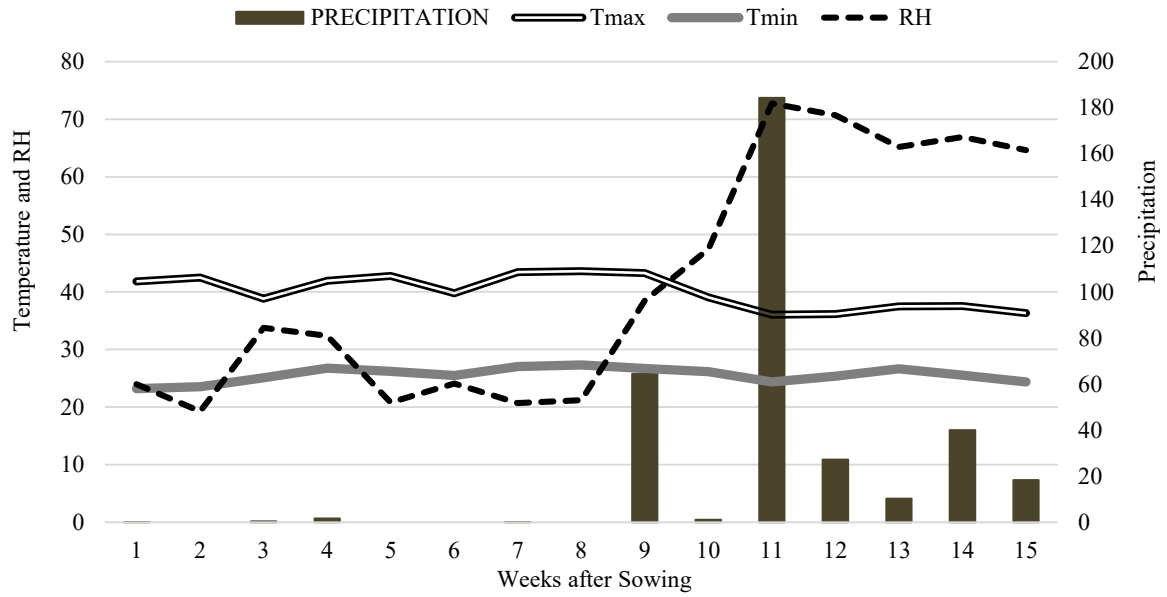

Figure 1. The temperature, RH and Precipitation data of experimental site during research period

Table 1. Details of experimental treatments with Ethephon and Pruning practices

Treatment	Treatment Designation
Ethephon dosages	
300 ppm	E1
Control spray	E2
Pruning practices	
3G Pruning	P1
2G Pruning	P2
No Pruning	P3
Interaction	
Ethephon 300 ppm with 3G pruning	T1
Ethephon 300 ppm with 2G pruning	T2
Ethephon 300 ppm with no pruning	T3
Control spray with 3G pruning	T4
Control spray with 2G pruning	T5
Control spray with no pruning	T6

Spraying of Ethephon and Pruning

At first, the commercial form of 39 % SL (Soluble Liquid) was diluted to 300 ppm. It was prepared by mixing of 0.7 ml of ethephon per liter of water and was stirred to ensure uniform mixing. The freshly prepared solution was used to maintain effectiveness. Two sprays of the prepared solution of ethephon were sprayed at two true leaf stage and four true leaf stage after transplanting using a hand pump sprayer. Pruning was conducted up to second generation (2G) and third generation (3G) in the experimental plots depending upon the treatment design to balance the vegetative and reproductive characters. In case of 2G pruning the main branch was allowed to grow 5-6 ft tall and pinched to allow growth of secondary branches. Similarly, the secondary branches were also pruned again after reaching 3-4 ft height to promote growth of tertiary branches in case of 3G pruning.

Four plants were chosen as sample plants from each experimental plot which remain after the border plants are excluded. The required parameters were observed from the sample plants at an interval of 15 days.

