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Effect of Different Doses of Ethephon on Vegetative Characters, Sex Expression and Yield of Cucumber [*Cucumis Sativus]* In Rainas Municipality, Lamjung, Nepal

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ABSTRACT

This study was carried out at the research field of Rainas Municipality, lamjung, Nepal from February to June 2022. It was conducted to evaluate the effect of different doses of ethephon on vegetative character, sex expression and yield of cucumber. The experiment was laid out in Randomized Complete Block Design (RCBD) with 4 replications and 5 treatments (four different doses of ethephon @ 100 ppm, @ 300 ppm, @ 400 ppm and @ 500 ppm as well as water spraying as control). Spraying was done twice, the 1st at two true leaf stage and the 2nd at four true leaf stage. The observed data were analyzed using Gen stat and Duncan's Multiple Range Test (DMRT) to find out the significant differences between the mean values at 5% level of significance. Among various concentration of ethephon, the most potent doses of ethephon to increase female flower were 100 ppm, 300 ppm and 400 ppm. The treatment with 300 ppm ethephon result early emergence of female flower, higher number of female flower and lower sex ratio followed by 400 ppm. Yield of cucumber was found higher with 300 ppm ethephon comparison to other treatment. The benefit-cost ratio (B:C ratio) was found highest at 300 ppm ethephon treatment and lowest in the control group. Considering various impacts of different doses of ethephon, treatment with 300 ppm ethephon is recommended.

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Introduction

The cucumber (*Cucumis sativus* L.) (2n = 14) is vegetable that grows on a trailing vine, an annual member of the Cucurbitaceae family. It has numerous uses as vegetables and salad along with superb flavor, texture, and therapeutic potential (Sebastian et al., 2010). Cucumbers help avoid dehydration because they contain essential electrolytes. Cucumbers are a warm-season crop, which can be harmed by cold and frost and requires ideally 75^0 to 90^0 F for plantation in summer. Extremely high temperatures can result in bitterness and a pale green fruit color as well water-logged soil can disrupt the growth of cucumber (Brandenberger, 2021). It contains Cucurbitacins which inhibit the growth of cancer cells. Tyrosinase inhibition has been used as a moisturizer and skin toner (Ugwu & Suru, 2021). The cucumber vine is a creeper that produces cruciform fruits and grows on frames and trellises by twirling tendrils around them. Its plant can grow up to 2-3 meters in height, producing radial and tubular flower. The economic part is fruit which is generally cylindrical in shape and called as pepo in pomology (Vidhi, 2016). Cucurbit plants have distinct male and female flowers in different parts of the plant, and only the female flowers ripen into fruit. Male flowers are at base of plant whereas females are at base of stem which appearance is controlled by genetics and environmental condition (Dhakal et al., 2019).

Agriculture is the main source of food, income, and employment for most people, with 65.6% of economically active people working in agriculture where 9.71% is normally contributed by vegetables. (MoALD, 2021/22). Due to limited area coverage and unawareness of farmer about its flowering, the production and productivity of cucumber in Nepal is almost less than half of the world's average productivity (Agriculture Guide, 2023). To enhance cucumber production, PGRS (plant growth regulators) and pruning are ideal options. Plant production can be improved in a geometric ratio by 3G cutting in conjunction with ideal pollination condition on branches to increase the number of female flowers on plants (Bhandari, 2020). Growth regulators greatly influence vegetative traits, sex expression, and flowering. Cucumber's sex expression is influenced by its internal growth hormone levels, but can also be induced by applying external growth regulators (Singh and Singh, 1988). They are phyto-hormones which are often active at very low doses for development of plants (Singh et al., 2021).

Ethephon suits best for the growth of cucumber and its tremendous development and increase in yield. It was found superior @ 400 ppm for increasing the number of female flowers and inhibiting male flowers, and consequently increase the yield (Pandey et al., 2019). Exogenous application of PGRs effects on endogenous hormones of plant which alter the physiological processes of plants and reduces the harvesting time of the fruit (Gosai et al., 2020). The action of ethephon during the early stages of vine growth was anticipated because it releases ethylene, which has been linked to a decrease in auxin levels and an inhibitory influence on shoot growth (Liberman & Knegt, 1977). The anti- gibberellic feature of ethylene stops mitotic processes in the meristem of roots and shoots causes plants' decreased height (Hayashi, Cameron, & Carlson, 2001). Fruits dipped in Ethephon 1000 ppm (Kriphone 39%, 2.56 ml per liter of water) for five minutes were effective for banana ripening, so there is no need to use a higher dose. Fruits started to be soften in three days and became ready to consume in five days (KC et al., 2009).

Certain growth regulators cause plants to grow taller and their shoots to grow longer, while other growth regulators function as retardants, causing plants to lose their vegetative and reproductive characteristics. Precision agricultural production benefits from the use of growth regulators that promote growth as well as those that function as retardants (Waqas et al., 2019).

For making low male to female flower ratio and for increasing fruit set, exogenous ethephon spraying is must today. Moreover, Lamjung is area with suitable climate and soil for commercialization of cucumber vegetable. The right way and right dose of application of ethephon is yet to be precisely determined for the optimum production in our country. Therefore, this experiment was carried out to assess the effectiveness of different ethylene concentrations on the performance of cucumber in Lamjung, Nepal.

Method and Methodology

Site Description

The experiment was conducted at Rainas Municipality-8, Lamjung district, Gandaki province, Nepal (Figure 1). This region lies in Subtropical mid hill of Nepal situated within 28° 48' North latitude to 84° 28' east longitude with an altitude of 600 masl. The study was carried out from 1st week of March 2022 to June 2022. The weather condition of the experiment site for the research plot was taken from secondary source (Department of Hydrology and Meterology, Ministry of energy, Water resource and Irrigation, Babarmahal, Kathmandu, Nepal, 2022). During the research period, the mean temperature and precipitation recorded on the field was 23.54°C and 1.2-15.4 mm respectively (Figure 2).

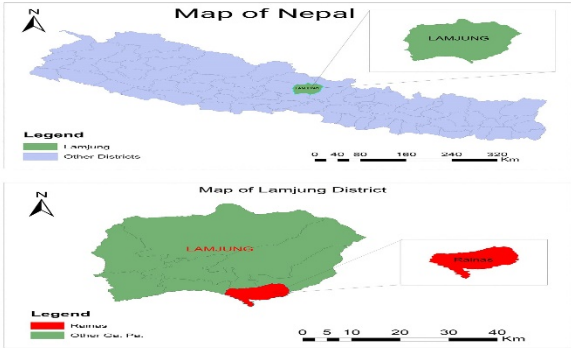

Figure 1. Map showing Lamjung district and research site

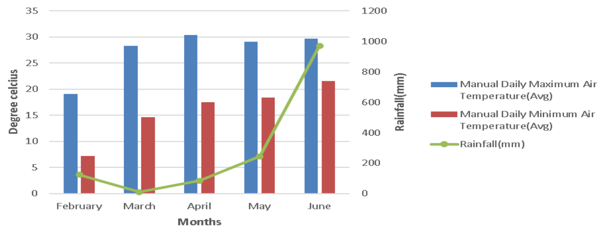

Figure 2. Weather condition of the research site at Lamjung from February to June, 2022

Experimental Design

The experiment was conducted in Randomized Complete Block Design (RCBD) with 5 treatments and each treatment was replicated 4 times. Individual plot was 5.5 m in length and 3m in breadth. Spacing was 2×1.5 m^2, in which plot will consist of two rows with four plants each. Net experimental plot area will be 16.5 m^2, space between replication was 1m and 50 cm in border, thus total area 535.5 m^2.