Growth, Fruit, Flower, and Yield parameters

Plant height was measured by using a meter scale. The height was measured from soil surface to the tip of the plant. Plant height was recorded after 30 DAT at 10 days interval up to 50 DAT. Days to first male flower, female flower and first harvest of the selected sample plants was recorded from each of the treatment plots and mean was calculated. Total number of male and female flowers of the experimental plots were manually counted, recorded, and averaged to calculate the number of male and female flowers per plant. The length and width of the randomly selected four fruits were measured using a standard measuring tape at the time of harvesting from each of the sample plants. The length and width of fruit was measured. At the time of harvesting three randomly selected fruits were weighed by weighing balance. The average fruit weight was calculated and subjected to analysis. Similarly, the number of fruits harvested from each sample plant was also recorded. The weight of harvested fruits from a sample plot was measured and recorded in each harvest. The weight from each recording was summed up to calculate the yield per plot and averaged to calculate the yield per plant. Fruit yield per hectare was calculated by multiplying yield per plant with number of plants (NP) per hectare and no of plants per hectare is calculated by the formula below.

$$NP = \frac{A}{\text{DBRR} \times \text{DBPP}}$$

A : Area
DBRR: Distance between row to row
DBPP : Distance between plant to plant

Statistical Analysis

The recorded data was entered into MS- Excel and proceeded to analysis of variance (ANOVA). R-Studio was used for data analysis. Duncan's Multiple Range Test (DMRT) was used for mean comparison at 5 % level of significance.

Results and Discussion

Plant Height

The study revealed that the plant height was significantly influenced by the application of ethephon as well as pruning at 30 DAT, 40 DAT and 50 DAT (Table 2). The highest height was observed in control spray (167 cm) and lowest height was observed in spray of ethephon @ 300 ppm (139.65 cm) at 50 DAT. In all the three dates of data collection for plant height, control spray had significantly higher plant height than spray of ethephon 300 ppm. Ethylene tends to inhibit IAA transport in plant systems elongation of tissue (Morgan & Gaussman, 1966). Hayashi et al. (2001) stated that the anti-gibberellic property of ethylene causes cessation of miotic process in meristem of root and shoot leading to decreased length which could be the reason for decreased plant height with application of ethylene @ 300 ppm.

Similarly, 3G pruning had significantly higher plant height at 30 DAT but lower at 40 DAT and 50 DAT than no pruning. The highest plant height (180.62 cm) was observed on no pruning at 50 DAT followed by 3G (147.53 cm) and 2G (131.84) respectively. At 30 DAT plant height on 3G pruning was 39.85 cm which was at par with 2G (37.85 cm) but significantly higher than no pruning (31.36 cm). At 30 DAT the higher plant height in 3G pruning and 2G pruning might be due to diversion of nutrients to main shoot after removal of lateral branches.

Comparable results were also reported by Baral et al. (2022) and Shivaraj et al. (2018). Reduced crop height in cucumber enhances light penetration, air circulation, boosting photosynthesis and facilitates tasks such as harvesting and pest control easier eventually promoting higher fruit development and yield.

Days to Flowering and First Fruit Harvest

Emergence of 1st male and female flower was significantly influenced by application of ethephon as well as pruning (Table 3). The Duncan Multiple Range Test(DMRT) test for the days to first harvest found that there was no significant difference between the use of ethephon @ 300 ppm and control spray. Also, no significant effect of pruning was seen on the first fruit harvest which was in line with the research of Baral et al. (2022).

Days to first male flower was observed significantly higher in control spray (30.65 DAT) over application of ethephon (26.63 DAT). In case of female flower, 300 ppm ethephon spray had early appearance of female flower than control spray. First female flower for control spray was observed at 38.13 DAT which was significantly higher than application of ethephon (34.21 DAT). The ethylene releasing chemicals enhances the growth of pistillate flowers and delays growth of staminate flowers of monoecious cucurbits (Bhandary et al., 1974; Sheshadri, 1990). This might be the reason for early appearance of male flowers in control spray and female flowers in ethephon @ 300 ppm. Ito et al. (1954) mentioned that application of certain chemicals at primordial stage can transform male flowers into female flowers.

Days to first male flower was significantly higher for 3G pruning (30.25 DAT) which was at par with 2G pruning (29.49 DAT) and lowest number of days for male flower was observed with no pruning treatment (26.18 DAT). First appearance of female flower was observed highest in no pruning treatment (39.41 DAT), and it was significantly higher than 2G (34.75 DAT) and 3G (34.34DAT). Shivaraj et al. (2018) and Suthar et al. (2007) also reported similar findings. Early flowering in cucumber may be due to increased plant height and increased leaf area which supplemented assimilates required to promote early flowering.

Table 2. Plant height as influenced by ethephon and pruning intensities of cucumber at Rupandehi, 2022

Treatments	Plant height (cm)		
	30 DAT	40 DAT	50 DAT
Ethephon			
300 ppm	32.46[b]	79.17[b]	139.65[b]
Control spray	40.25[a]	106.35[a]	167[a]
SEm (±)	0.83	2.71	3.99
F probability	7.99e^{-06}***	3.67e^{-06}***	0.00021***
Pruning			
3G	39.85[a]	87.95[b]	147.53[b]
2G	37.85[a]	82.11[b]	131.84[c]
No pruning	31.36[b]	108.21[a]	180.62[a]
SEm (±)	1.10	3.32	4.88
F probability	7.73e^{-05}***	0.00014***	1.33e^{-05}***
CV %,	7.93	10.11	9.01
Grand mean	36.35	92.76	153.33
Interaction (Ethephon ×Pruning)	Ns	Ns	Ns

Note: SEm: Standard error of means; CV: Coefficient of Variation; Means followed by same letter in a column are not significantly different by DMRT at 5 % level of significance, ***=significant at 0.1 % probability level; Ns: Non significance; DAT: Days After Transplanting.

Table 3. Days to first flowering and first harvest as influenced by ethephon and pruning intensities of cucumber in Rupandehi, 2022

Treatments	Days after transplanting		
	Male flower	Female flower	First Harvest
Ethephon			
300 ppm	30.65[a]	34.21[b]	47.23[a]
Control spray	26.63[b]	38.13[a]	50.9[a]
SEm (±)	0.76	1.02	1.37
F probability	0.0018**	0.02*	Ns
Pruning			
3G	30.25[a]	34.34[b]	48.38[a]
2G	29.49[a]	34.75[b]	48.19[a]
No pruning	26.18[b]	39.41[a]	50.63[a]
SEm (±)	0.93	1.25	1.68
F probability	0.016 *	0.02 *	Ns
CV %,	9.15	9.76	9.69
Grand mean	28.64	36.17	49.06
Interaction (Ethephon × Pruning)	Ns	Ns	Ns

Note: SEm: Standard error of means; CV: Coefficient of Variation; Means followed by same letter in a column are not significantly different by DMRT at 5 % level of significance, *=significant at 5 % probability level, **=significant at 1 % probability level; Ns: Non significance; DAT: Days After Transplanting.

Table 4. Number of flowers as influenced by ethephon and pruning intensities of cucumber in Rupandehi, 2022

Treatments	Number of flowers		
	Male	Female	M:F ratio
ethephon			
300 ppm	46.98^{b}	39.89^{a}	1.31^{b}
Control spray	68.14^{a}	27.93^{b}	2.55^{a}
SEm (±)	2.06	1.27	0.11
F probability	0.000***	0.000***	0.000***
pruning			
3G	45.86^{c}	41.99^{a}	1.21^{c}
2G	59.45^{b}	33.48^{b}	1.94^{b}
No pruning	67.39^{a}	26.27^{c}	2.65^{a}
SEm (±)	2.53	1.55	0.135
F probability	0.000***	0.000***	0.000***
Interaction			
T1	33.80^{d}	50.51^{a}	0.68^{e}
T2	50.29^{c}	40.39^{b}	1.27^{d}
T3	56.85^{c}	33.40^{c}	2.00^{c}
T4	57.92^{bc}	28.78^{cd}	1.74^{cd}
T5	68.59^{ab}	26.57^{cd}	2.60^{b}
T6	77.92^{a}	23.77^{d}	3.31^{a}
F probability	Ns	0.40*	Ns
CV %,	12.41	12.97	19.69
Grand mean	57.57	33.91	1.93