Seedling Preparation and Transplantation

The cucumber seeds were planted on the tray for germination on 4th March 2022. The medium was prepared by mixing vermiculite, coco-peat, soil and perlite at a ratio of 3:1:1:1; the amount was as set as required. The tray was kept under seedling tunnel inside which temperature was 23°-25°C where it was protected and regular watered. The seedlings were ready for transplantation after 20 days as 2-3 true leaves appeared on all the seedlings and attained a height of about 3-4 inches. The seedlings were transplanted in the well-prepared main field on 26th March 2022 in given spacing. Manual weeding was done three times at 20 DAP (Days after planting), 30 DAP and 40 DAP. Irrigation was done through surface irrigation system as per plant requirement.

Experimental Materials

The experimental materials which was used for the investigation comprised of Bhaktapur local variety of Cucumber. Different concentration of ethephon (2-chloroethyl phosphonic acid) was applied to study its effect on vegetative character, flowering, yield and quality traits of cucumber.

Stages of plant with two and four true leaf were given different doses of ethephon that were prepared in the lab. Only the freshly prepared solutions have ethephon 39% S.L- a commercial form of ethephon. First, the weighted amount of chemicals was dissolved and the necessary amount of distilled water was added to create the stock solution of 1000 ppm for ethephon. It was diluted to 125 ppm, 250 ppm, 375 ppm, and 500 ppm using distilled water at the time of foliar application for solution of various concentration. Sticker (surfactant) was used at concentration of 0.25% in volume to increase the effectiveness of application of ethephon. A sufficient amount of ethephon was sprayed on the shoot until runoff.

Treatment of Experiment

There were total of 5 treatments of different doses of ethephon replicated four times.

T1	Check
T2	100 ppm dose of ethephon
T3	300 ppm dose of ethephon
T4	400 ppm dose of ethephon
T5	500 ppm dose of ethephon

Manuring and Fertilizer

The recommended dose of nitrogen, phosphorus and potassium is 140:40:100 kg/ha, was applied along with well-decomposed FYM (farm yard manure). Full dose of FYM, DAP (di-ammonium phosphate) and MOP (murate of potash) and half of recommended urea was applied as basal dose and remaining urea was top-dressed in split application at different vegetative stages. Staking was arranged in; single row trellis type such that a rope was run along the plant line and remain held by poles fixed at the ends.

Data Collection and Analysis

Among 8 plants, randomly selected 4 sample plants in each plot were observed for data collection to record vegetative characteristics, flowering behaviors and yield of each plot. Vegetative observation was done by measuring length of main stem (cm), number of primary branches per vine and number of nodes on main stem and calculating their average. This was recorded five times in the interval of 15 days beginning from 30 DAT (days after transplanting). For observation of sex expression, we recorded days to first female and male flower emergence after sowing, node number for emergence of first female and male flower, number of female and male flower per plant, sex ratio and calculated their average. For yield observation, Fruit length(cm), fruit circumference (cm), number of fruit per plant, fruit weight per vine (cm), fruit yield per hectare (mt/ha) was measured and average was calculated.

Data was entered using MS Excel and one-way ANOVA of the treatment was done by using G-stat. The significance of the difference among the means was evaluated by Duncan's Multiple Range Test (DMRT) by (Gomez and Gomez, 1984) for interpretation of the result at a 5% level of probability.

To assess the economic feasibility of the research, benefit cost analysis (BCA) was applied encompassing research activities. It involves identifying, quantifying and comparing the expected benefits and costs associated with research which supports in decision-making, resource allocation and proper justification. In this experiment, BCA of using different dose of ethephon was carried out by using formula:

B/C ratio = (Gross return / Variable cost)