Note: SEm: Standard error of means; CV: Coefficient of Variation; Means followed by same letter in a column are not significantly different by DMRT at 5 % level of significance, *=significant at 5 % probability level, ***=significant at 0.1 % probability level; Ns: Non significance; DAT: Days After Transplanting.

Male Flowers, Female Flowers, and M:F Ratio

It was revealed that there are significant differences in the data recorded for total number of male flowers, female flowers, and M:F ratio due to spray of ethephon as well as pruning of the plant.

Control spray had significantly higher (68.14) number of male flowers than ethephon @ 300 ppm (46.98), but the number of female flowers observed in ethephon @ 300 ppm (39.89) was significantly higher than in control spray (27.93). Thus, higher M:F ratio was observed in control spray, as it had significantly higher no. of male flowers and lower no. of female flowers in comparison to ethephon @ 300 ppm. Application of ethephon decreases internodal distance and increases the number of leaves (Chaudhary & Singh, 1970; Baral et al., 2022). As ethylene increased the number of leaves, there was increased photosynthate accumulation, increased level of carbohydrate and starch (Singh, 1984) which might have promoted the number of female flowers.

Similarly, significantly highest number of male flowers was reported in no pruning (67.39) followed by 2G (59.45) and least was observed in 3G (45.86), but in case of female flower 3G (41.99) was superior to 2G (33.48) and no pruning had lowest value (26.27). As a result, the highest M:F ratio was obtained in no pruning (2.65) followed by 2G (1.94) and least in 3G (1.21). Pruning increases the hormone level which stimulates the cell division, increases stem potential, induces canopy transpiration, and improves water status which might have affected flowers in plants (Saifuddin et al., 2010). Pruning activity removed the lower branches which were likely to bear greater number of male flower and less female flower bearing nodes it might also be the reason for decrease in the total no. of male flowers and M:F ratio.

The interaction effect was observed significant in case of no. of female flowers. Significantly higher number of female flowers were obtained with combination of ethephon @ 300ppm with 3G pruning (50.51) and significantly lowest number of female flowers were obtained with control spray with no pruning (23.77) which was at par with control spray with 2G running and control spray with 3G pruning. This might be due to promotion of female flowers due to hormonal regulation of ethephon for female flowers and optimum allocation of resources because of 3G pruning.

Yield Parameters

As illustrated in Table 5, both factors i.e., ethephon and pruning had significant differences in the yield of cucumber.

The fruit length was significantly higher in control spray than ethephon @ 300 ppm, whereas fruit width was observed highest in ethephon @ 300 ppm (20.82 cm) than control spray (18.68 cm). The reduced fruit length with the spray of ethephon is similar to the results observed by Rafeekher et al. (2002) & Dhakal et al. (2019). The length of fruit was not statistically different with the variation in pruning, but higher length of fruit was obtained with no pruning. In the case of fruit width, pruning had a significant effect. The highest fruit width was obtained with 3G pruning (21.20 cm) which was statistically higher than with 2G and lowest width was measured in no pruning (19.26 cm). Thakur et al. (2018) also reported that fruit length was not affected by pruning. The increase in width might be due to increased photosynthetic activity and assimilation of nutrients in fruits.

Table 5. Fruit quality parameters as influenced by ethephon and pruning intensities of cucumber in Rupandehi, 2022

Treatments	Fruit metrics				
	Length (cm)	Width (cm)	Weight (g)	Number/plant	Yield (ton/ha)
ethephon					
300 ppm	23.03^{b}	20.82^{a}	497.31^{a}	13.19^{a}	65.59^{a}
Control spray	25.58^{a}	18.68^{b}	426.79^{b}	11.02^{b}	47.00^{b}
SEm(±)	0.62	0.343	10.24	0.27	1.28
F probability	0.01*	0.000***	0.000***	0.000***	1.25e^{-08}***
pruning					
3G	23.74^{a}	21.20^{a}	497.20^{a}	13.47^{a}	66.97^{a}
2G	23.84^{a}	19.44^{b}	459.95^{ab}	11.72^{b}	53.90^{b}
No pruning	25.34^{a}	18.62^{b}	429.00^{b}	11.12^{b}	47.68^{c}
SEm(±)	0.76	0.42	12.54	0.33	1.57
F probability	Ns	0.001**	0.005**	0.0005***	1.20e^{-06}***
Interaction					
T1	22.55^{b}	23.21^{a}	558.84^{a}	14.68^{a}	77.25^{a}
T2	22.36^{b}	19.84^{b}	490.31^{b}	12.50^{b}	69.46^{b}
T3	24.17^{ab}	19.42^{bc}	442.79^{bc}	12.37^{bc}	54.64^{c}
T4	24.93^{ab}	19.20^{bc}	435.56^{bc}	12.25^{bc}	52.96^{c}
T5	25.30^{ab}	19.04^{bc}	429.60^{c}	10.93^{cd}	44.59^{d}
T6	26.50^{a}	17.82^{c}	415.21^{c}	9.8^{d}	39.73^{d}
F probability	Ns	0.041*	0.047*	ns	0.045*
CV %,	8.80	6.01	7.67	7.75	7.90
Grand mean	24.30	19.75	462.05	12.10	56.44

Note: SEm: Standard error of means; CV: Coefficient of Variation; Means followed by same letter in a column are not significantly different by DMRT at 5 % level of significance, *=significant at 5 % probability level, **=significant at 1 % probability level, ***=significant at 0.1 % probability level; Ns: Non significance; DAT: Days After Transplanting.

A significantly higher weight per fruit was obtained in ethephon @ 300 ppm than control. Also, significantly higher number of fruits per plant was observed in ethephon spray than control spray. As a result, fruit yield was observed higher in ethephon @ 300 ppm spray (65.59 t/ha) than control spray (47.00 t/ha). Etheral at 200 or 300 ppm promotes appearance of female flowers and number of fruits, reduces the number of male flowers, fruit setting and increases the productivity of cucumber (Li, 1983). Thus, increased leaf number and area might have directed the assimilates to the sink leading to increased fruit weight. Similarly, pruning also had a major influence on fruit weight, fruit number and yield of cucumber. Significantly the highest fruit weight was obtained in 3G (497.20 g). Also, in case of pruning 3G (13.47) had significantly higher fruit number per plant than 2G and no pruning. The higher number of fruits per plant and weight per fruit contributed to highest yield per hectare with 3G (66.97 t/ha) and lowest was obtained with no pruning. Mardhina et al. (2017) mentioned that pruning helps to increase light interception to whole canopy, improves air circulation and $C0_2$ increased photosynthesis and yield.

The interaction between level of ethephon and pruning was also observed significant for fruit width and fruit weight. A significantly higher fruit width was observed in T1 (Ethephon @ 300ppm with 3G pruning). Similarly, in case of fruit weight, the highest fruit weight was also observed with T1, and lowest fruit weight was observed in T6 (control spray with no pruning) which was at par with T5 (control spray with 2G pruning), T3 (control spray with no pruning) and T4 (control spray with 3G pruning). The higher fruit weight in case of treatment combination of ethephon @ 300ppm with 3G pruning might be promotion of physiological processes like cell expansion, and metabolic changes during fruit growth due to ethylene and pruning might have directed more resources toward fruit development. This synergistic effect could be the major reason behind higher fruit width and weight of fruit with combination of ethephon with 3G pruning.