Results and Discussion

Vegetative Characters

At 90 DAS (days after sowing), maximum plant height was observed with control (279.5 cm) while the minimum height with ethephon @500 ppm (256.1 cm) (Table 1). Similar results were found at 30 DAS, 45 DAS, 60 DAS and 75 DAS. Duncan's Multiple Range Test (DMRT) at $p<0.05$ shows similarities among ethephon concentration @400 ppm and @500 ppm while ethephon @100 ppm and @300 ppm are being statistically par at 90 DAS. For branching, at 90 DAS, the maximum number of branches were seen in case of 300 ppm (5.34) followed by 100 ppm (4.83), 400 ppm (5.42), 500 ppm (4.34) and least number of branches were found in control (3.92) (Table 2). Duncan's Multiple Range Test (DMRT) at $p<0.05$ shows similarities among ethephon concentration @400 ppm and @500 ppm at 90 DAS. Then for node number, at 90 DAS, the maximum number of nodes were seen in case of 300 ppm (44.33) followed by 400 ppm (44.25), 100 ppm (43.00), 500 ppm (42.33) and least number of nodes were found in control (40.42) (Table 3). Similar trend was seen on 30 DAS, 45 DAS, 60 DAS and 75 DAS. DMRT at $p<0.05$ shows that 300 ppm was statistically at par with 400 ppm.

Table 1. Plant height at various days after Sowing

Concentration of ethephon	Plant height at various days after Sowing in cm				
	30 DAS	45DAS	60DAS	75DAS	90 DAS
Control	38.500^{a}	85.50^{a}	186.2^{a}	266.8^{a}	279.5^{a}
100 ppm	34.67^{b}	78.92^{ab}	181.8^{ab}	259.7^{ab}	271.5^{ab}
300 ppm	34.67^{b}	75.75^{bc}	171.1^{bc}	253.4^{abc}	265.2^{ab}
400 ppm	34.75^{b}	76.25^{bc}	169.2^{c}	247.3^{bc}	262.1^{ab}
500 ppm	34.08^{b}	71.33^{c}	163.1^{c}	244.2^{c}	256.1^{b}
GM	35.43	77.55	174.3	255.37	266.9
SEM	1.011	3.051	3.63	4.25	5.39
LSD	3.1157	6.647	11.19	13.10	16.60
CV%	5.70	5.60	4.20	3.3	4.0
F test	*	**	**	**	*

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance.

Table 2. Effect of different dose of ethephon on number of primary branches/ vine

Concentration of ethephon	Effect of different dose of ethephon on number of primary branches/ vine				
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Control	0.25[a]	1.333[b]	2.583[bc]	3.833[d]	3.917[c]
100 ppm	0.1667[a]	1.750[a]	2.750[abc]	4.417[b]	4.833[b]
300 ppm	0.333[a]	1.833[a]	3.250[a]	5.167[a]	5.333[a]
400 ppm	0.5[a]	1.583[ab]	3.000[ab]	4.167[bc]	4.417[bc]
500 ppm	0.25[a]	1.417[b]	2.417[c]	3.917[cd]	4.333[bc]
Grand mean	0.300	1.583	2.800	4.300	4.567
SEM	0.1498	0.0998	0.2453	0.0900	0.1574
LSD	0.4617	0.3074	0.5345	0.2773	0.4849
CV%	99.9	12.6	12.4	4.2	6.9
F test	NS	**	**	***	***

Means followed by common letter(s) within column are non-significantly different based on Duncan's Multiple Range Test (DMRT) at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Table 3. Effect of different dose of ethephon on number of node

Concentration of ethephon	Effect of different dose of ethephon on number of node				
	30 DAS	45DAS	60 DAS	75DAS	90 DAS
Control	5.250[a]	14.83[a]	23.50[b]	40.00[c]	40.42[c]
100 ppm	5.917[a]	15.08[a]	23.92[ab]	42.42[ab]	43.00[ab]
300 ppm	6.583[a]	15.92[a]	24.17[ab]	43.58[a]	44.33[a]
400 ppm	7.417[a]	17.08[a]	25.42[a]	43.50[a]	44.25[a]
500 ppm	6.167[a]	15.25[a]	23.75[ab]	41.83[b]	42.33[b]
Grand mean	6.27	15.63	24.15	42.27	42.87
SEM	0.812	0.773	0.533	0.466	0.480
LSD	2.502	2.380	1.641	1.437	1.479
CV%	25.9	9.9	4.4	2.2	2.2
F test	NS	NS	*	**	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Table 4. First Flowering Date