Conclusion

Foliar spray of ethephon 300ppm is better for promoting plant height, earliness in female flowers, number of female flowers, number of fruits harvested per plant and yield of cucumber. Among different types of pruning, 3G pruning is better in improving the performance of cucumber through increased number of female flowers, number of fruits and yield. Also, the combination of ethephon with 3G pruning is found to be beneficial for optimum yield of cucumber. Future research could be conducted investigating interactions on different growing seasons, different genotypes of cucumber and also on other cucurbit crops to improve the robustness and applicability of the findings.

Declarations

Author Contribution Statement

K.G.: Research design, Data collection, methodology, investigation, formal analysis, and writing the original draft

P.R.D.: Research design, supervision, conceptualization, methodology, review

K.B.: Data collection and investigation, Data analysis, review, and editing

S.B.R.: Data analysis, review, and editing

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

I would like to express my deep sense of gratitude to Sandesh Dhital and staffs of Agriculture Knowledge Center, Rupandehi for the encouragement, material acquisition, concern, constructive comments, and efforts during my research. I am also bound to acknowledge Agriculture and Forestry University, Prime Minister Agriculture Modernization Project for the opportunities on-field as well as off-field, monitoring, and mentorship provisions. I also appreciate the time for constructive criticisms and support of Mr. Puspa Raj Dulal, Mrs. Asmita Karki, Ms. Kalyani Shrestha, Mr. Binay Baral, Ms. Shristi Parajuli, Ms. Nikita Neupane and all the helping hands throughout the research.

References

Adams, P., Graves, C. J., & Winsor, G. W. (1992). Some responses of cucumber, grown in beds of peat, to N, K and Mg. *Journal of horticultural science*, 67(6), 877-884. https://doi.org/10.1080/00221589.1992.11516321

Al-Masoum ,A.A., Al-Masri, H. (1999). Effect of ethephon on flowering and yield of monoecious cucumber. *Egyptian J.Hort*, 26, 229-236.

Arora, S.K., Pandita, M., Pratap, P.S. and Barta, B.R. (1994). Response of long melon (Cucumis melo var. utilissimus) to foliar application of plant growth substances. *Indian Journal of Agricultural Sciences*, 64(12), 841-844. https://epubs.icar.org.in/index.php/IJAgS/article/view/29675

Arpan, H, (1974). The researches on effect of 2-Chloroethylophosphonic acid (Ethrel) on gender appearance and some other characters of cucumber. *Faculty of agricultural publication*, 165(99), 149-153.

Bantoc, G.B. (1964). Further studies on sex expression and sex ratio in cucumber as affected by plant regular spray. *Indian Journal. Hon*., 17, 210-216.

Baral, B., Shrestha, M., Subedi, S., Dulal, P.R., & Joshi, N.R. (2022). Effect of foliar spray of ethephon doses and pruning intensities on growth, sex expression, and yield of cucumber (var- Bhaktapur local) in Kaski, Nepal. *Archives of Agriculture and Environmental Science*, 7(3), 347-354, https://dx.doi.org/10.26832/24566632.2022.070307

Bhandary, K. R., Shetty, K. P. V., & Sulikeri, G. S. (1974). Effect of ethrel (2-chloroethyl phosphonic acid) on the sex expression and yield of cucumber (Cucumis sativus L.). *Prog Hortic*.

Chaurasiya, D. K., Kumar, M., Sahni, S., & Singh, S. (2020). 3G Cutting. A Wonderful Technique to Redouble the Production of Cucurbits. *Biotica Research Today*, 1308-1310.

Dhakal, S., Karki, M., Subedi, P., & GC, A. (2019). Effect Of Ethephon Doses On Vegetative Characters, Sex Expression and Yield Of Cucumber (Cucumis sativus cv. Bhaktapur Local) In Resunga Municipality, Gulmi, Nepal. *International Journal of Applied Sciences and Biotechnology*, 370–377. https://doi.org/10.3126/ijasbt.v7i3.25284

FAOSTAT. (2022). Retrieved from Food and Agriculture Organization of the United Nations website: https://www.fao.org/faostat/en/#data/QCL

Hayashi, T., Heins, R. D., Cameron, A. C., & Carlson, W. H. (2001). Ethephon influences flowering, height, and branching of several herbaceous perennials. *Scientia Horticulturae*, 91(3-4), 305-324.