Concentration of ethephon	First Flowering Date (DAS)	
	Male	Female
Control	31.17[c]	45.92[a]
100 ppm	34.42[b]	43.67[b]
300 ppm	35.92[ab]	42.50[c]
400 ppm	35.92[ab]	42.33[c]
500 ppm	37.17[a]	43.83[b]
Grand mean	34.92	43.65
SEM	0.756	0.255
LSD	2.329	0.787
CV%	4.3	1.2
F test	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Sex Expression

Earliest male flowering (31.17 DAS) was seen in control followed by 100 ppm (34.42 DAS) and later male flowering (37.17 DAS) was seen in 500 ppm which is statistically at par with 400 ppm and 300 ppm (Table 4). Likewise, earliest female flowering (42.33 DAS) was seen in 400 ppm which is statistically similar with 300 ppm (42.50 DAS). The later female flowering (45.92 DAS) was seen on control. Application of ethephon @ 500 ppm produced male flower at upper nodes (4.84) compared to other treatments being at par with 400 ppm (4.67) (Table 5). Control produced male flower at lower nodes (3.25) followed by 100 ppm (3.50). In case of female flowers 500 ppm produced female flowers in lowest node (5.58) being at par with 400 ppm (6.17) and control produced female flowers in uppermost nodes (8.58) being at par with 100 ppm (8.08). The highest number of male flower (38.75) was obtained in control. And least number of male flower was obtained in 400 ppm (24.00) (Table 5). Plant treated with 300 ppm produced highest number of female flowers (22.25) per plant compared with higher and lower concentrations. Similarly, lowest number of female flowers were found in control (12.50). Highest sex ratio (3.106) was found in control while lowest sex ratio was found in 400 ppm (1.100) (Table 6).

Table 5. First Flowering node

Concentration of ethephon	First Flowering node	
	Male	Female
Control	3.25[d]	8.583[a]
100 ppm	3.5[c]	8.083[a]
300 ppm	4.25[b]	6.667[b]
400 ppm	4.667[a]	6.167[bc]
500 ppm	4.833[a]	5.583[c]
Grand mean	4.1	7.02
SEM	0.0761	0.260
LSD	0.2344	0.800
CV%	3.7	7.4
F test	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Table 6. Total male flower, female flower and sex ratio

Concentration of ethephon	Total male flower, female flower and sex ratio		
	Male flower	Female flower	Sex ratio
Control	38.75[a]	12.50[c]	3.106[a]
100 ppm	29.83[b]	19.25[b]	1.568[b]
300 ppm	25.33[c]	22.25[a]	1.148[c]
400 ppm	24.00[c]	21.83[a]	1.100[c]
500 ppm	24.08[c]	20.08[ab]	1.199[bc]
Grand mean	28.40	19.18	1.624
SED	0.761	0.737	0.0695
LSD	2.346	2.270	0.2140
CV%	5.4	7.7	8.6
F test	***	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Table 7. Average fruit length and Circumference

Concentration of ethephon	Average fruit length and Circumference in cm	
	Circumference	Length
Control	22.77[d]	24.34[a]
100 ppm	23.93[c]	24.04[a]
300 ppm	25.91[a]	22.99[b]
400 ppm	26.51[a]	22.92[b]
500 ppm	24.90[b]	22.13[c]
Grand mean	24.80	23.29
SEM	0.225	0.232
LSD	0.693	0.716
CV%	1.8	2.0
F test	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance.

Yield

The highest fruit length was obtained in control (24.34 cm) being at par with 100 ppm (24.04 cm) followed by 300 ppm (22.99 cm) and 400 ppm (22.92 cm) while lowest fruit length was obtained in 500 ppm (22.13 cm) (Table 7). Fruit weight in 400 ppm (511.90 g) was found superior to other treatment being statistically similar with 300 ppm (510.80 g) followed by 500 ppm (496.80 g) (Table 8). Control had least fruit weight (477.70 g) being at par with 100 ppm (482.0). Similarly, Highest fruit number was seen in 300 ppm (12.17) followed by 400 ppm (12.08) and higher or lower concentrations had decreasing fruit number and least number of fruits was seen on control (9.25).

All application of ethephon and water spray are profitable. The BC ratio was affected by application of ethephon as with increase in level of ethephon there was increase in BC ratio upto 300 ppm (4.604) and beyond 300 ppm there was decrease in bc ratio. The minimum BC ratio was found in control (3.272).

All doses of ethephon sprayed on plant showed significant differences in the vegetative development of the plants as compared to control treatment. Although ethephon @300 ppm was found to be most effective for maximum branching and node number, control or no application of ethephon was found to be effective for maximum height.

Table 8. Individual fruit weight and number of fruit per plant

Concentration of ethephon	Individual fruit weight and number of fruit per plant		
	Weight(gm)	Number	Yield(mt/ha)
Control	477.70[b]	9.25[c]	14.73[c]
100 ppm	482.0[b]	11.08[b]	17.81[b]
300 ppm	510.8[a]	12.17[a]	20.72[a]
400 ppm	511.9[a]	12.08[a]	20.61[a]
500 ppm	496.8[ab]	11.33[ab]	18.80[b]
Grand mean	495.9	11.18	18.53
SEM	6.52	0.283	0.549
LSD	20.08	0.873	1.692
CV%	2.6	5.1	5.9
F test	**	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

Table 9. Total cost (NRS lakh/ha), total revenue (NRS lakh/ha), net revenue (NRS lakh/ha) and b: c ratio

Concentration of ethephon	Total cost (NRS lakh/ha), total revenue (NRS lakh/ha), net revenue (NRS lakh/ha) and b:c ratio			
	Cost of cultivation	Total revenue	Net revenue	B:C ratio
Control	1.8	5.890[c]	4.090[c]	3.272[c]
100 ppm	1.8	7.122[b]	5.323[b]	3.957[b]
300 ppm	1.8	8.288[a]	6.488[a]	4.604[a]
400 ppm	1.8	8.242[a]	6.443[a]	4.579[a]
500 ppm	1.8	7.519[b]	5.719[b]	4.177[b]
GM		7.412	5.613	4.118
SEM		0.2196	0.2196	0.1220
LSD		0.6768	0.6768	0.3760
CV%		5.9	7.8	5.9
F test		***	***	***

Means followed by common letter(s) within column are non-significantly different based on DMRT at P=0.05; LSD, Least Significant Difference; SEM, Standard Error of Mean; CV, Coefficient of Variation; DAS, Days After Sowing; NS, Non-Significant, * significant at 5% level of significance, ** significant at 1% level of significance, *** significant at 0.1% level of significance

This result is found to support the research conducted in *Cucumis sativus* by Dhakal et al. (2019). The reduced height of plants may be due to ethylene's anti gibberellic property, which stops mitotic processes in the root and shoot's meristem, impacting plant length (Hayashi et al., 2001). During the initial stage of vine development, the anticipated impact of ethephon was based on its ability to release ethylene, as the inhibitory effect of ethylene on shoot growth has been linked to the decrease in levels of auxin (Liberman and Knegt, 1977). Ethephon at 300-400 ppm proved superior to its higher levels and control for increasing number of branches and nodes. This may be related to fact that ethephon at 300 and 400 ppm reduced plant height to a greater extent as compared to higher concentrations. A significant alteration in the physical characteristics of plants, characterized by increased branching, which could be attributed to modifications in the nuclear genomes, was documented by Selga and Selga (1993) and Rafeekhar et al. (2001). The increased number of nodes due to ethephon treatment may be attributed to reduction in inter nodal distance by suppressing cell division (Dhakal et al., 2019).