Hossain, D., Karim, M., Pramanik, M., & Rahman, A. (2006). Effect of gibberellic acid (GA3) on flowering and fruit development of bittergourd (Momordicacharantia L.). *International Journal of Botany*, 329-332.

Ito, H., Hashimoto, K., & Saito, T. (1954). Factors responsible for the sex expression of Japanese cucumber. *Journal of the Japanese Society*, 25,141–151.

Kumar, K., Singh, D. P., Saini, P. K., & Yadav, R. K. (2019). Progress in Pruning to Vegetable Crops: A Review. *International Journal of Advances in Agricultural Science and Technology*, 6, 19-32.

Mardhiana, M., pradana, A. P., Adiwena, M., Kartina, K., Santoso, D., Wijaya, R., & Maliki, A. (2017). Effects of pruning on growth and yield of cucumber (Cucumis sativus) Mercy variety in the acid soil of North Kalimantan, Indonesia. *Cell Biology and Development*, 1(1), 13-17

Mia, B., Islam, S. & Shamsuddin H. (2014). Altered sex expression by plant growth regulators: An overview in medicinal vegetable bitter gourd (Momordicacharantia L.).J. *Med. Plants Res*.,8 (8), 361- 367.

Morgan, P. W., & Gausman, H. W. (1966). Effects of ethylene on auxin transport. *Plant Physiology*, 41(1), 45–52, https://doi.org/10.1104/pp.41.1.45.

Rafeekher, M., Nair, S. A., Sorte, P. N., Hatwal, G. P., & Chandhan, P. M. (2002). Effect of growth regulators on growth and yield of summer cucumber. J. *Soils Crops*, 12(1), 108-110.

Saifuddin, M., Hossain, A.B.M.S., Normaniza, O. (2010). Impacts of shading on flower formation and longevity, leaf chlorophyll and growth of Bougainville glabra. *Asian J Plant Sci*, 9, 20–27. https://doi.org/10.3923/ajps.2010.20.27

Seshadri, U. S. (1990). Cucurbits. In: T.K. Bose & M.G. Som (eds.) *Vegetable Crops in India*. Naya Prakashan, India., 91-154.

Shivaraj, D., Lakshminarayana, D., Prasanth, P., & Ramesh, T. (2018). Studies on the Effect of Pruning on Cucumber cv. Malini Grown Under Protected Conditions. *International Journal of Current Microbiology and Applied Sciences*, 7(03), 2019–2023, https://doi.org/10.20546/ijcmas.2018.703.237

Singh, S. (1984). Chemical sex modification and its effect on fruiting in cucumber (Cucumis sativus L.). *South Indian Horticulture*, 32(3), 127–131.

Suthar, M. R., Arora, S. K., Bhatia, A. K., Singh, V. P., & Malik, T. P. (2007). Effect of pruning and ethrel application on flowering behaviour of cucumber (Cucumis sativus L.) under polyhouse conditions. *Haryana Journal of Horticultural Sciences*, 36(1/2), 135-138.

Szyjewicz E, Rosner N and Kliewer WM (1984). Ethephon(2-chloroethyl) phosphonic acid, ethrel, CEPA in viticulturea review. *American journal of Enology and Viticulture*, 35(3), 117-123.

Thakur, O., Kumar, V., & Singh, J. (2018). A review on advances in pruning to vegetable crops. *International Journal of Current Microbiology and Applied Sciences*, 7(2), 3556-3565.

Usenik, V., Solar, A., Meolic, D., & Štampar, F. (2008). Effects of summer pruning on vegetative growth, fruit quality, and carbohydrates of 'Regina' and 'Kordia' sweet cherry trees on 'Gisela 5'. *European Journal of Horticultural Science*, 73(2), 62–68.