With increasing level of ethephon first male flower appearance delayed while female flowering was enhanced. It showed similar result of earliness to female flowering within ethephon application is in agreement with Pandey, (2019). According to Singh & Singh (1984), reason for earliest production of female may be attributed to the maximum increase in starch and carbohydrate with ethephon treatments. On other side, with an increase in ethephon dosage, it demonstrated a trend of rising nodes for first male and falling nodes for first female. Early appearance of female flowers on lower nodes and delayed induction of male flowers on upper nodes with different concentrations of ethephon is in confirmation with the result of Nikumbh and Musmade (2006) with 100 ppm in cucumber and Ranjit and Satya (2006) with 250 ppm in pumpkin.

Total number of male flowers decreased with increasing dose and vice versa for total number of female flowers. Sex ratio was highest in no application of ethephon and lowest at high dose of its application. This result was found similar with decrease in number of male flowers with narrow sex ratio due to application of ethephon given by Bhandary (1974). Little et al. (2007) proved the dual role of ethylene in both sex determination and subsequent carpel maturation in melon. PGR application at the crucial stages of two and four leaf stages, which determine whether to promote or suppress both sexes, is essential for the variations of the sex ratio (Hossain et al., 2006).

With application increasing ethephon concentration fruit length decreased and fruit circumference increased significantly. The decrease in fruit length and increase in fruit circumference with ethephon treatment is in agreement with Dhakal et al. (2019). However, highest fruit number, weight and yield was obtained from plant applied with @300 and @400 ppm dose of ethephon and lowest in control. The increase in yield was predominantly due to increased number of pistillate flowers, fruit number and was also linked to increase in fruit diameter and average fruit weight (Patrick, 1982). Yield in 300 ppm was found almost twice compared to control according to Dhakal et al. (2019).

Conclusion

The research findings show that among different concentrations of ethephon; 300 ppm and 400 ppm were found effective. As the concentration of ethephon increased, the length of the main stem decreased. The treatment with 300 ppm ethephon resulted in the highest number of primary branches per vine and the highest number of nodes on the main stem. Furthermore, the application of 300 ppm ethephon led to the early emergence of female flowers, an increased number of female flowers, and a lower sex ratio. In terms of cucumber yield, it was higher with the 300 ppm ethephon treatment compared to others. The benefit-cost ratio (B: C ratio) was the highest with the 300 ppm ethephon treatment and lowest in the control group. This study recommends 300 ppm ethephon as the best alternative for inducing female flowers and increasing yield.

Declarations

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References

Ahmad, W., Awais, H. A., & Muzafar, S. (2019). Behavior of cucumber plants under the application of different growth regulators: A review. *International Journal of Research*, 16-19.

Bhandari, Barsha, and Name. “3G Cutting in Plants.” *Lean Agro*, 3 Dec. 2020, learnagro.com/3g-cutting-in-plants/#:~:text=Procedure%20for%203G%20cutting%20%28Steps%20of%203G%20cutting%29,their%20number%20up%20to%203-4%20branches.%20More%20items.

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

Brandenberger, L., Shrefler, J., Rebek, E., & Damicone, J. (2021). Cucumber Production.

Cucumber: Production and varieties, India.Vidhi J, 2016 https://www.biologydiscussion.com/vegetable-breeding/cucumber-origin-production-and-varieties-india/68566

Dhakal, S., Karki, M., Subedi, P., & Aarati, G. C. (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*, 7(3), 370-377. https://doi.org/10.3126/ijasbt.v7i3.25284.

Dostogir Hossain, D. H., Karim, M. A., Pramanik, M. H. R., & Rahman, A. A. M. S. (2006). Effect of gibberellic acid (GA3) on flowering and fruit development of bitter gourd (Momordica charantia L.).

Economic Survey 2020/21 - Ministry of Finance, www.mof.gov.np/uploads/document/file/1633341980_Economic%20Survey%20(Engslish)%202020-21.pdf. Accessed 19 Mar. 2024.

Gosai, S., Adhikari, S., Khanal, S., & Poudel, P. B. (2020). Effects of plant growth regulators on growth, flowering, fruiting and fruit yield of cucumber (Cucumis sativus L.): A review. *Archives of Agriculture and Environmental Science*, *5*(3), 268-274. DOI:10.26832/24566632.2020.050306

Hayashi, Takahiro, et al. “Ethephon influences flowering, height, and branching of several herbaceous perennials.” *Scientia Horticulturae*, vol. 91, no. 3–4, Dec. 2001, pp. 305–324, https://doi.org/10.1016/S0304-4238(01)00225-4

STATISTCAL INFORMATION ON NEPALESE AGRICUTURE 2078/79 (2021/22) https://moald.gov.np/wp-content/uploads/2023/08/Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22.pdf

Kumar, J. R. Influence of Ethephon on Vegetative Character, Flowering Behaviour and Sex Expression of Cucumber in Pokhara Lekhnath, Kaski.

Lieberman, M., & Knegt, E. (1977). Influence of ethylene on indole-3-acetic acid concentration in etiolated pea epicotyl tissue. *Plant Physiology*, *60*(4), 475-477. https://doi.org/10.1104/pp.60.4.475

Little, H.A., Papadopoulou, E., Hammar, S.A. *et al.* The influence of ethylene perception on sex expression in melon (*Cucumis melo* L.) as assessed by expression of the mutant ethylene receptor, *At-etr1-1*, under the control of constitutive and floral targeted promoters. *Sex Plant Reprod* 20, 123–136 (2007). https://doi.org/10.1007/s00497-007-0049-5.

Morris Lieberman, Erik Knegt, Influence of Ethylene on Indole-3-acetic Acid Concentration in Etiolated Pea Epicotyl Tissue, *Plant Physiology*, Volume 60, Issue 4, October 1977, Pages 475–477, https://doi.org/10.1104/pp.60.4.475

Nikumbh, M. P., Musmade, A. M., & More, T. A. (2006). Effect of ethrel and fruit pickings on growth characters of cucumber (Cucumis sativus L.) cv. Himangi

Rafeekher, M., Gondane, S. U., Goramnagar, H. B., Murkute, A. A., Chaudhari, D. U., & Patil, R. R. (2001). Hormonal regulation of growth, sex expression and yield of cucumber in kharif season.

Ram, B. K. C., Gautam, D. M., & Tiwari, S. (2009). Use of Ethephone and indigenous plant materials in ripening banana in winter. *Nepal Agriculture Research Journal*, *9*, 113-117.

Ranjit Chatterjee, R. C., & Satya, P. (2006). Sex expression and phenotypic performance of local pumpkin cultivars as influenced by ethrel application.

Sebastian, P., Schaefer, H., Telford, I. R., & Renner, S. S. (2010). Cucumber (Cucumis sativus) and melon (C. melo) have numerous wild relatives in Asia and Australia, and the sister species of melon is from Australia. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(32), 14269–14273. https://doi.org/10.1073/pnas.1005338107

Selga, T. A., & Selga, M. P. (1993). Effect of ethylene producer Camposan M on the genome and morphogenesis of plants.

0Singh,G. P.and Singh,R. K., 19851641061, English, Journal article, 32, (3), South Indian), Chemical sex modification and its effect on fruiting in cucumber (Cucumis sativus L.). Horticulture, (127–131

Ugwu, C.E., & Suru, S.M. (2021). Cosmetic, Culinary and Therapeutic Uses of Cucumber (Cucumis sativus L.). *Cucumber Economic Values and Its Cultivation and Breeding*.